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COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVI JANUARY, 1911 No. 1

GEORGE WESTINGHOUSE TELLS OF THE INVENTION AND DEVELOPMENT OF THE AIR BRAKE

Perhaps the most notable event of the annual meeting (Dec., 1910) of the American Society of Mechanical Engineers, was the address by the President of the Society, Mr. George Westinghouse, giving his account of the invention of the air brake. We present here an abstract of the essential portions of this address.

Mr. Westinghouse was first led to apply his mind to the devising of means for the braking and control of trains in 1866, by a collision on the road between Schenectady and Troy which resulted in his detention for a couple of hours. He first tried familiar and obvious devices which already in some form had been tried by others and he concluded that he would have to seek success in other directions.

He goes on to say: Shortly after I had reached this conclusion, I was induced by a couple of young women who came into my father's works to subscribe for a monthly paper, and in a very early number, probably the first one I received, there was an account of the tunneling of Mount Cenis by machinery driven by compressed air conveyed through 3,000 feet of pipes. This account of the use of compressed air instantly indicated that brake apparatus of the kind contemplated for operation by steam could be operated by means of compressed air upon any length of train, and I thereupon began actively to develop drawings of apparatus suitable for the purpose and in 1867 promptly filed a caveat to protect the invention.

At that time no compressed air of importance had within my knowledge been put in operation. The apparatus was laboriously constructed in a machine shop in Pittsburgh, and completed in the Summer or early Autumn of 1868. This apparatus consisted of an air pump, a main reservoir into which air was to be compressed for the locomotive equipment, and four or five cylinders to be put under the cars, with the necessary piping, all so arranged that their operation as upon a train could be observed. Railway officials were then invited to inspect the apparatus and witness its operation, and the Superintendent of the Panhandle Railroad, Mr. W. W. Card, offered to put the Steubenville accommodation train, a locomotive and four cars, at my disposal. Upon its first run after the apparatus was attached to the train, the engineer, Daniel Tate, on emerging from the tunnel near the Union Station in Pittsburgh, saw a horse and wagon standing upon the track. The instantaneous application of the air brakes prevented what might have been a serious accident, and the value of this invention was thus quickly proven and the air brake started upon a most useful and successful career.

In the development and introduction of the air brake, I was controlled by the apparent fact that the apparatus would have to be uniform upon all cars to provide for the convenient change of the composition of trains. It also was most obvious, in view of the crying demand for some better means for stopping trains, that some power brake would inevitably be universally applied to all of the cars and engines upon all railways. These ideas naturally involved a further one, namely, the importance of having all of the brake apparatus made by one company, so as to insure absolute uniformity and consequent interchange-ability, and this led to the formation of the Westinghouse Air Brake Company early in 1869.

The essential parts of the air brake as first applied were:

An air-pump driven by a steam engine receiving its supply from the boiler of the locomotive;

A main reservoir on the locomotive into which air was compressed to about 60 or 70 lbs. pressure per square inch;

A pipe leading from the reservoir to a valve mechanism convenient to the engineer;

Brake cylinders for the tender and each car;

A line of pipe leading from the brake valve under the tender and all of the cars, with a pipe connection to each brake cylinder;

Flexible hose connections between the cars provided with couplings having valves which were automatically opened when the two parts of the couplings were joined and automatically closed when the couplings were separated.

The piston of each cylinder was attached to the ordinary hand-brake lever in such a manner that when the piston was thrust outward by the admission of compressed air, the brakes were applied. When the engineer had occasion to stop his train, he admitted the air from the reservoir on the locomotive into the brake cylinders through the train pipe. The pistons of all cylinders were, it was then supposed, simultaneously moved to set all of the brakes with a force depending upon the amount of air admitted.

To release the brakes, the handle of the brake valve was moved so as to cut off communication with the reservoir and then to open a passage from the brake pipe to the atmosphere, permitting the air which had been admitted to the pipes and cylinders to escape.

The success of the apparatus upon the first train was followed by an application of an equipment to a train of six cars on the Pennsylvania Railroad. The train was run to Altoona and the air brakes were used exclusively for controlling the speed of the train on the eastern slope of the Alleghenies, and special stops were made at the steepest portions of the line in such an incredibly short distance (as we all thought then) as to firmly establish in the minds of all present the fact that trains could be efficiently and successfully controlled by means of brakes operated by compressed air.

Mr. Westinghouse then enumerates a number of demonstrations of the brake upon different roads, followed at once by a great rush of orders for equipment.

I refer to these details, he says, to illustrate the readiness with which railway officials took up this invention and the comparative ease with which the required orders were secured, and because it has been often stated that the trials and tribulations in the introduction of the brake were of the severest nature.

It soon developed that it took considerable time to apply the brakes with full force and a longer time to release them, and that in the event of a break-in-two of a train (a frequent occurrence in those days) the rear section would be uncontrolled, and when this occurred upon an ascending gradient, the rear detached section might run away with disastrous results. To overcome this difficulty a new development was necessary, the outcome of which was what has since been known as the automatic air brake.

In the automatic air brake equipment there were the same air-pump, reservoir, train pipe and brake cylinder, but in addition to these there were two important features added to the tender and each car equipment; the first, an auxiliary reservoir, and the second, a triple valve or device interposed between the brake pipe, brake cylinder and auxiliary reservoir. This triple valve was so constructed that when air was admitted to the train pipe, an opening was established between the train pipe and the auxiliary reservoir whereby the train pipe and reservoir were filled with air under pressure. The valve also opened a passage from the brake cylinder to the atmosphere. This was the normal condition of the apparatus when the brakes were off. To apply the brakes, the engineer discharged a portion of the air from the train pipe, whereupon the triple valve closed the connection between the brake pipe and the reservoir and between the brake cylinder and the atmosphere and then opened a passage from the auxiliary reservoir to the brake cylinder, the piston of which was moved outwardly by the air from the auxiliary reservoir so as to apply the brakes. The restoration of the pressure within the brake pipe released the brakes and recharged the reservoir. The development occurred during 1872 and 1873.

The automatic brake was at that time supposed to be instantaneous in its action in applying the brakes, and almost instantaneous in releasing them. In the event of the escape of air from the train pipe by its rupture or by the separation of the train, the air stored in the auxiliary reservoirs instantly and automatically applied the brakes to all parts of the train and they could only be released by either repairing the damage and restoring the pressure, or by means of special release valves operated by the train men.

The automatic brake having proved itself vastly superior to the plain or straight air brake first described, it soon became a standard, but during the transition period an automatic brake was easily converted into a plain brake by a manually operated special valve arranged in the casing of the triple valve.

As a part of the automatic air brake passenger equipment, I had developed in the '70s a system of train signalling involving the use of a second train-pipe, which is now in general use upon all of the railways. This signalling apparatus had a sensitive valve device connected to a small reservoir upon the locomotive and these were so arranged that when compressed air was admitted through a small opening into the signalling pipe, both the pipe and reservoir were charged to a low pressure (at the present time at 45 lbs.). By opening a valve at any point in the train to permit a small quantity of air to escape from the signal pipe, the delicate valve referred to was caused to move so as to admit air from its auxiliary reservoir to blow a whistle located in the cab of the locomotive. It was found upon experimentation that when the valve in any car remote from the engine was quickly opened and closed as many as five times, the whistle would be blown an equal number of times, the first time being after the last escape of air; that is to say, there were set in motion five distinct waves of air each capable of doing work.

During these developments it was found that the waves of air within the brake pipe travelled as rapidly as sound, *i. e.*, about 1100 feet a second.

Being fully impressed with the idea that if the wave of air which was utilized for signalling could be made to operate the triple valves upon the cars, there would then be an almost instantaneous application of the brakes upon the front, rear and other portions of the train, this idea, with hard work and a large number of experiments, shortly produced what is now known as the quick-action automatic brake.

No sooner had the quick action automatic brake been developed to operate successfully on trains of fifty cars than new conditions were presented. Steel freight cars carrying enormous loads had in the meantime been developed and freight locomotives had been increased in capacity, so that trains were often composed of seventy to eighty cars, and more recently some trains have had as high as one hundred cars. This possibility had, however, been foreseen and experiments were constantly being carried on to so improve the apparatus, that it could be used to control trains of any practical length, and these experiments also had in view the more nearly instantaneous action of the brakes for ordinary service purposes than was possible with the automatic brake or with the quick action brake. The result was a most important development.

The present improved triple valve has the emergency feature, but it also has what is known as the quick-service application feature, that is, for ordinary purposes the air is admitted to all of the brake cylinders so quickly that the longest freight train can be handled with almost the precision obtainable in the control of passenger trains of from six to twelve cars.

In the matter of the development of the brakes for operation upon passenger trains, nothing that skill and perseverance could suggest has been omitted in securing the highest degree of perfection. The requirements during the past few years, by reason of the greater weight of cars and locomotives and of the higher speeds at which they are run, have necessitated the redesigning of all of the passenger train brake apparatus, including the method of attaching the brake shoes to the cars and the levers and connections for bringing these shoes to bear with the required pressure upon the wheels. For the purpose of insuring the highest efficiency, every wheel of a passenger train, including those under the locomotive, is now acted upon, whereas formerly many of the master mechanics and engineers were apprehensive that it would not be possible to make use of all of the wheels of a locomotive for braking purposes.

During the past twelve months, most elaborate tests of the latest form of apparatus for passenger service have been carried out under the direction of officials of several railways and of the Westinghouse Air Brake Company, in order to prove the operativeness of the new constructions and their capability to insure the highest degree of efficiency.

I have spoken of four chief developments. It has been necessary, in order to avoid disastrous consequences, that each development should be of such a kind that cars fitted with newer apparatus could operate with little inconvenience with cars fitted with earlier apparatus. As it stands to-day, scarcely any of the old type of brake and the first type of automatic brake are in use, but should a car fitted with the first form of automatic brake be found and put into a train with the more modern apparatus, such older apparatus would be found to operate fairly well with the more perfect form. The prevailing idea in the development and introduction of the brake has therefore been an adherence to such uniformity of apparatus that the interchange of traffic over various roads could go on uninterruptedly.

There is probably no apparatus in use today which received such thoughtful consideration and has been the object of such care in every one of its details as what is now popularly known as the air brake, and which is in universal use in the United States and in many other countries of the world.

In my estimation, there could be no better illustration of the value of the maintenance of standards than has been given by the manufacture and introduction of air brakes upon railways, for without such standards, train brakes would not have come into general use, with consequences which railway officials and the public can well appreciate.

My story would be incomplete without a reference to the splendid assistance which the railways of this and many other countries have rendered. They have been lavish in providing those facilities for making the thousands of tests which were necessary to progress in the developments I have recited; to the Pennsylvania Railroad especially, upon which the most important experiments were first made, the other railways of the country, as well as the traveling public, owe a debt of gratitude. When a railway (as did the Southern Pacific two years ago) provides a new train of one hundred steel cars to be fitted with the newer form of automatic brake, in order to carry on, with a staff of skilled men under the direction of the chief officers of the company, a series of experiments upon its heaviest gradients, requiring several weeks, for the purpose of securing greater safety and an increased carrying capacity per train, with the consequent lessening of the cost of transportation, it is just that the managers of such a corporation should receive credit for their farsighted policy. To name the railways and to merely state chronologically the tests of brakes which have been made during forty years would require several volumes.

TRANSPORTING LIVING ANIMALS IN WATER JARS CHARGED WITH OXYGEN

By Dr. Raymond C. Osborn, Assistant Director of the New York Aquarium.

A very interesting experiment in the transportation of aquarium specimens has recently been made by Mr. Emil Gundelach, of Gehlberg, Germany, with the assistance of the New York Aquarium. Arrangements were made through the forwarding house of Oelrichs & Co., of New York, for the shipment of living specimens from the Aquarium to Mr. Gundelach's home in Germany.

Sixteen 3-liter glass jars were filled with water and the specimens introduced. The jars were then inverted under water, as in a pneumatic trough, and oxygen gas was introduced to replace the water until the jars were about one-third full of the oxygen. The jars were then tightly corked and covered with parchment to prevent an escape of the gas. They were packed in crates and shipped at once on the North German Lloyd steamer, *Kaiser Wilhelm der Grosse*, on the morning of September 13.

The list of specimens for this experiment was as follows:

Common sunfish (*Eupomotis gibbosus*) in fresh water.

Variegated minnow (*Cyprinodon variegatus*).

Cunner (*Tautogolabrus adspersus*).

Beau Gregory (*Eupomacentrus leucostictus*).

CHARGING WITH OXYGEN AND CLOSING THE JARS.

Star corals (*Astrangia danae*).

Sea anemones (species undetermined).

Tunicates (*Molgula manhattensis*).

Common shrimps (*Crangon vulgaris*).

Horseshoe crabs (*Limulus polyphemus*), a couple of dozen of young, just hatched, and one so large that it could not straighten out in the jar.

Fiddler crabs (*Uca pugnax*), several specimens in wet sand, with an atmosphere of oxygen.

An extract from Mr. Gundelach's letter of September 26, acknowledging the receipt of the specimens, shows what success was met with: "The collection arrived at Gehlberg on the evening of September 22. Notwithstanding the length of time (over nine days) the specimens reached my home in safety. The Beau Gregory and the Cunner got chilled because the temperature was too low, and both of these fishes died the next day, but all the other specimens lived and are in the best of condition. It is very important that the experiment has succeeded, and you can now exchange any specimens with any European institutions in this way."

In order to know what losses, if any, might be laid to temperature Mr. Albers, second officer of the ship, kindly consented to make daily records of the temperature of the room in which the crates were placed through the voyage. His report indicates a gradual decrease from 73 degrees to 66 degrees Fahrenheit, and Mr. Gundelach informs me in his letter that it was as low as 63 degrees in Germany at the time the specimens arrived there. The Beau Gregory, being a tropical fish, evidently did succumb to the cold, but the Cunner is a northern form and the same explanation will not apply. The specimen was probably too large for the jar and the supply of oxygen. It was the largest fish sent and was selected to test the size limit. It did not, however, suffocate during shipment, but it was probably weakened by confinement for so long a time in its very narrow quarters, and possibly the oxygen supply ran a little short. The journey was made entirely without food.

Mr. Gundelach had previously made successful experiments in shipping for the shorter distances in Europe, but nothing paralleling the present experiment has thus far been undertaken. The particular advantage in this method is that specimens can be sent apparently any distance without any care whatever during transit, thus doing away entirely with the expense of an attendant or any special machinery for aerating the water—*North German Lloyd Bulletin.*

AIR OF THE NEW YORK SUBWAY

BY DR. GEO. A. SOPER.

When the New York subway was first opened there was a good deal of complaint as to the condition of the air. The subway grew hot and there were unpleasant odors. Some more or less scientific people made a few quick-and-easy determinations of the oxygen and the carbon dioxide in the air, and published alarming reports in the newspapers. Professor Chandler, of Columbia University, made some careful examinations of the carbon dioxide, which were reassuring enough for him and for many others, but the Rapid Transit Railroad Commissioners were not fully satisfied. They held the view that here was a great experiment. The subway was certainly uncomfortable. Something was the matter with the ventilation. Was the air dangerous to breathe? If the air was bad and could not be made wholesome, there would be no more subways built. The importance of this question was considered great enough to warrant thorough investigation. I was asked to make the investigation and did so.

The temperature and humidity were determined. There were 50,000 determinations of the temperature and humidity. The oxygen was estimated; there were 80 determinations of oxygen. The carbon dioxide was determined; there were 3,000 analyses of that. The numbers of bacteria were determined; there were about 2,500 bacteriological examinations. The dust was analyzed. I found the problem to be largely one of dust, so far as health was directly and seriously concerned.

I found at the outset that the ordinary quick-and-easy methods of analysis employed in most ventilation work were not suitable for this case. And so the most accurate determinations which it was practicable to make on a large scale and under the difficult conditions of subway traffic were employed.

It was only by the most refined methods that we could detect any difference between the oxygen in the subway and that in the outside air. The difference averaged only about 1½ parts of carbon dioxide per 10,000 parts of air. It was almost incredible that such a slight difference should exist while the air in the subway was so unpleasant, yet the fact could not be disputed.

It was difficult to get samples. It was desirable that they should be collected, as far as possible, away from people. So I had the sample bottles put in a basket with a pump and a thermometer. The investigator appeared to be a young man proceeding to market. He would go to the part of the subway previously determined on, await his opportunity and then take the cover off the basket sufficiently to insert a rubber tube. Then with the air pump he would pump air through a flask until the flask was filled with the air to be analyzed. I found we could get a reliable sample in that way, and in that way alone.

Fig. 1 shows some of the results. There were about 2,000 analyses averaged to get the figures from which these curves were made. The amount of carbon dioxide in the air of the subway is shown by the heavier upper line; that in the streets by the lighter line below. Note the correspondence between the rising and the falling of these two lines.

You see the observations extended over several months. I found there was a difference in the amount of carbon dioxide in the air of the streets at different hours of the day. Rush hours in the subway always gave larger amounts of carbon dioxide than other hours. And, curiously enough, the rush hours in the subway appeared to be the rush hours in the streets. Apparently, the air in the streets was affected by the great numbers of people in them. The striking rise shown in December is due to the large increase in the number of people using the subway and streets. It was the Christmas season.

There were regular variations in the chemical condition of the air at different hours of the day and night. At six o'clock in the morning the carbon dioxide in the subway was at a minimum. It then increased rapidly up to the end of the morning rush hour. From the end of the morning rush hours, there was a gradual reduction until just before noon, when the reduction ceased and there was a slight increase. The increase

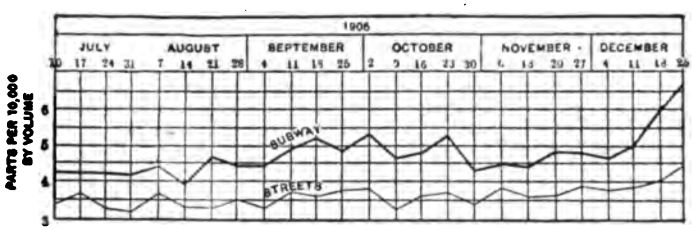


FIG. 1.

was apparently due to the fact that there was a slight rush of people who used the subway about noon in the shopping district. After noon there was a progressive reduction down to the beginning of the rush hours of the afternoon, when there was a decided increase. From that time there was a pretty constant reduction until morning.

There was much more carbon dioxide at six o'clock at night than during the rush hours of the morning, because more people traveled at that time. The crowding was much greater because the rush period was shorter. Most of the people who went to business between seven and nine wanted to get home as soon after six as possible.

Fig. 2 shows a compound diagram which may need a word of explanation. We have here the amount of carbon dioxide found at the different stations. The subway, you know, is 20 miles long, and the most interesting part of it, from the standpoint of ventilation, is between Brooklyn Bridge and Seventy-ninth Street. This diagram represents the conditions between those two points. The amount of carbon dioxide in the air at different stations for the period from July 14 to September 1 lies along the lower broken line. Now, later in the season, when more people were traveling, there was much more carbon dioxide at those stations. We have this fact shown on another broken line. Later, in November, when the heat began to abate and more active business conditions led more people to take the subway, there was a further increase in the amount of carbon dioxide, and so on until the end of December. There is one diagram for the afternoon hours and one for the morning hours. For each station you will find on this diagram the amount of carbon dioxide for the months covered in the investigation.

One of the most useful results of the whole work is illustrated in Fig. 3. The point illustrated is that a distinct relation existed between the number of openings to the street and the condition of the air. I think you can follow the diagram without my aid. It led me to the opinion, which I have since been able thoroughly to confirm, that the New York subway and other subways of its kind will ventilate themselves if they are given a chance. The New York subway did not have

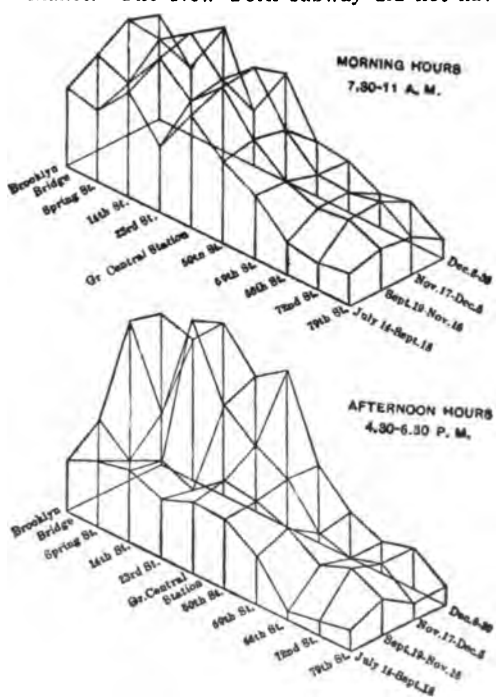


FIG. 2.

a chance, and the Paris subway did not, for the reason that it was too tightly enclosed for the air to move in and out with the requisite freedom.

It is not necessary to put fans into subways like the New York subway. In fact, it is doubtful if fans, even on the largest scale practicable, will produce material improvement, except immediately at the points where,

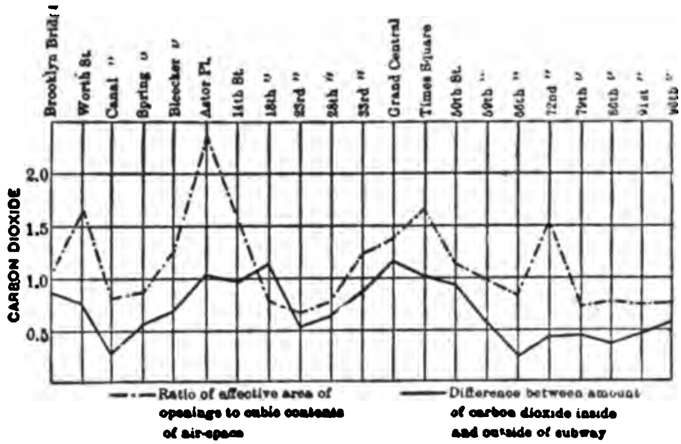


FIG. 3.

for example, outside air is pumped in. Fans will not improve the air sensibly for any considerable distance. This was proved by my investigations. But if you will give the subway openings enough, it will breathe of itself. The breathing bears a rather close analogy to the breathing of animals.

The subway in New York has been materially improved by providing blow-holes through which the air set in motion by the trains can move in and out. I have said the need of so much opening was not evident at first.

way commonly employed in bacterial analysis.

As was said, the fans did not materially improve the general air in the subway; the blow-holes did. Before the fans were put in it is probable that the air was renewed once every half hour. The amount of renewal after large sections of the roof were opened was very great. It wasn't possible to tell exactly how often the air was renewed, for the reason that the number of people traveling in the subway was not known by the city. There was no census of travel for a long time

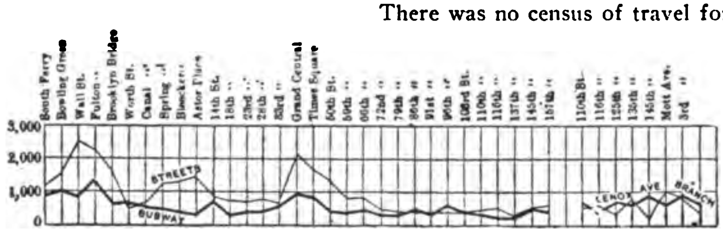


FIG. 4.

Bacteriological examinations of the air were made. Professor Sedgwick devised filters for air some years ago, and it was partly upon his plan that our filters were devised. They are small tubes filled with sand and plugged with cotton at both ends. We fastened two filters in tandem on a rubber tube, which was connected with a well made and carefully operated pump. The number of strokes of the pump gave us the quantity of air passed through the filters. In passing through the filters the air parted with its germs. After filtration the filters were taken to the laboratory and there dealt with in a after the subway was put in operation, and none until after my investigations had been completed.

In Fig. 4 you see the results of determinations of the number of bacteria at the different stations throughout the length of the subway and in the streets overhead. There is a general correspondence between these two sets of figures. The average of all the analyses shows that about half as many bacteria were found in the air of the subway as in the air of the streets. The numbers of bacteria varied with a good many circumstances, one of them being the amount of air moving in the subway.

TABLE.—EFFECT ON THE NUMBERS OF BACTERIA IN THE AIR OF THE SUBWAY PRODUCED BY SWEEPING THE PLATFORMS IMPROPERLY.

PLACE.	TIME, A.M.	MICROÖRGANISMS PER CUBIC METER OF AIR.		RATIO OF BACTERIA TO MOLDS.
		Bacteria.	Molds.	
Fulton Street Station, South End, west platform. Remote from openings to streets	10.25	4 900	100	49 : 1
Porter began sweeping near by	10.41	13 200	50	264 : 1
Still sweeping, but farther off	10.57	8 100	0	......
Still sweeping, middle of platform	11.12	8 500	0	......
Average	.....	8 600	38	226 : 1

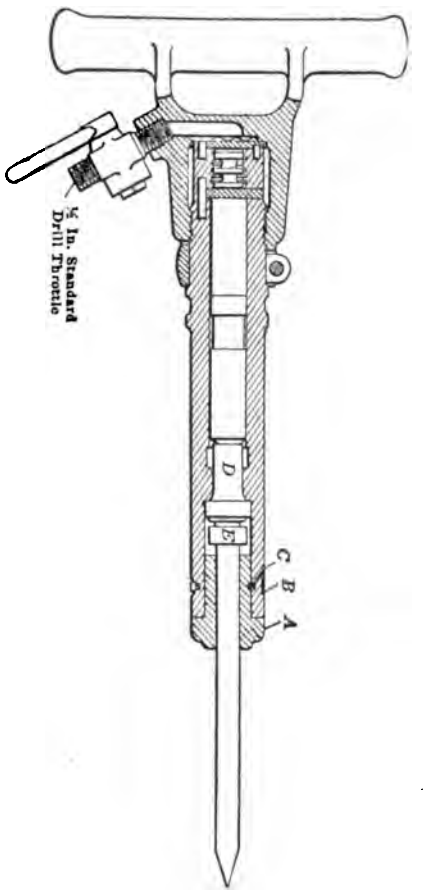
The accompanying table tells its own story and shows the effect of improper methods of cleaning. The porters swept the platforms without first moistening them, and this greatly increased the numbers of bacteria in the air. The movement of the trains kept the bacteria in the air because the movement of trains set the air in motion, and the dust particles, which we will consider later, were kept afloat also by the air currents.

It was very difficult to devise a plan for determining the quantity of dust in the air. The difficulty lay in the necessity of examining a large volume of air. The amount of dust was small to separate and weigh with accuracy, so that a special apparatus was employed. It consisted partly of an ordinary Root blower, adjusted so that it drew air through a gas-meter. The meter was carefully tested and found to work with sufficient accuracy in this manner. A filter was attached to the gas meter, so that when this pump was operated, the air passed down through the filter to the meter. The filter was composed of sugar. After a sufficient number of cubic feet of air had been passed through the filter, the filter was disconnected and taken to the laboratory. There the sugar was dissolved in water. The water was then filtered and the solid particles were dried and weighed.

The world's production of metallic aluminum has risen from about 7,300 tons in 1900 to 24,200 tons, last year.

FIRING OF GASES BY COMPRESSION

At a recent meeting of the Manchester, Eng., School of Technology, Professor Dixon gave an address on the above topic. Professor Dixon said that the importance of the ignition point of gases lay, he thought, in two things—one, the theory of the combustion of gases and the explosion of gases, and the other, the fact that the ignition of gas by compression was an actual industrial process in certain gas engines, and might soon be in motors. Dr. Coward and he had been conducting research work for some years on the determination of the ignition point of gases, and while they had been working a paper appeared in an American journal by Mr. Falk, who, working with Professor Nernst, at Berlin, had carried out similar research by compressing the gases suddenly by a piston in a cylinder and determining the volume to which it was necessary to compress them before they fired. The results obtained by Nernst's method were in agreement with some of the results he and Dr. Coward has obtained, but were very different from some other experiments of theirs. Professor Dixon said that he had been investigating the causes of these differences, and he had found that the chief cause was that some gases heated themselves far more rapidly than others before the flame appeared, and this pre-flame period was a very important period in the ignition of gases—that was to say, it might take a considerable time during which the gases were heating themselves up. He went on to show and to explain an apparatus by which it was possible to determine the real ignition point by the compression of gases independently of this pre-flame period.



CUTTING TIMBERS WITH AIR HAMMERS

By S. H. Hill.

In the Lake Superior district it has been customary to cut the hitches required in timbering by hand, usually with a moil. However, since a great number of first-class air-hammer drills have come upon the market the use of an air moil for this work has met with favor upon the grounds of economy and speed. The air moil can, of course, only be used in headings that are piped for air. A reducer can be used on the end of the pipe and air for the hand tool taken from the nipple used for heading machines. However, this necessitates doing the hitch cutting or squaring when the heading machines are not in use or while one of them has been purposely stopped. The introduction of a manifold on the end of air pipe, having one opening especially for the hand tool is more satisfactory.

A standard tool, such as shown in the accompanying illustration, of the Hornet hand hammer drill manufactured by the Ingersoll-Rand Company, is used for this work. The hand drills now on the market vary in weight from 20 lb. up. The bushing *A* for the drill steel is removable from the cylinder upon the removal of dowel pin *C*, which is held in place by snap spring *B*. As is seen, quite a recess is afforded between the rear end of the bushing *A* and the front end of anvil block *D*. In practice, steel of proper form to fit whatever bushing the drill is equipped with, is used. One end of this steel is shaped into a moil bit (which at no place can exceed the diameter of the steel itself) and the other end upset in such a way that it will ride easily in the recess between the bushing and anvil block, and at the same time the steel will be prevented from being shot from the drill in case the moil is not tight against the ground. The moil can be removed from the hammer drill by removing snap spring *B*, dowel pin *C* and pulling out both the moil and bushing. The bushing can then be taken from the moil by simply slipping it over the point. The use of the above-described contrivance means a saving of time. There is also a possibility of making use of this outfit in sampling breasts, etc.—*Engineering and Mining Journal.*

VARIETIES OF POWER APPLICATIONS IN A RAILROAD SHOP

An installation of considerable interest for the varied use to which the power is put, is the plant of the railroad repair shops of the New York Central Lines at West Albany, N. Y. Electric current, both alternating and direct, is used for lighting and power to a considerable extent. For transmission from the power house to the various parts of the shops the current, which is generated at 480 volts, 3-phase 60 cycle, is stepped up to 2,300 volts, and at each shop stepped down through transformers for operating the induction motors. Arc lights in the yards are on the alternating-current circuit, while to provide direct current for incandescent lighting and about 40 per cent. of the motor load there is a direct-current service of 250 volts generated by 3 motor generator sets. Compressed air to the extent of 95,000,000 cu. ft. per month is furnished at an average pressure of 90 lb. per sq. in. by two Ingersoll-Rand 360-hp. compressors, this service being used for operating pneumatic tools, boiler tube cleaners, and for testing air brake equipments, and various other uses. Hydraulic power also is used to a large extent, principally for pipe testing and similar uses, and to supply the necessary amount of water under pressure, a three million gallon service pump is provided.

OLD BOILER TUBES

An exchange advises its readers that "old boiler tubes which are merely rusted out at the ends may generally be utilized by re-threading and used as air or water pipes. Often they are thrown away as useless, but it is rarely the case that they will not withstand a pressure of 100 lbs., or even more."

On the word of an old machinist of the shop, the scheme will not work. Boiler tubes are so thin that a threading tool would almost cut through them, and besides that their external diameters do not correspond with those of standard pipe fittings. Old tubes are often made "good as new" by cutting off the bad ends and then welding or brazing a piece to one end sufficient to make up the required length.

CLEAN INTAKE AIR FOR TROLLEY CAR COMPRESSORS

The lines of the Rhode Island Company, of Providence, R. I., traverse a country which is largely underlaid with slate, and the mechanical department has experienced much trouble from grit and dust cutting the teeth of motor gears and pinions and compressor gears. Master Mechanic W. D. Wright has largely overcome these troubles by placing felt shields on the motor cases and by piping the compressor air from points above the car roof. On a number of open cars this has been done by utilizing two of the down spouts designed to carry off water from the eave troughs, while on closed cars pipe is carried up back of the controller and up through the roof. By this method clean air for the compressor is secured at all times.

HIGH PRESSURE MANUFACTURED GAS FOR FUEL

The Birmingham, Eng., Gas Committee are anxious to encourage the use of high-pressure gas as fuel instead of coal or coke in manufactories and workshops. As a test, high-pressure gas has been installed on a large scale at the works of the Birmingham Aluminum Casting Company. The furnace has a fireclay surround of 3½ in. in thickness, to which the gas is conducted in high-pressure resisting pipes. There is no necessity for any special burner, but a careful adjustment of the air aperture in the furnace is essential, after which no other attention than lighting is required. When the gas has been lighted, the crucible, which is capable of holding more than I cwt. of aluminum, is raised to a high temperature, and the metal is brought to a fluid state in about sixty-five minutes at a cost of 1s. 4d.

SAMPLING SCREEN DRIVEN BY COMPRESSED AIR

Several interesting labor-saving devices are used in the fine-grinding room of the sampling works of the Cananea Consolidated Copper Company. One of these is an air-actuated sampling screen. It consists of an ordinary screen held in a light steel frame, attached to the piston of a small air hammer.

The usual 80-mesh screen with the sample in it is placed in the frame. The attendant turns on the air and merely holds his hand on the screen, steadying it in its back and forth motion. The stroke is about 1½ in. and the compressed air is taken from a main at about 80 lb. pressure. With this device it is possible to screen from 50 to 60 samples per hour while formerly a Mexican screened only from 20 to 25 per hour.—*Engineering and Mining Journal.*

MEASURING ALTITUDES WITH THE ANEROID BAROMETER

For approximately measuring differences of elevation between two points where the observations can be made with only short intervals of time between them the aneroid barometer is very useful, but if much time elaspes the measurements may not be accurate on account of the changes of the local atmospheric pressure. On a certain occasion an excellent barometer indicated an altitude of 1,600 ft. It was carried up a hill to the summit of a ridge where it read 1,900 ft. Twenty minutes after the first reading, on returning to the gulch the instrument indicated 1,615 ft., showing a discrepancy of 15 ft. This is the way of the aneroid barometer. The depth of a shaft can usually be determined with considerable accuracy if there be no delay in going from one level to another, or from the top to the bottom. If there be delay from one level to the next, take separate readings, and then take several trips, reading both top and bottom. From these several readings take the mean, which should agree closely with the actual figures as determined by leveling.

HORSE POWER FOR COMPRESSING AIR

[The following article by Mr. J. William Jones, Painted Post, N. Y., we are enabled to reproduce by the kind permission of the editor of *Machinery* in which it first appeared, the tables constituting a portion of the December contribution to the valuable series of Data Sheet Supplements regularly accompanying that publication. The entire matter is copyrighted by the Industrial Press of New York.]

In estimating the various items in compressed air computations, it is customary to employ formulas previously determined, and generally published in various hand-books. This custom not only eliminates the possibility of errors, but saves time that would otherwise be used in long calculations. For the same reason the tables accompanying this will be found valuable to those who have to deal with calculations relative to compressed air.

When air is compressed in a cylinder without the removal of any heat due to compression, the compression is termed "adiabatic." On the other hand, when the heat of compression is removed as fast as produced, the compression is known as "isothermal." Neither of the above conditions are ever met with in actual practice. The actual compression curve, however, follows the adiabatic curve closely, and we, therefore, assume that the compression is adiabatic, as any slight difference is on the safe side. Isothermal compression is an impossible ideal, and the horsepower, mean effective pressure, etc., relating to isothermal compression are employed in the making of comparisons only.

The formula for calculating the horsepower required to compress, adiabatically, a given volume of free air to a given pressure is as follows:

$$H.P. = \frac{144\,N P V n}{33000\,(n-1)}\left[\left(\frac{P_1}{P}\right)^{\frac{n-1}{Nn}} - 1\right]$$

In which

N=number of stages in which compression is accomplished,

P=atmospheric pressure in pounds per square inch,

P_1=absolute terminal pressure in pounds per square inch=gage pressure plus atmospheric pressure.

V=volume of air in cubic feet, to be compressed per minute, at atmospheric pressure,

n=exponent of the compression curve, taken as 1.41 for adiabatic compression.

Simplifying the above formula for the different stages and for a value of one cubic foot we have:

For one-stage compression:

$$H.P. = 0.015\,P\,(R^{0.29} - 1)$$

For two-stage compression:

$$H.P. = 0.030\,P\,(R^{0.145} - 1)$$

For three-stage compression:

$$H.P. = 0.045\,P\,(R^{0.097} - 1)$$

For four stage compression:

$$H.P. = 0.060\,P\,(R^{0.0725} - 1)$$

In these formulas $R = \frac{\quad}{P}$ = number of atmospheres to be compressed.

For computing the horsepower required to compress, isothermally, a given volume of free air to a given pressure, the following formula should be employed:

$$H.P. = \frac{144 \times PV}{33000}\left(\text{Nap. log. } \frac{P_1}{P}\right)$$

The Napierian logarithm is obtained by multiplying the common logarithm by the factor 2.302585.

In the fourth and fifth columns of the tables for two- and three-stage compression, it will be noticed that these columns cover the cor-

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.
Single-Stage Compression.
Initial Temperature of Air taken as 60° F.—Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Isothermal Compression		Adiabatic Compression			
			Mean Effective Pressure	Horsepower	Mean Effective Pressure, Theoretical	Mean Eff. Pressure plus 15 per cent Friction	Horsepower, Theoretical	Horsepower plus 15 per cent Friction
5	19.7	1.34	4.13	0.018	4.46	5.12	0.019	0:022
10	24.7	1.68	7.57	0.033	8.21	9.44	0.036	0.041
15	29.7	2.02	11.02	0.048	11.46	13.17	0.050	0.057
20	34.7	2.36	12.62	0.055	14.30	16.44	0.062	0.071
25	39.7	2.70	14.68	0.064	16.94	19.47	0.074	0.085
30	44.7	3.04	16.30	0.071	19.32	22.21	0.084	0.096
35	49.7	3.38	17.90	0.078	21.50	24.72	0.094	0.108
40	54.7	3.72	19.28	0.084	23.53	27.05	0.103	0.118
45	59.7	4.06	20.65	0.090	25.40	29.21	0.111	0.127
50	64.7	4.40	21.80	0.095	27.23	31.31	0.119	0.136
55	69.7	4.74	22.95	0.100	28.90	33.23	0.126	0.145
60	74.7	5.08	23.90	0.104	30.53	35.10	0.133	0.153
65	79.7	5.42	24.80	0.108	32.10	36.91	0.140	0.161
70	84.7	5.76	25.70	0.112	33.57	38.59	0.146	0.168
75	89.7	6.10	26.62	0.116	35.00	40.25	0.153	0.175
80	94.7	6.44	27.52	0.120	36.36	41.80	0.159	0.182
85	99.7	6.78	28.21	0.123	37.63	43.27	0.164	0.189
90	104.7	7.12	28.93	0.126	38.89	44.71	0.169	0.195
95	109.7	7.46	29.60	0.129	40.11	46.12	0.175	0.201
100	114.7	7.80	30.30	0.132	41.28	47.46	0.180	0.207
110	124.7	8.48	31.42	0.137	43.56	50.09	0.190	0.218
120	134.7	9.16	32.60	0.142	45.69	52.53	0.199	0.229
130	144.7	9.84	33.75	0.147	47.72	54.87	0.208	0.239
140	154.7	10.52	34.67	0.151	49.64	57.08	0.216	0.249
150	164.7	11.20	35.59	0.155	51.47	59.18	0.224	0.258
160	174.7	11.88	36.30	0.158	53.70	61.80	0.234	0.269
170	184.7	12.56	37.20	0.162	55.60	64.00	0.242	0.278
180	194.7	13.24	38.10	0.166	57.20	65.80	0.249	0.286
190	204.7	13.92	38.80	0.169	58.80	67.70	0.256	0.294
200	214.7	14.60	39.50	0.172	60.40	69.50	0.263	0.303

TABLE I.

rect ratio of the cylinders, and the intercooler pressure, respectively. The correct ratio of cylinders (r) is obtained by the following formula:

For two-stage compression:

$$r = \sqrt{\frac{P_3}{P}}$$

For three-stage compression:

$$r = \sqrt[3]{\frac{P_3}{P}}$$

Thus, for two-stage compression we extract the square root of the number of atmospheres to be compressed, and for three-stage we extract the cube root. This proportion of cylinder volumes divides the work equally between the different stages, providing the intercooler abstracts all the heat due to compression in the preceding stage. The intercooler gage pressures, as shown in the fifth column, are obtained by multiplying the absolute intake pressure by the ratio of the cylinder volumes, and subtracting from this result the atmospheric pressure. It should be remembered that the intake pressure of the second-stage cylinder of any three-stage machine is the absolute intercooler pressure from the cooler between the first and second stages.

Let
P_1=intercooler pressure between first and second stages,
P_2=intercooler pressure between second and third stages,

Then, for two-stage compression:

$$P_1 = \left(P \times \sqrt{\frac{P_3}{P}}\right) - P$$

For three-stage compression:

$$P_1 = \left(P \times \sqrt[3]{\frac{P_3}{P}}\right) - P$$

$$P_2 = \left(P_1 \times \sqrt[3]{\frac{P_3}{P}}\right) - P$$

It is sometimes advantageous to know the mean effective pressure per stroke as shown in the tables. By dividing 144 by 33,000 we obtain a factor 0.00436, which divided into the horsepower will give the mean effective pressure per stroke.

CANAL ZONE MEETING, AMERICAN INSTITUTE OF MINING ENGINEERS

The Canal Zone Meeting of the American Institute of Mining Engineers began on October 21 and ended on November 15. The steamer Prinz August Wilhelm of the Hamburg-American Line was chartered and the party consisted of 121 persons, most of them members of the Institute, there being 84 men, the balance being made up of wives, daughters and guests.

It is doubtful whether the Institute has ever before gathered so representative a body of its members in any one excursion. An analysis of the list shows that 36 colleges were represented and that of the 84 men 60 were college men. Columbia and Lehigh led with 10 representatives each, Harvard and the University of Pennsylvania following, the balance being distributed over nearly every college in the country. Eighteen states were represented.

Metal mining was represented by such men as Hennen Jennings, Gardner F. Williams, H. C. Perkins, all veterans of early South African mine developments, Mr. Williams having been for some eighteen years the General Manager of the De Beers & Kimberley diamond mines, Messrs. Perkins and Jennings representing the Robinson and other Werner-Beit properties, the largest and richest gold mines in Africa. All three of these men have international reputations, made because of their skill and character. The work they did in South Africa, and the reputations they made did credit to their American citizenship, and no one envies them the fortunes which they have made and the pleasures which they now enjoy. Other miners in precious metals were R. B. Watson, General Manager of the Nipissing and La Rose mines at Cobalt, Ontario; W. E. C. Eustis, of Boston; A. C. Carson, of New York; Walter J. Page, Manager of the Guggenheim Smelters at Omaha; and Harry C. James and David G. Miller, of Denver.

Copper and other metal mining interests were represented by George D. Barron, C. W. Goodale, Manager of the Boston & Montana, Butte; William Kelly, General Manager Penn. Iron Mining and Republic Mines in Michigan; and David W. Brunton, of Denver.

More than fifty per cent. of the anthracite coal producers were represented in person, among them being W. J. Richards, Vice-President of the Reading Coal & Iron Company, with a pay-roll of twenty millions a year, (larger than that of the Panama Canal) and with an equal number of men employed; that is, 33,000. W. A. Lathrop, President of the Lehigh Coal & Navigation Company; S. D. Warriner, Vice-President and General Manager of the Lehigh Valley Coal Company; R. V. Norris, of Wilkes-Barre; James S. Cunningham, of Johnstown, Pa.; H. N. Eavenson, Chief Engineer of the United States Coal & Coke Company, of West Va.; Rowland F. Hill, of Pulaski, Va.; Eugene McAuliffe, Chicago; Samuel A. Taylor, Pittsburg; Philip Goodwill, formerly President of the Pocahontas Company, of West Virginia; W. S. Ayres, of Hazleton, Pa.; and F. W. Scarborough, of Richmond, Va.

In other branches of engineering were Dr. Drinker, President of Lehigh University; Prof. Richards, of Lehigh; William Kent, Dr. Raymond, Charles Kirchhoff, Col. D. C. Dodge, the railroad builder of Denver; Edward W. Parker, D. M. Riordan, David B. Rushmore, Dr. Struthers, Jos. Underwood, Thos. Robbins, Howard Wood and Walter Wood, of Philadelphia; C. M. Russell, of Massillon, Ohio; and Frank M. Warren, of Minneapolis.

Perfect weather was enjoyed from New York to Havanna, notwithstanding the apprehensions felt because of the recent hurricanes. There was an informal reception held on shipboard on Saturday, the day following that of sailing, which brought the members and their guests together. Much interest was excited by an exhibition made by Mr. Gardner Williams of diamonds taken from the Kimberley mines.

On Saturday, October 23, religious service was held in the dining saloon, conducted by Dr. Raymond.

For the first time it was noticed that the eminent Doctor is a singer as well as a preacher, and on this occasion he sang with such zeal that his voice commanded a halt when his sermon had run but twenty minutes. The Doctor spoke of immortality, and at the end of the service the Captain of the ship added a peroration to the sermon by calling attention to the fact that the sea beneath us was two

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.

Two-Stage Compression.

Initial Temperature of Air taken as 60° F.—Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Correct Ratio of Cylinder Volumes	Intercooler Gage Pressure	Isothermal Compression: Mean Effective Pressure	Isothermal Compression: Horsepower	Adiabatic Compression: Mean Eff. Pressure, Theoretical	Adiabatic Compression: Mean Eff. Pressure plus 15 per cent Friction	Adiabatic Compression: Horsepower, Theoretical	Adiabatic Compression: Horsepower plus 15 per cent Friction	Percentage of Saving over One-Stage Compression
50	64.7	4.40	2.10	16.2	21.80	0.0095	24.30	27.90	0.106	0.123	10.9
60	74.7	5.08	2.25	18.4	23.90	0.104	27.20	31.30	0.118	0.136	11.3
70	84.7	5.76	2.40	20.6	25.70	0.112	29.31	33.71	0.128	0.147	12.3
80	94.7	6.44	2.54	22.7	27.52	0.120	31.44	36.15	0.137	0.158	13.8
90	104.7	7.12	2.67	24.5	28.93	0.126	33.37	38.36	0.145	0.167	14.2
100	114.7	7.80	2.79	26.3	30.30	0.132	35.20	40.48	0.153	0.176	15.0
110	124.7	8.48	2.91	28.1	31.42	0.137	36.82	42.34	0.161	0.185	15.2
120	134.7	9.16	3.03	29.8	32.60	0.142	38.44	44.20	0.168	0.193	15.6
130	144.7	9.84	3.14	31.5	33.75	0.147	39.86	45.83	0.174	0.200	16.3
140	154.7	10.52	3.24	32.9	34.67	0.151	41.28	47.47	0.180	0.207	16.7
150	164.7	11.20	3.35	34.5	35.59	0.155	42.60	48.99	0.186	0.214	16.9
160	174.7	11.88	3.45	36.1	36.30	0.158	43.82	50.39	0.191	0.219	18.4
170	184.7	12.56	3.54	37.3	37.20	0.162	44.93	51.66	0.196	0.225	19.0
180	194.7	13.24	3.64	38.8	38.10	0.166	46.05	52.95	0.201	0.231	19.3
190	204.7	13.92	3.73	40.1	38.80	0.169	47.16	54.22	0.206	0.236	19.5
200	214.7	14.60	3.82	41.4	39.50	0.172	48.18	55.39	0.210	0.241	20.1
210	224.7	15.28	3.91	42.8	40.10	0.174	49.35	56.70	0.216	0.247	
220	294.7	15.96	3.99	44.0	40.70	0.177	50.30	57.70	0.220	0.252	
230	244.7	16.64	4.08	45.3	41.30	0.180	51.30	59.10	0.224	0.257	
240	254.7	17.32	4.17	46.6	41.90	0.183	52.25	60.10	0.228	0.262	
250	264.7	18.00	4.24	47.6	42.70	0.186	52.84	60.76	0.230	0.264	
260	274.7	18.68	4.32	48.8	43.00	0.188	53.85	62.05	0.235	0.270	
270	284.7	19.36	4.40	50.0	43.50	0.190	54.60	62.90	0.238	0.274	
280	294.7	20.04	4.48	51.1	44.00	0.192	55.50	63.85	0.242	0.278	
290	304.7	20.72	4.55	52.2	44.50	0.194	56.20	64.75	0.246	0.282	
300	314.7	21.40	4.63	53.4	45.80	0.197	56.70	65.20	0.247	0.283	
350	364.7	24.80	4.98	58.5	47.30	0.206	60.15	69.16	0.262	0.301	
400	414.7	28.20	5.31	63.3	49.20	0.214	63.19	72.65	0.276	0.317	
450	464.7	31.60	5.61	67.8	51.20	0.223	65.93	75.81	0.287	0.329	
500	514.7	35.01	5.91	72.1	52.70	0.229	68.46	78.72	0.298	0.342	

TABLE II. *See page* 5110.

miles deep. In the afternoon Dr. Raymond repeated that delightful and instructive address which he gave on Jamaica at the New Haven meeting of the Institute. As Jamaica was en route every one was eager to get information about the Island from one who had spent so much time there.

The first session of the Institute was held on the ship the afternoon of October 24. President Brunton welcomed the members and said that the Institute was to be congratulated not only on the large number present, but especially in that there had never before been so representative a gathering of the prominent and distinguished men of the mining industries. Dr. Raymond read by title only a long list of papers, giving notice that some of them would be taken up and read or discussed at future meetings of the Institute.

A general discussion was held on the extinguishing of mine fires. Mr. William A. Lathrop introduced the subject by referring to the fire at the Summit Hill mine of the Lehigh Coal & Navigation Company. Mr. Warriner, formerly General Manager of the Calumet & Hecla mines, explained how the fire in the Calumet & Hecla was extinguished. Mr. R. V. Norris described the fire at the Lykens Colliery, and W. J. Richards called attention to the fact that shutting off the air is sometimes more effective in putting out a mine fire than flooding by water. Mr. Samuel A. Taylor referred to certain fires in the Wyoming field which had been caused by crossing of the electric wires. President Brunton spoke of the great fire at the Anaconda Mine, it being generally known that Mr. Brunton's skill contributed very largely toward the control of this fire. He described how futile were the attempts to extinguish the fire by water, and it was only by building bulkheads at intervals closer and closer to the fire that the territory was brought under control.

An interesting feature of Mr. Brunton's remarks was the description of how the men wore helmets, to which they attached hose which was connected with the regular compressed air pipe in the mine, this air not only serving to keep down the temperature, but to blow away the smoke and noxious gases, enabling the men to reach places in the mine otherwise inaccessible. At these places stone walls were built blocking off the air. Mr. Brunton said that the men got so accustomed to the use of these air helmets that it was a common remark that with such an equipment a man might build a stone wall around Hell. In the evening a general entertainment was given in the music room, followed by dancing.

So favorable had been the weather that the ship arrived in Havana early on Tuesday, the 25th, being so much ahead of time that the party of Cuban engineers who had planned to receive us were not on hand. A reception was given at the Plaza Hotel in the afternoon. On arriving in Havana a party of enthusiastic mining engineers hired a cab and told the driver to show them the town. He went straight to the big hill back of Havana and pointed out the beautiful panoramic view of the city and harbor. Going on a little further he stopped in front of a stone mansion where armed guards were marching, and exclaimed, "Presidio." "Ah," said an M. E. who prided himself on his Spanish, "yes, this is the residence of the President,—presidio, I know. What a beautiful spot and what a substantial mass of buildings!" In the evening of the same day this party was received by President Gomez, and for the first time learned from the President himself that the presidio was the penitentiary. The impression made upon every one was that Havana could no longer be looked upon as a dirty city; that it was distinctly clean and healthy. Little evidence was seen of the hurricane, which had done its greatest damage in the interior by the destruction of tobacco.

On Thursday, the 27th, en route to Jamaica, the Institute held a session on the ship, continuing the discussion on mine fires. This was participated in by Mr. Norris and Mr. Kelly. Mr. Kelly described four cases of fire, referred to the use of the fire helmet, and said that he had learned as soon as an alarm of fire was sounded to first get the men out of the mine and next not to use candles but acetylene lamps. Prof. Brunton said that in his experience with carbon-monoxide in mines there was a note of alarm sounded when the danger point was reached, this being a tickling sensation in the forearm or in the legs, or both, and that as soon as this sensation is felt one should get out of the mine as quickly as possible. Dr. Raymond read a letter from E. E. Ludlow about an explosion in the Pelawo mine in Mexico. Mr. Parker in discussing this case said that the explosion was probably due to the powder used,—a cheap dynamite, not one of the explosives known as permissible in the United States Government regulations, and that all coal in this mine was shot from the solid, no undercutting being done. Prof. Brunton spoke of the effect of putting water in contact with certain sulphur ores in mine fires as resulting in greater heat, thus being ineffective in extinguishing a fire. Gardner Williams described the great mine fire at the De Beers, where 202 persons were killed. Hennen Jennings was introduced by Dr. Raymond as a man who had never had any mine fires. Mr. Jennings said that the conditions in the Johannesburg mines were essentially safe, little or no timber being used; that these mines had produced nearly three hundred million pounds of Sterling in gold, and that his story about mines fires would have to be like the treatise which the man wrote on the snakes in Ireland; namely, there are no snakes in Ireland.

In the morning, Friday the 28th, the entire party indulged in sports. Sober men, who carry responsibilities at home, could be seen in their shirt sleeves doing cock fights across a spar which the Captain had strapped above the deck; indulging in pillow fights, races and a general tug-of-war. Another session of the Institute was held in the afternoon, Prof. Richards, of Lehigh, read a paper on the Production of Pig Iron by the Electric Furnace in Sweden. Sports continued in the afternoon, the old watchman, a black, Jamaica negro, dancing a jig to the amusement of the passengers and to his own utter demoralization by being in the presence of such an audience. A concert was held in the evening, the Jackdaw of Reims being read and an original poem a la Ingoldsby Legends by Dr. Raymond. Saturday and Sunday, the 29th and 30th, were spent at Jamaica. Much of the enjoyment at Jamaica was due to the courtesy of Mr. Meyer, the General Passenger Agent of the Hamburg Line, who accompanied the party throughout the trip, and to Captain Forward, the agent at Jamaica. The natural scenery of this island is so striking,

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.
Three-Stage Compression.
Initial Temperature of Air taken as 60°F.—Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Correct Ratio of Cylinder Volumes	Intercooler Gage Pressures—First and Second Stages	Isothermal Compression: Mean Effective Pressure	Isothermal Compression: Horsepower	Adiabatic Compression: Mean Eff. Pressure, Theoretical	Adiabatic Compression: Mean Eff. Pressure plus 15 per cent Friction	Adiabatic Compression: Horsepower, Theoretical	Adiabatic Compression: Horsepower plus 15 per cent Friction	Percentage of Saving over Two-Stage Compression
100	114.7	7.8	1.98	14.4 42.9	30.30	0.132	33.30	38.30	0.145	0.167	5.23
150	164.7	11.2	2.24	18.2 59.0	35.59	0.155	40.30	46.50	0.175	0.202	5.92
200	214.7	14.6	2.44	21.2 73.0	39.50	0.172	45.20	52.00	0.196	0.226	6.67
250	264.7	18.0	2.62	23.8 86.1	42.70	0.186	49.20	56.60	0.214	0.246	6.96
300	314.7	21.4	2.78	26.1 98.7	45.30	0.197	52.70	60.70	0.229	0.264	7.28
350	364.7	24.8	2.92	28.2 110.5	47.30	0.206	55.45	63.80	0.242	0.277	7.64
400	414.7	28.2	3.04	30.0 121.0	49.20	0.214	58.25	66.90	0.253	0.292	8.33
450	464.7	31.6	3.16	31.8 132.3	51.20	0.223	60.40	69.40	0.263	0.302	8.36
500	514.7	35.0	3.27	33.4 142.4	52.70	0.229	62.30	71.70	0.273	0.314	8.38
550	564.7	38.4	3.38	35.0 153.1	53.75	0.234	65.00	74.75	0.283	0.326	8.80
600	614.7	41.8	3.47	36.3 162.3	54.85	0.239	66.85	76.90	0.291	0.334	8.86
650	664.7	45.2	3.56	37.6 171.5	56.00	0.244	67.90	78.15	0.296	0.340	9.02
700	714.7	48.6	3.65	38.9 180.8	57.15	0.249	69.40	79.85	0.303	0.348	9.18
750	764.7	52.0	3.73	40.1 189.8	58.10	0.253	70.75	81.40	0.309	0.355	
800	814.7	55.4	3.82	41.4 199.5	59.00	0.257	72.45	83.25	0.315	0.362	
850	864.7	58.8	3.89	42.5 207.8	60.20	0.262	73.75	84.90	0.321	0.369	
900	914.7	62.2	3.95	43.4 214.6	60.80	0.265	74.80	86.00	0.326	0.375	
950	964.7	65.6	4.03	44.6 224.5	61.72	0.269	76.10	87.50	0.331	0.381	
1000	1014.7	69.0	4.11	45.7 233.3	62.40	0.272	77.20	88.80	0.336	0.383	
1050	1064.7	72.4	4.15	46.3 238.3	63.10	0.275	78.10	90.10	0.340	0.391	
1100	1114.7	75.8	4.23	47.5 248.3	63.80	0.278	79.10	91.10	0.344	0.396	
1150	1164.7	79.2	4.30	48.5 256.8	64.40	0.281	80.15	92.20	0.349	0.401	
1200	1214.7	82.6	4.33	49.0 261.3	65.00	0.283	81.00	93.15	0.353	0.405	
1250	1264.7	86.0	4.42	50.3 272.3	65.60	0.286	82.00	94.30	0.357	0.411	
1300	1314.7	89.4	4.48	51.3 280.8	66.30	0.289	82.90	95.30	0.362	0.416	
1350	1364.7	92.8	4.53	52.0 287.3	66.70	0.291	84.00	96.60	0.366	0.421	
1400	1414.7	96.2	4.58	52.6 293.5	67.00	0.292	84.60	97.30	0.368	0.423	
1450	1464.7	99.6	4.64	53.5 301.5	67.70	0.295	85.30	98.20	0.371	0.426	
1500	1514.7	103.0	4.69	54.3 309.3	68.30	0.298	85.80	98.80	0.374	0.430	
1550	1564.7	106.4	4.74	55.0 317.3	68.80	0.300	86.80	99.85	0.378	0.434	
1600	1614.7	109.8	4.79	55.8 323.3	69.10	0.302	87.60	100.8	0.382	0.438	

TABLE III. *See page* 5110.

its history so unique, and the natives so simple, yet polite, clean and intelligent, that one is well repaid by a visit. Parties going to the Canal Zone would do well to stop en route at this interesting island, some of the mountain peaks of which are nearly a mile and a half high. The effects of the earthquakes are visible throughout Kingston, especially at that interesting city, Port Royal, once known as the wickedest city in the world.

From Jamaica to Colon is a two-day trip. The party was entertained en route by a parade of the "Kingston missfits" and other sports. The weather had become so warm that many availed themselves of the opportunity to purchase light suits of clothing at Kingston. Another session of the Institute was held on Monday, and a general history and description of the Panama Canal was given by the writer, followed by an interesting address on Panama and its people by Mr. John M. Sherrerd. On the evening prior to arrival at Colon the Captain's dinner was held, being rather unexpected, and as the passengers were in their shirt sleeves, because of the warm weather, a committee was appointed to ask the Captain about the formalities of the occasion. His reply was characteristic: "Do as you like, gentlemen, this ship is for the passengers, not the passengers for the ship."

Arrangements had been made to visit the Gatun Dam on November the 1st, the day of arrival at Colon, but the ship's engine went wrong during the night, or, as stated on the blackboard the next day, "The fly wheel jumped over the eccentric," hence the arrival at Colon was too late to follow the program, the party being met by Col. Goethals and Admiral Rousseau, who took the train directly to Panama. This journey gave the first general view of the Canal, as the railroad follows the line closely. The cars are comfortable, an observation car being carried at the rear. The first impression made upon one who had visited the Isthmus before was that great progress had been made in and about Gatun, and next it was plain that Gatun Lake was already a reality, for along the line for miles the train followed through swampy places, the water at times being over the rails, conditions that had not before been seen by one who was over the line three years ago.

This water was the backing up of the lake behind that portion of the Gatun Dam already finished, the limitation, as Col. Goethal explained, being the height of the spillway gates through which a torrent of water ran below the dam. A part of this journey from Colon to Panama was over the re-located line of the Panama Railroad. This line has been relocated throughout its entire length, though much work has yet to be done upon it. A high tribute was paid to John F. Stevens by Col. Goethals, who said that the army engineers now building the Canal were not railway builders, but that Stevens had left them an inheritance in this relocation of the Panama Railroad which was very much appreciated, and which had aided so much in carrying out the general plan of the work.

Through the courtesy of the engineers a special train took us through the Culebra Cut on November the 2nd. The story was told of a Congressman who was taken to the bottom of the Gatun locks and looking upward through that immense gorge between masonry walls he said to Col. Goethals, "At last I may now say that I stood on the bottom of Culebra Cut. Will you now please show me the Gatun Dam." The Culebra Cut, as we saw it, resembles a canyon in Colorado. It is about eight miles in length and has been excavated at each end to within about five feet of completion. In the middle seventy feet more in depth has to be taken out. The walls on either side rise in varying slopes to a height of about 400 feet. Huge slides are in evidence, one of them reaching back 1,400 feet from the cut, the material in this slide being estimated at three million cubic yards. These slides are gradual in movement, though occasionally a heavy and rapid fall of material takes place, one of these slides having submerged a steam shovel. The material of the Culebra Cut is the most unusual conglomeration of basaltic and sedimentary rock that has ever been seen in one place. It varies in color, hardness and in chemical composition, these variations taking place at frequent intervals. No man can estimate when or where a slide will occur or how much material will work its way into the cut before it reaches the angle of rest. Col. Goethals in answer to the question, "What is the angle of rest?" said that the material had not stood still long enough for them to measure it and that it varied all the way from zero to 90 degrees. One could not stand at the bottom of this cut and view the uncertainties of the situation without reaching the conclusion that to deepen the Canal eighty-five feet more might involve difficulties and delays beyond calculation. From the nature of the material it would seem that when the water is in the cut it will aid in holding it in place, and the plan which is being followed is to let it slide as it will, removing it with shovels until it reaches its level. This will probably go on after the Canal is finished, but the dredges will then be able to take care of the surplus material even better than the steam shovels.

The party were entertained at a reception given by the President of Panama, Senor Arosemena, a genial Panamanian, dark enough in complexion to indicate the presence of Indian blood, democratic to an extreme and proud of the Canal and his country. November the 3rd being the anniversary of the independence of Panama, we had the pleasure of seeing a renewal of the old Fourth of July fireworks system, which is becoming obsolete in the United States. The President reviewed the army from the balcony of his residence. This army is nothing more than the police force, consisting of fifty men, quite sufficient to protect a country which is under the surveillance of the United States. Here we have an allustration of the practical nature of the Monroe Doctrine when applied to a Central or South American republic. They save enormous expenditures of money by devoting their time and attention, and the funds of the state, to causes other than defense, depending entirely upon the United States to protect them against enemies within and without. An opera party at the National Theater in the evening was a pleasant diversion. This theater is maintained by the government, the players being brought over from Spain at the government's expense; a nominal fee only is charged for admission.

On November the 4th an evening session of the Institute was held at the Tivoli Hotel, where Dr. Gorgas described the work of sanitation which has accomplished so much on the Isthmus and at Havana. The Doctor gave a few instances of the conditions that existed on the Canal under the French. He said that three out of every four Frenchmen who came to build the Canal died of yellow fever or some other disease; that of twenty-four Sisters of Charity who came there as nurses, only two survived; that a French Director General lost through yellow fever every member of his family, consisting of his wife and three children, he himself becoming insane. He described in detail the sanitation of the city of Panama, which had been known throughout the world as one of the most unhealthy cities. Each residence formerly had a cistern to catch rain water for drinking purposes. The water in these cisterns bred mosquitoes, which transmitted yellow fever and malaria. The yellow fever mosquito is a different mosquito from the malaria mosquito. The yellow fever mosquito is invariably a female. She cannot transmit disease until she herself has taken it, but after a certain period the mosquito becomes infected with yellow fever and transmits it to others. This mosquito is domestic in its nature and does not fly far from its place of birth. Were it otherwise, Dr. Gorges said, the yellow fever mosquito might almost exterminate the human race.

Dr. Hayes, of the United States Geological Survey, talked on the subject of the geology of the Isthmus, and Gardner Williams showed lantern slides of the diamond and gold mines in South Africa.

November 5 was a day of play and excursions to Taboga Island, a beautiful spot in the Pacific Ocean, near the entrance of the Canal. In the evening the Institute gave a reception with dancing and a supper. This was attended by the English, French and other ministers, by prominent Panamanians with their wives and daughters, and by the officers and families of the Canal service. Col. Goethals, Dr. Gorgas with wife and daughter, Col. Seibert, Gov. Thatcher, the Civil Administrator of the Canal Zone, Admiral Rousseau, and others were present. Mr. Campbell, the American Charge d'Affaires, assisted in this reception. The sensitive nature of the native Panamanians was shown by the fact that at the conclusion of the dances the orchestra played the Panama national hymn, to which two or three persons danced, very much to the indignation of the Panamanian ladies.

On Sunday the hospital at Ancon was visited. No one can see this hospital without admiring its equipment, the skill of those in charge of it and the beneficient influence to those not only on the Isthmus but throughout Central and South America. Pilgrimages are made to Ancon Hospital and large sums paid to the government for surgical operations and treatment there. An evening session was held, in which Mr. Parker read a paper on Coal Mining Machinery, illustrated with lantern slides. Mr. Rushmore illustrated electrical devices, and Mr. Gardner Williams told the story of Rhodes and the development of South Africa, with some splendid views of the country, the men and the animals.

On November 7 the Gatun Dam and locks were inspected, occupying the entire day. Though this was the rainy season there had been little rain on the Pacific end of the Canal. Statements were made that the rainfall on the Pacific end is only half as great as that on the Atlantic end. This was verified when the party reached Gatun, where there was a baptism of rain which fell at the rate of 3.28 inches in 59 minutes. Forty-two per cent. of the lock work on the Atlantic end has been completed and fifteen per cent. of the work on the Pacific end. About one-third of the Gatun Dam is finished. The toe-walls, consisting of dumps of broken rock about one-quarter of a mile apart, are plainly in evidence, the loose material being pumped in between. This material hardens when it settles, and it would seem to form an impervious bed for the dam. The material is being pumped into the dam at the rate of 550,000 cubic yards per month, the entire volume of the dam being twenty-three million yards.

The figures show that concrete is being laid on the Pacific end at $4.65 per yard, a figure unusually low, but the conditions there are very favorable, the stone being brought from the Ancon quarries close at hand, grades are favorable and the sand coming from the Pacific end. The concrete costs about $2 in excess of these figures at the Atlantic end. To explain this the statement was made that the work is done in eight-hour shifts on the Pacific end and in twelve-hour shifts on the Atlantic. These eight-hour shifts split up the work and effect economies of operation. Cantilevers are used on the Pacific end and cable-ways on the Atlantic, it being claimed that the cantilevers effect economies in transportation of the material. Wood forms are used on the Pacific end, steel forms on the Atlantic. It is questionable whether the steel forms give any advantage over the wood, as they are very expensive; hence there is not a surplus at hand to give elasticity in movement from one place to another, the forms being left in place until the cement is set. Furthermore, the steel forms do not adapt themselves so well to varying conditions.

At the Atlantic end the stone for the concrete cost $2.40 per yard in the stock pile. Of this $1.10 is amortization of the plant, tugs, etc. This is a heavy amortization due to the fact that the quarries are at Porto Bello, requiring a large equipment of scows and tugs and double handling of material. At the Pacific end the material is brought down grade from the quarry in cars and delivered, directly to the concrete mixer, hence there is little or no amortization charge against the cost of the stone in the Pacific end, which is said to be 80 cents per yard in the stock pile. Another point which must not be lost sight of is that the weather, not only in the storms at sea, but in the rainfall, is worse on the Atlantic than on the Pacific end. The figures appear to show but little difference in cost of concrete when based upon taking the stone and sand from the stock pile and mixing and placing. Even with the added cost on the Atlantic end the figures compare favorably with those given for concrete on the New York Barge Canal, which is said to be $7.34 per yard.

The figures show that rock is being removed on the Canal for about 50 cents per cubic yard in the dry. This cost, however, does not include administration expenses, which would bring it up to about 70 cents. The removal of rock under water by the drill scow and by the Lobnitz system is said to cost somewhere between $1 and $2 per cubic yard, the figures not being accurately determined because insufficient dredging has been done so far. Both systems appear to have a place on this work, the drill scow for heavy cutting and the Lobnitz for light work at a depth of 2 or 3 feet. The submarine rock excavation has been reduced to something like 150,000 yards by the plans which are being carried out of cofferdamming the work, hydraulicing the material over the rock and pumping it into the dam, removing the rock in the dry.

To sum up, it is plain that the Canal is being built expeditiously on plans which are wise and with an organization that is well fitted to carry out these plans. Recent floods have deposited hundreds of thousands of yards of gravel at the mouth of the Chagres River, thus contradicting the arguments made by the sea level advocates, that the Chagres was not a sediment carrying stream. This sedimentary material is in evidence everywhere, being used in the towns for road building. It consists mainly of pebbles. With the enlargement of the mouth of the Chagres by the Gatun Lake, which carries the waters of the lake ten miles up the river, it is not likely that this material will be a menace to the Canal.

The work of excavation is nearly three-quarters done, but no attempt is made to finish the excavation in advance of the work on the Atlantic end, the plans following a system of coordination of work from one end of the Isthmus to the other. That the Canal will be finished some time during the year 1914 there appears to be no reason to doubt.

The Hotel Tivoli at Panama is a first-class hostelry on a hill facing the Pacific, beautiful in its surroundings and comfortable, notwithstanding the difficulties which must accompany an effort to give food and service to those who are accustomed to hotels in the North. The food is drawn from the government commissariat; vegetables are not raised on the Isthmus and chickens are scarce, hence everything is imported. The waiters are easy-going West Indians, some good and some bad and others very bad. Mrs. William Kelly was greeted by a Tivoli waiter, who put a finger bowl in front of her with the exclamation, "Wash your fingers, miss." This same waiter was transferred to Gatun when the party was given a luncheon, and recognizing Mrs. Kelly he apologized for the absence of finger bowls by giving her a soup bowl to "wash her fingers in."

The party left the Isthmus on the 8th and were loudly cheered. It was not explained whether this cheer was a compliment or otherwise. It was said that a delegation of Congressmen were also cheered and that a man on the dock was heard to exclaim: "The Lord gave and the Lord hath taken away, blessed be the name of the Lord."

As the ship was warped from the dock the songs went over the water: "Here's to Col. Goethals, may Culebra Cut have no falls."

Homeward bound the party held an election for Governor of New York, resulting in a majority for Mr. Stimson, Captain Krause assuring us that never had his passengers failed to correctly indicate the result of the elections.

Sessions of the Institute were resumed, the subject of discussion being the Panama Canal where a uniform sentiment of approval was shown. This was embodied in a signed statement which has already been published.

November 10 was spent at Kingston, Jamaica, where the party took lunch at the Myrtle Bank Hotel on the invitation of President Brunton, who received his reward in cheers for "Baby Brunton whose daddy went a'hunting." It was moved, seconded, and unanimously adopted, that Brunton be continued as President of the Institute until the completion of the Canal. An enthusiastic member moved as an amendment, that "Judgment Day" be substituted for "Canal." We were honored by a visit from a German Prince, the nephew of the Emperor, and an alligator. The Prince being in Kingston Harbor on a German warship, and having shot an alligator he wanted it despatched home, so took advantage of the sailing of the August Wilhelm.

Sessions of the Institute were continued, a paper was read by Mr. Goodale, of Butte, on the Utilization of Electric Power. He explained the system being installed there by which power at 110,000 volts is taken 132 miles to Butte, where it is to be converted into compressed air for running thirty hoists, all situated within one and a half miles, the plant being located in the center of the district. Mr. Watson described the Taylor system of compressing air which is in use at Cobalt and said that they had found that this air contained less oxygen than normal compressed air, the effect being such as to prevent the use of candle in the mines, and that at times if the air is drawn on rapidly moisture is carried over with the air. The last stopping point, before reaching New York, was Fortune Island, where thirty-eight negroes, known as deckers, were put ashore, these men having been taken on only for the purpose of handling freight. Fortune Island is a narrow strip, about a mile wide and several miles long. It belongs to the British Bahama Group and is peopled by negroes. The Governor of the Island, a white man, came aboard and was asked if there were any white people on the Island. He replied "Yes," and pointing to a dark-skinned companion, he said, "I and the postmaster there." It seems that this governor has lived on the Island almost a lifetime. He lost his first wife and has recently married again. Captain Krause told us of the exuberant joy with which the Governor greeted him recently, saying that "I have got a fine wife now, Captain. She weighs 250 pounds."

The President of the United States was on his way to the Canal while this ship was en route North, hence a wireless was sent into the air as follows: "American Mining Engineers returning from Isthmus congratulate you upon good plan, splendid management and satisfactory condition of work." To this came the following reply:

"Your message received. It is most satisfactory to have the assurance of men who are experts that the great Canal construction has been well planned and is being carried on to a successful completion. I thank you for this visit and the courtesy of your kind message. Taft."

To pass a President of the United States was an era in the good record of Captain Krause, who bore on his breast a medal from the old German Emperor for saving a life and the Honor of the Golden Cross from the present Emperor for saving a ship, so when these wireless messages were received this gallant captain slept not at all. Disregarding the compass he veered his ship landward, and as became an old mariner, he figured the time and place when the Prinz August Wilhelm might pass the two warships bearing the President of the United States. About two dozen passengers kept company; instilled with the same spirit, paced the deck, straining their eyes landward in the cold moonlight, hoping to catch a glimpse of the President. All at once there was a sound of revelry on board, men ran about the decks, the halyards rattled, and at the sound of the Captain's whistle the port side of the ship was ablaze with red, white and blue lights, discharged at intervals from each deck and from many portholes. The wireless man was also put in action, sending his sputtering notes and lightning flashes at the foremast. It was indeed a sight that "left itself forever on your mind." But the land lovers who stood up to see this failed to recognize a thing but the pale moon and its streaks across the water. "See it there," said the Captain, "right under the moon." Time passed, the lights went out, quiet was restored, when the watch in the crow's nest sent the signal soon plain to everybody, that over the starboard quarter came two mammouth warships bearing the President, and the good Captain confessed that he had saluted a coal hulk bearing its load of Pocahontas down to the Isthmus. The Captain was sure that the coal hulk responded to the signals as he saw something "going up" in the air in the light of the flashes from the August Wilhelm. Imagination only can picture the exultation on the deck of the coal hulk, and the things that went up were doubtless chunks of best coal, thrown mastward in acknowledgment and appreciation of the noble salute. The log of no coal hulk ever before recorded such a history.

The sessions of the Institute were continued. Mr. Ayres presenting his paper, Conservation of Coal and Its Production for Market. President Brunton read a report of the Thirtieth Annual Convention of the American Mining Congress which was held at Los Angeles, Cal., September 26, 1910. Mr. Taylor presented a report of the Mining Congress on rules governing the installation of electricity in mines, referring briefly to a report in detail which would be presented and printed in the transactions of the Institute. Dr. Raymond read a letter from Prof. Edw. H. Williams, Jr., of Woodstock, Vt., in regard to the proposed mining laws. The printed report of the Committee on Uniform Mining Laws for the Prevention of Mine Accidents was discussed by Mr. George H. Warren, Mr. Kirchhoff, Mr. McAuliffe, Mr. Warriner and Mr. Jennings. Mr. Jennings dwelt particularly on the question of secrecy and said that the true policy of a mining company, like the true policy of any company presenting its stock for sale on the market, should be to give the public all information available concerning the mine, the costs included. He said, "If we desire or demand the open shop we should give an open office. This hushed, underbreath talk about mines only hurts the industry and helps the swindler." Messrs. Goodale, Kelly and Watson also joined in the discussion. Mr. Gardner Williams said that in English countries the regard for law and the enforcement of law is very much greater than in the United States.

On Sunday the 13th services were held by Dr. Raymond in the morning. Robt. P. Porter, representating the London Times, addressed the Institute upon South America, and the evening was given up to an enthusiastic celebration of the birthday of Dr. Joseph Struthers, who while not the master of the ship was surely the master of the trip. To Dr. Struthers, more than to any other one person, belongs the credit for the success of the meeting.

On the 14th sessions of the Institute were continued. Dr. Raymond read a paper expressing approval of the plan of work of the Panama Canal, which after amendment, was unanimously adopted. Prof. Richards addressed the Institute on the Electrical Manufacture of Steel, and the President adjourned the meeting with congratulations for an experience which can only be characterized as one continuous carnival of pleasure and interest.

W. L. SAUNDERS.

COMPRESSED AIR ON THE PANAMA CANAL.

From the report of the Isthmian Canal Commission for the year ending June, 1910, we learn that the air compressor subdivision compressed during the year 7,227,203,513 cubic feet of free air, as against 4,935,110,000 cubic feet for the preceding year, an increase of 46 per cent. Two additional compressors of 2,500 cubic feet free air capacity were installed. All compressor plants have been equipped with hot water meters, fuel oil heaters and other accessories for keeping close accounting of the output per barrel of fuel oil, of water evaporated per barrel of oil and the general economies of plant operation.

On account of slides occurring in Culebra cut, 18,810 feet of main pipe line were removed and relaid. Also 3,000 feet of 8 inch main pipe was installed between Balboa plant an Ancon rock crushing plant. During the year, in furnishing air connections for drills and other purposes, 1,838,128 feet (348 miles) of pipe was laid, 3,040 feet of pipe was repaired.

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CONTENTS

AIR COMPRESSOR DEVELOPMENT

It has often been remarked that those most intimately responsible for compressed air practice, in the designing of apparatus and in the installation and operation of air plants, have been neglectful of the possible efficiencies, so that, up to very recently, compressed air as a means of general power transmission has been dicredited and its adoption in many cases has been delayed by the prevalence of unnecessarily wasteful practices which have operated as deterrent examples. In recent years there has been an encouraging change for the better in this particular, so that now it may be said that much of the air used is compressed at one third of the actual power cost, with commensurate reductions also in labor and other accompanying items, as composed with the costs of less than a score of years ago. It is no wonder that it is found out at last that it will pay to use compressed air in large and more or less permanent engineering operations, where it would not have been thought of when air first began to be compulsorily used for mining and tunneling and subaqueous work, the possible economies in practice being then so generally ignored.

We may gather what consolation we can from the fact that steam economy developed even more slowly than that of compressed air. From the Great Eastern to the Campania there was an interval of forty years, the former having 8,000 horsepower and the latter 30,000 upon practically the same coal consumption. In the successive trans-Atlantic steamers which came out in the meantime, each at the time represented the best skill and judgement of its designers, but the same could hardly have been said of air compressors until very recent years. The standard compressor and practically the only compressor of the leading builders less than a score of years ago had a single steam cylinder and a single air cylinder, thus ignoring the even then well known possibilities of economising at each end of he machine.

The attention of the engineering world was at this time being especially directed to the possibilities of steam economy by the various reports of tests of pumping engines in the Transactions of the Mechanical Engineers and elsewhere, so that there would seem to have been special suggestion and incentive to consider and adopt similar economies in compressed air practice. The possible explanation of the failure to do so may be two-fold. The water pumping problem is a vastly simpler one than that of air compression; indeed, there would seem to be no easier proposition for the steam engineer than the high duty pump, while that of the air compressor is among the most complex and difficult.

In the pumping engine the work is continuous. The machine may run day and night, and always at its best, without a governor and without change of adjustment. The resistance agaist the piston is constant for the entire stroke, and the same for every stroke, and there is no such thing even as clearance to be thought, the pump being its own meter, its count of strokes being its record of delivery.

In the air compressor the work is never constant, because the rate of consumption is constantly varying and the air can be stored in advance only in comparatively small volume. In the compressing cylinder a constantly increasing resistance opposes a constantly diminishing steam pressure. Clearance cannot be all eliminated and whatever there is represents reduced capacity. The heating of the air during compression necessitates the cooling of the working surfaces to secure safe lubrication, and the keeping of the air itself as cool as possible is a necessary expedient in the saving of power. While water may be pumped to any pressure in a single cylinder, air must be compressed in stages with efficient cooling of it between them. To control the intake and delivery of the air to correspond with the rate of consumption and at the same time keep the compressor in reliable and economical operation has challenged the ingenuity of the best engineers, with results now most satisfactory.

In the designing and in the operating of the steam driven air compressor all the conditions, at both ends, or in the operation of both functions of the machine, are to be considered. Comparing the best and recent practice with what was only lately too prevalent, it is found, after all, that considerably more is to be saved at the steam end than at the air end of the machine, and those who have had the most to say about the economy of, say, two-stage air compression for the usual working pressures, while ignoring the possible steam economies for the same machines have not been true missionaries.

Of course the complete, self-contained and up-to-date machine, which embodies all that is best in capacity, efficiency, economy and reliability is not the cheapest to build, nor the machine easiest to sell to the uninformed, and the temptation to build the cheap and inefficient has too often prevailed, but now customers are being educated, and especially the best enigneers are becoming alert and are seizing their opportunities, and large permanent plants embodying all that skill can design and capital command are becoming frequent.

NEW BOOK

ROCK DRILLS, Design, Construction and Use. By Eustace M. Weston. McGraw-Hill Book Company, New York. 370 pages, 6x9 inches, 193 cuts and numerous tables. Price, $4.00.

The author of the book is an Associate of the School of Mines, Ballarat, Australia, and a Lecturer on Mining in the Transvaal University College. He has had practical mining experience in Australia, South Africa and the United States and his book throughout bears evidence of complete familiarity with its subject. The various makes of both piston and hammer drills are described, with notable omissions of one or two of the most prominent of the latter class. The largest part of the book is devoted to rock drill practice and to mining and tunneling in general. Numerous examples from actual practice under widely diversified conditions are given with detailed information of actual results secured.

A TWO CYLINDER SINGLE-ACTING AIR COMPRESSOR

[We reproduce here, complete, from *The Engineer,* London, cuts and description of a small air compressor, said to be an example of good engineering practice and design. It is not good practice to compress by single-stage to 100 lbs. Water jacketing of cylinders and heads merely keeps the metal cool and does little to cool the air during compression, so that the two cylinders instead of one give little advantage in this respect. Volumetric efficiency minutely greater or less is scarcely worth talking about for compressors whose maximum capacity is, say, 50 cubic feet of free air per minute, although if it were 5000 cubic feet it might be proper to consider it. The mechanical instinct which would make small machines, especially if high

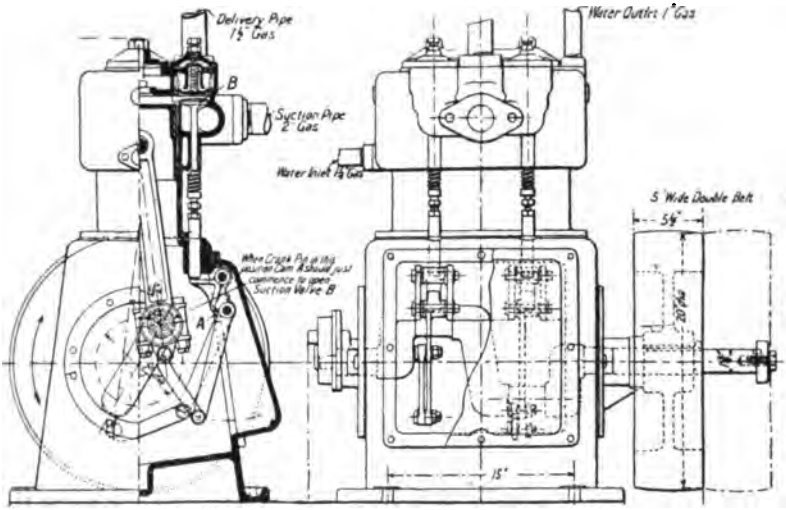


FIG. 1.

speeds were desired, as simple as possible is still entitled to respect and does not lead to trouble.]

The ever-widening field of usefulness for compressed air is causing engineering firms to turn their attention to the production of compact and simple compressors to work at high speeds with efficiency. For the smaller machines two small single-acting cylinders are more efficient than a single cylinder, owing to the greater cooling surface they provide. The compressor of which we give an illustration in Fig. 1 herewith, is made by Broom and Wade, Limited, High Wycombe, and is an example of a modern single-acting machine in which good engineering practice and design have been embodied. This machine has two 6in. cylinders by 7in. stroke, and is fitted with a special form of automatic unloading valve, to which we shall allude later. The machine has been designed to compress air to 100 lb. pressure per square inch at one stage. The valves are mechanically operated, and the inlet valve is lifted by means of a special wiper and link off the connecting-rod. As will be seen in Fig. 2, the wiper works on a pallet with a rolling motion, closing and opening the valve noiselessly at the correct period of the stroke, the air flowing freely through the cylinder until the end of the stroke, and it is claimed that by means of its inertia the cylinder is filled with air at a pressure slightly above that of the atmosphere, thus increasing the volumetric efficiency. This method of operation increases the life of the valve and seat and ensures noiseless working. The valves are made of the finest nickel steel and are practically indestructible. The pistons are accurately

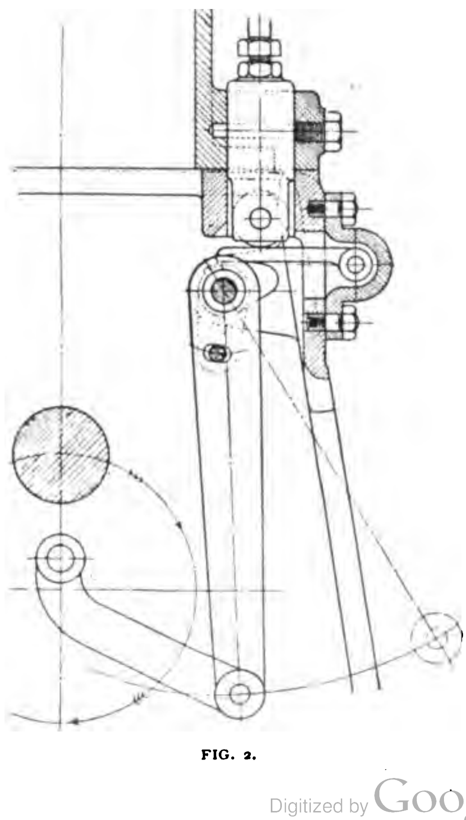


FIG. 2.

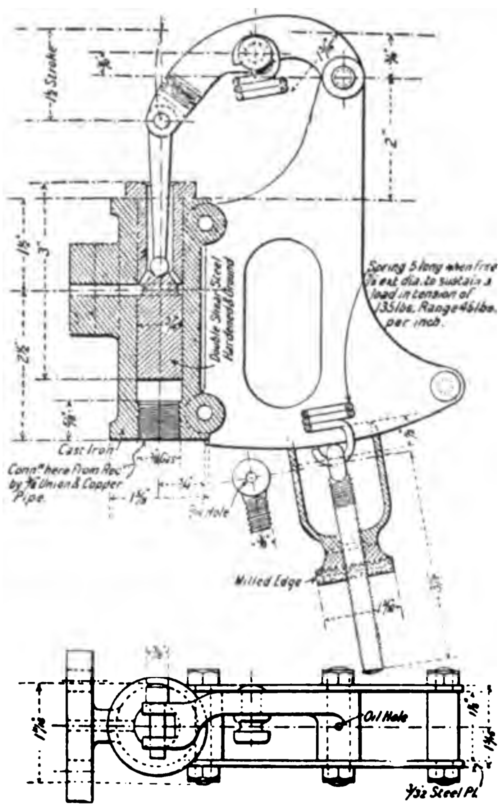


FIG. 3.

ground to fit the cylinders and are fitted with rings of a special type.

The bearings are lubricated by means of a rotary geared oil pump mounted on the end of the shaft. This pump has neither valves, plungers, nor eccentrics to cause trouble. It is positive in action, and has only one pipe connection to the oil well in the base. It delivers oil through its own casing and a hole drilled through the crank shaft to each main bearing and to the gudgeon pin bearings. The cylinders are water-jacketed, and the cylinder casting is firmly secured to a heavy cast iron crank case, which also acts as the base of the machine and is provided with an oil well. The cranks are placed opposite one another, and the valve gear for each cylinder is operated by its own connecting-rod. Both the inlet and delivery valves are of ample area with only a small lift, and the delivery valve has a heavy spring which enables it to close quickly. Owing to these features, coupled with relatively small cylinders and large cooling surfaces, the volumetric efficiency of these two cylinder compressors is claimed to be greater than that of single-cylinder machines of the same capacity. Moreover, the whole of the cylinder head is available for cooling the air.

The automatic unloading device is mounted on the cylinder cover, and is independent of the rest of the machine. This appliance consists of a controlling valve—Fig. 3—which operates of its own accord when the receiver

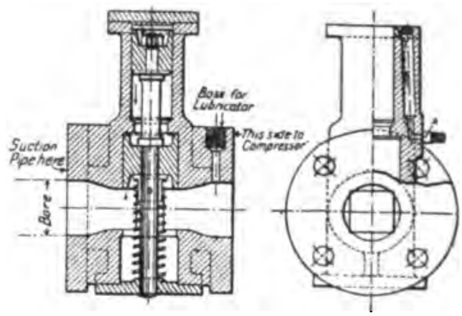


FIG. 4.

pressure rises to a fixed maximum or falls to a predetermined minimum. This valve in turn controls a piston-operated air inlet valve —Fig. 4—in such a way that when the pressure reaches the maximum the air supply is cut off and the compressor runs light. On the other hand, when the pressure has fallen to the minimum, the valve is opened and the compressor takes up its load again. The piston-operated inlet valve consists of a casing, provided with flanges, so that it may be mounted on the inlet supply pipe, and carrying a small air cylinder at its upper side. This cylinder has a piston, which is fixed on one end of an internal spindle, on which the piston valve is mounted. The piston and valve are normally kept in their upper open position by the helical spring shown. On the operation of the controlling valve, however, the upper end of the cylinder is put in communication with the air receiver, so that the pressure forces down the piston, overcomes the spring, and closes the piston valve. The working conditions remain thus until, owing to a fall of the receiver pressure, the controlling valve opens the cylinder in the inlet valve to the atmosphere, when the spring—Fig. 4—being no longer balanced by the pressure above the piston, extends, and opens the valve again. Connection between the inlet valve cylinder and the automatic controlling valve is made by a small pipe, joined up to the air passage, shown in Fig. 3.

NOTES

According to a report made to the Geological Society of Mexico by Prof. Juan S. Agraz, a meteorite found on the Arenalas ranch, 88 km. northwest of Durango, contained: Iron, 96,60 per cent.; nickel, 0.99; cobalt, 2.39; carbon, 0.13. This is the first time carbon has been reported in any of the many meteorities found in Mexico.

The taxes on automobiles in Great Britain are determined according to the horsepower, on a rising scale. A car not over 6½ horsepower pays about $10 a year, while a machine of from 35 to 40 horsepower pays a trifle over $50, and one of from 40 to 60 horsepower, slightly over $100 a year. Automobiles with engines rated at over 60 horsepower are taxed at the rate of $202.70 a year.

For the 46 locks on the Panama canal, there will be 92 gate leaves. The leaves will be hung from the canal sides, meeting in the center when closed, and each leaf will weigh about 600 tons; will be 65 feet wide by 77 feet high and 7 feet thick; composed of girders and steel plating, with interior air chambers. The plating will be 7/16 inch thick at top, increasing to 13/16 at bottom.

A natural gas well of tremendous flow has been struck at Kessarmas, Hungary. The drill hole is 951 ft. deep and the flow of gas is about 31,782,600 cu. ft. per 24 hours. The gas carries about 99.25 per cent. of methane (CH_4) with a heat value of about 8,500 to 8,600 calories. The gas escapes from the drill with a velocity of about 420 miles per hour, causing a roar which can be heard about 2½ miles.

"The superstition with regard to the effect of water on the spine," says the Second Report of the Royal Commission on Mines, "does not appear yet to have entirely disappeared, according to Mr. E. B. Wain, who said that in Staffordshire the men still have a rooted objection to washing their backs, and we believe it lingers in others parts of the country. But, generally speaking, we believe that miners as a class are cleanly, and it must be remembered that in the case of men employed in severe manual exertion like hewing coal, often in a high temperature, perspiration acts as a cleansing agent; in fact, many miners may be said to take a daily Turkish bath."

The Hudson & Manhattan Railroad is now operating more than 2,200 trains a day in the tunnels under the Hudson River between New York, Jersey City and Hoboken. This is the largest number of trains operated daily on any double-track railroad in the world. During the rush hours the headway of trains in and out of the Cortlandt street terminal station is only 1 minute, and the maximum headway of trains between the hours of 6 a. m. and 12 midnight is 2½ minutes.

The amounts of air required in different portions of a mine, for ventilating purposes, are not apt to be supplied proportionally by the natural splitting of the currents. While the longer splits are likely to employ a larger number of men and accordingly require a greater quantity of fresh air, the natural division of the air would give them less and the shorter splits more than required. Accordingly, regulators are placed in the air ways to divide the current according to the demands of the different working places.

The Kruppe Works at Essen are growing as rapidly as ever. On July 1st of last year the firm employed 68,726 officials, clerks and workmen, who, with their families, made up the population of a large town; 37,761 were employed in the steel foundry and the gun-testing grounds alone. The coal and coke consumption amounted to 2,491,406 tons. The number of steam engines was 569, developing 89,430 horse-power. The firm has its own electricity works and gasworks, which latter produces 18,487,300 cubic metres of gas. There are 87 miles of railway, 52 locomotives, and 2,396 cars.

The bolometer, devised by the late Professor Langley to measure the heat of the stars, is a marvelous instrument. The heat of the average star is no greater to us than the heat of a candle placed three miles away, yet this delicate instrument will measure the varying degrees of heat given off by different stars. A spider's web, a thread of spun glass, the gauze of a fly's wing and a mirror as small as a pin head, are some of the things that enter into its construction. It is so sensitive to heat that the image of a man's face thrown upon it at a distance of a half mile will be registered sharply.

The concrete pipe line just completed for the Ontario Power Company is declared to be unique in its engineering features among the great pipe lines of the continent. It is, in fact, the only one of its kind and size in the world. In diameter it is 18 feet, and a mile and a quarter in length. It took but five months to complete it. Resting on a solid foundation of concrete, it traverses a section of almost every known variety of soil. Rock, gravel, loam, and quicksand were encountered. The number of bags of cement used was 247,642, besides 2,350 tons of steel. Its walls are fully 18 inches in thickness. The big pipe could easily be used as an underground railway tube for an ordinary trolley or passenger train.

The perfilograph is an ingenious instrument for recording graphically the undulations of the bottom of a channel in depths to about six or seven fathoms. It is the invention of Augustus Mercau, an Argentine engineer, by whom a paper was read at Buenos Ayres before the Naval Section at the recent meeting of the International American Scientific Congress. A heavy weight of from 150 to 200 pounds is slowly dragged along the bottom by a wire rope attached to the stern of a steam launch. As the depth changes, the inclination of the wire varies. The sine of the angle made by the wire with the horizontal plane is registered graphically in parallel ordinates on a roll of paper which is slowly unwound by means of clockwork at a rate proportionate to that of the vessel.

The Missouri Sand Blast and Cleaning Co. of Chicago has recently made successful experiments in roughing the surfaces of sample concrete blocks, made from materials which are being used in the construction of a bridge at Lake Bluff, Ill. Experiments showed that a very good surface could be obtained in a short time with air at 50 to 55 lbs., and that best results are more easily obtained on concrete a month old or more than on green concrete. The proper surface cutting is obtained by holding the nozzle at an angle with the surface, and by varying the distance between the nozzle and the surface about 1,000 sq. ft. a day is easily covered, and with good men a maximum area of 2,000 sq. ft. could be done.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 1.

974,261. AIR-COMPRESSING APPARATUS. WILLIAM U. GRIFFITHS, Philadelphia, Pa.

974,267. DRILLING APPARATUS. JOHN J. HENNESSY and EDWARD A. CAPOCEFALO, Syracuse, N. Y.

1. A pneumatic apparatus comprising a case, an air compressing piston and a hammer piston movable in the case, the pistons being spaced apart therein and being unconnected, the spaces in the case behind the compressing piston and in front of the hammer piston being unconnected, and a catch extending through the case for holding the hammer piston in its retracted or starting position, during the compression stroke of the first mentioned piston, substantially as and for the purpose described.

974,286. VACUUM CLEANING APPARATUS. FRANK J. MATCHETTE, RICHARD RADDATZ, and CHARLES MOUKOS, Milwaukee, Wis.

974,328. FLUID-PRESSURE-CONTROLLED SWITCHING DEVICE. CHRISTIAN AALBORG, Wilkinsburg, Pa.

974,345. CENTRIFUGAL PUMP AND COMPRESSOR. HARRY F. BENSON, Lynn, Mass.

974,366. PUMP, INJECTOR, OR THE LIKE. GERHARD JOAN OTTO DORIS DIKKERS, Lonneker, near Hengelo, Netherlands.

974,375. FLUID-PRESSURE-ACTUATED IMPACT-TOOL. GEORGE H. GILMAN, Claremont, N. H.

974,409. COUPLING-VALVE FOR PNEUMATIC CLEANING-TOOLS. FRANK J. MATCHETTE and CHARLES MOUKOS, Milwaukee, Wis.

974,413. PRESSURE-FLUID ENGINE. HENRY H. MERCER, Claremont, N. H.

974,483. PNEUMATIC STACKER. JOHN GOODISON, Sarnia, Ontario, Canada.

974,540. SPRAYING APPARATUS. SAMUEL TRUDEAU, Toledo, Ohio.

974,543. FLUID-PRESSURE MOTOR. DANIEL SHAW WAUGH, Denver, Colo.

974,563. AUTOMATIC PRESSURE-CONTROLLER FOR WATER AND OTHER PIPES. IRA G. FOSLER, Chicago, Ill.

974,582. AIR-PUMP. JOHN J. MCINTYRE, Hartford, Conn.

974,617. RECEIVING APPARATUS FOR PNEUMATIC-DESPATCH SYSTEMS. HAROLD D. WATERHOUSE, Quincy, Mass.

974,618. SENDING MECHANISM FOR PNEUMATIC-DESPATCH APPARATUS. HAROLD D. WATERHOUSE, Quincy, Mass.

974,640. SPRAYING APPARATUS. MOTT BILLINGS BROOKS, Rochester, N. Y.

974,645. MINING-MACHINE. ALFRED U. DAVIS, Lutherville, Md.

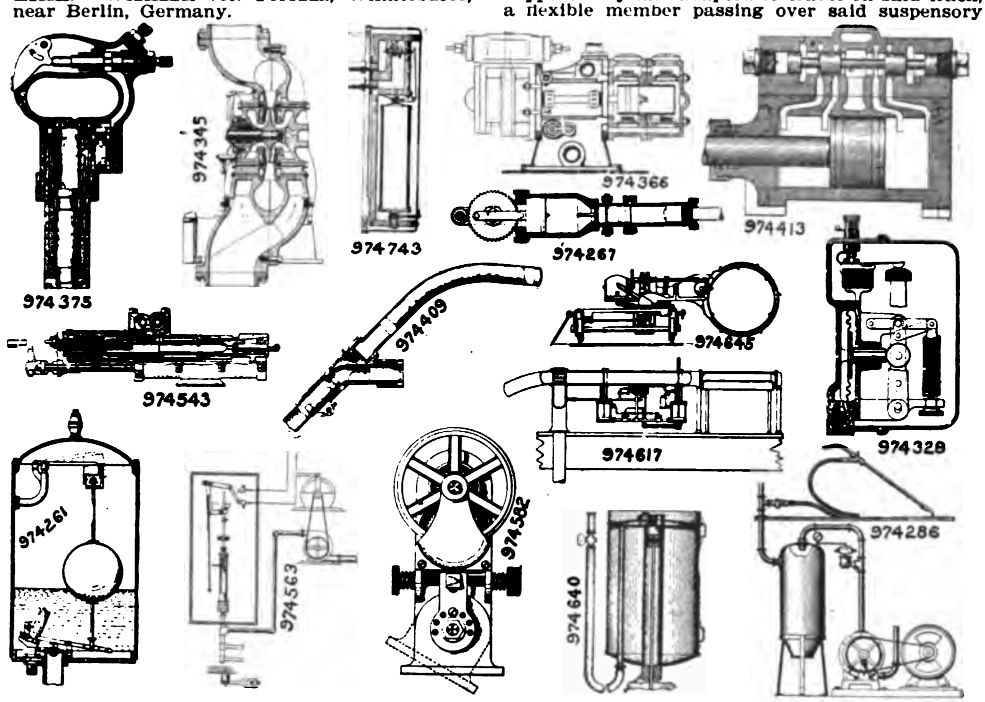
974,743. PNEUMATIC THERMOSTAT. CHARLES E. BONNET, Philadelphia, Pa.

NOVEMBER 8.

974,789. OZONIZER. DAVID S. HENNEY, Newark, N. J.
974,795. CRUDE-OIL BURNER. LEE O. HUDSON, Altus, Okla.
974,799. PNEUMATIC-DESPATCH-TUBE APPARATUS. JOHN S. JACQUES, Hingham, Mass.
974,872. FLUID-PRESSURE VALVE. JOHN FOURNIA, Albany, N. Y.

1. In combination with the valve mechanism of a fluid-pressure motor, means co-operative with the valve mechanism tending to place the mechanism in starting position, and means controlled by the pressure fluid for rendering the co-operative means inoperative.

974,913. ROTARY COMPRESSOR OR THE LIKE. WILHELM VON PITTLER, Wilmersdorf, near Berlin, Germany.



PNEUMATIC PATENTS NOVEMBER I

974,934. METHOD OF CASTING METAL. CHARLES H. UPSON, Waterbury, Conn.

The method hereinbefore described of casting metal consisting in supplying air under pressure to the metal when pouring the same.

974,995. WIND-MOTOR. JOHN SCHIES, Anderson, Ind.
974,997. AIR-REGULATOR. WILLIAM A. SHORB and GUY R. RODGERS, Decatur, Ill.
975,028. VACUUM-CLEANER. JOHN A. FORNEY, Reading, Pa.
975,040. PROCESS FOR REMOVING OXYGEN FROM VESSELS. ROBERT HOPFELT, Cologne-Klettenberg, Germany.

Process for the elmination of oxygen from any desired containers by union of the oxygen with phosphorus, consisting in causing phosphorus-halogen gases mixed with hydrogen to ignite in the previously evacuated container.

975,136. AIR-COMPRESSOR. JAMES J. KIELY, Chicago, Ill.

1. The combination in an air compressor of an explosion engine, air tanks mounted adjacent said engine, said engine comprising a horizontal stationary cylinder open at both ends, oppositely acting pistons mounted in the respective ends of said cylinder, levers fulcrumed at one end and having their opposite ends connected respectively to said pistons, resilient means interposed between said levers for normally holding said pistons at their inner extremities of movement, and means for automatically feeding a percussion-powder ball into said cylinder with each reciprocation of said pistons, and means co-acting with said pistons whereby, upon each reciprocation of said pistons, air is forced into said tanks, substantially as described.

975,196. APPARATUS FOR TESTING FLYING-MACHINES AND LEARNING THE ART OF AVIATION. RICHARD ALEXANDER-KATZ, Berlin, Germany.

1. A device of the character described comprising an aerial track, a suspensory device rotarily supported by and adapted to travel on said track, a flexible member passing over said suspensory device and to one end of which the flying machine or aviator may be suspended, a counterweight attached to the other end of said flexible member, and means for limiting movements of ascent and descent of said counterweight and object suspended from said member.

975,229. FLYING-MACHINE. ROSCOE C. GORE, Tecumseh, Nebr.
975,230. PNEUMATIC STACKER. JOHN HAGEN, Hopkins, Minn.
975,233. AIR-COMPRESSOR. JOHN HANNA and ALBERT HENRY HANNA, Troy, N. Y.
975,258. PNEUMATIC-CUSHION FURNITURE. WILLIAM E. KURTZ, Oakland, Cal.
975,275. INTERNAL-COMBUSTION ENGINE. GEORGE MORTIMER PERLEWITZ, Chihuahua, Mexico.

1. An internal combustion engine, comprising a casing, a power wheel mounted therein and provided with a high pressure side and a low pressure side, means for supplying air into said low pressure side, mechanism for compressing said air thus supplied into said low pressure side, an

explosion chamber connected with said high pressure side, means for conducting said air after receiving a compression into said explosion chamber, means for supplying a fuel into said explosion chamber, an igniting device for exploding a mixture of said fuel and said air under compression and allowing the gases of combustion to explode in said high pressure side, and means for conducting said gases after expansion in said high pressure side over to said low pressure side of said power wheel.

975,380. VACUUM CHURN APPARATUS. THOMAS BERNTSON, Pittsburg, Pa.

NOVEMBER 15.

975,396. VACUUM CLEANING APPARATUS. FREDERIC B. COCHRAN, New York, N. Y.

975,403. AEROPLANE. JOHN WILLIAM DUNNE, London, England.

975,435. VACUUM CLEANING APPARATUS. HERMAN G. KOTTEN, Englewood, N. J.

975,467. FLUID-PRESSURE APPLIANCE. THOMAS S. SCOTT, Pittsburg, Pa.

975,957. FRICTIONAL AIR-COMPRESSOR. CHARLES AVERY JAQUA, Portland, Ind.

975,997. CENTRIFUGAL PUMP, CONDENSER, AND COMPRESSOR. EDMUND SCOTT GUSTAVE REES, Wolverhampton, England.

976,004. COMPRESSED-AIR WATER-ELEVATOR. ERNEST C. SMITH and WILLIAM A. CRUMPACKER, Centerview, Mo.

976,081. AIR-PURIFYING APPARATUS. JOHN H. KINEALY, Ferguson, Mo.

NOVEMBER 22.

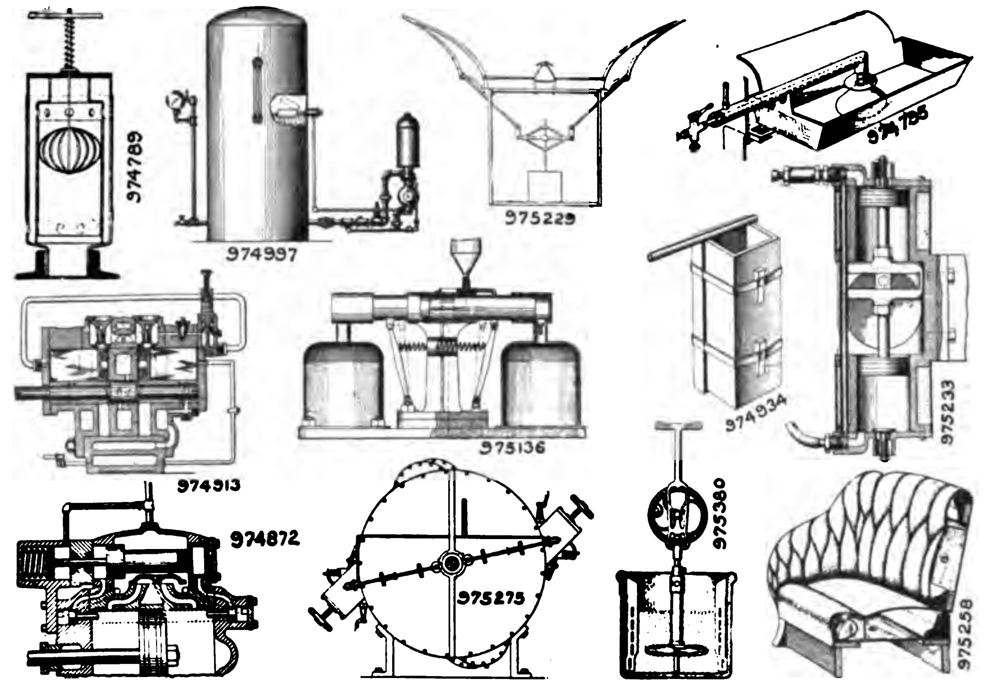
976,161. FLYING-MACHINE. SILAS H. FRENCH, Oberlin, Ohio.

976,174. STANDARDIZING DEVICE FOR GOVERNORS. GEORGE J. HENRY, JR., San Francisco, Cal.

976,224. AIR-BRAKE. AUGUSTUS A. ST. CLAIR, Indianapolis, Ind.

976,242. AQUARIUM. JOHN F. WOHLFAHRT, St. Louis, Mo.

976,268. APPARATUS FOR BURNING CRUDE OIL. ALBERT R. KUNKEL, Palestine, Tex.



PNEUMATIC PATENTS NOVEMBER 8.

975,473. AIR-PUMP. GREGORY J. SPOHRER, Franklin, Pa.

975,501. PNEUMATIC-DESPATCH APPARATUS. THOMAS BEMIS, Indianapolis, Ind.

975,532. MOTOR SUCTION-PUMP. WILLIAM H. KELLER, Philadelphia, Pa.

975,588. PNEUMATIC SYSTEM FOR AUTOMOBILES. ROBERT S. WALLACE, Forney, Tex.

975,578-9. GLASS-BLOWING MACHINE. WILLIAM DAYTON FREDERICK, Bridgeton, N. J.

975,774. TIRE-INFLATING PUMP. CHARLES LEWIS, Auburn, N. Y.

975-782. SAND-BLAST APPARATUS. WILLIAM P. MOTT, Chicago, Ill.

975,891. HAMMER-DRILL. WILLIAM PRELLWITZ, Easton, Pa.

975,903. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHARLES F. STODDARD, Boston, Mass.

975,905. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.

2. A crude oil burner comprising an elongated tubular mixing chamber, a nozzle for compressed air discharging into said chamber at one end, a nozzle for crude oil under pressure discharging across said air inlet, discharge nozzles for the mixed air and oil leading laterally from said chamber, and needle valves in said nozzles.

976,285. FLUID-PRESSURE-ACTUATED VISE. JOHN E. OSMER, Chicago, Ill.

976,305. MILKING MECHANISM. DAVID TOWNSEND SHARPLES, West Chester, Pa.

976,429. PNEUMATIC GUN. AXEL LINUS BLOMEN, Sundyberg, near Stockholm, Sweden.

976,458. VALVE-GEAR FOR FLUID-PRESSURE MOTORS. CHARLES HAMMEN, Chicago, Ill.

976,494. VACUUM-SWEEPER. FRANK JULIUS QUIST and MALCOLM BLANCH, Worcester, Mass.

976,556. DEVICE FOR ESTABLISHING A PULSING MOTION OF FLUID IN CONDUITS. GUSTAF DALEN, Stockholm, Sweden.

1. In pulsators for milking machines operated by pressure, the combination with a casing, of a block movable therein between two seats, two conduits opening into the casing chamber above the block, one of said conduits opening through one of said seats, a piston connected with the block and movable in a part of the casing beneath the block, a branch from one of the conduits, opening into the casing chamber beneath the piston, a transverse partition wall between the block and the piston, provided with the second seat for the block, and an outlet conduit opening in the casing chamber between the partition wall and the piston.

976,566. PNEUMATIC CLEANER. ELWOOD GROSS, WILLIAM E. GROSS and WALTER FELTER, West Pittston, Pa.

976,592. LIQUID-FUEL BURNER. BENTON MOORE, Cherryvale, Kans.

1. A liquid fuel burner comprising a pan, an air pipe discharging thereinto, an oil pipe in the air pipe, and discharging in the direction of the said chambers being provided with an upwardly opening outlet.

NOVEMBER 29.

976,840. SECTIONAL PNEUMATIC TUBE. FRANCIS R. BAYLIS, Lansing, Mich.

976,853. GOVERNING MECHANISM FOR FLUID-PRESSURE ENGINES. HERBERT H. Dow, Midland, Mich.

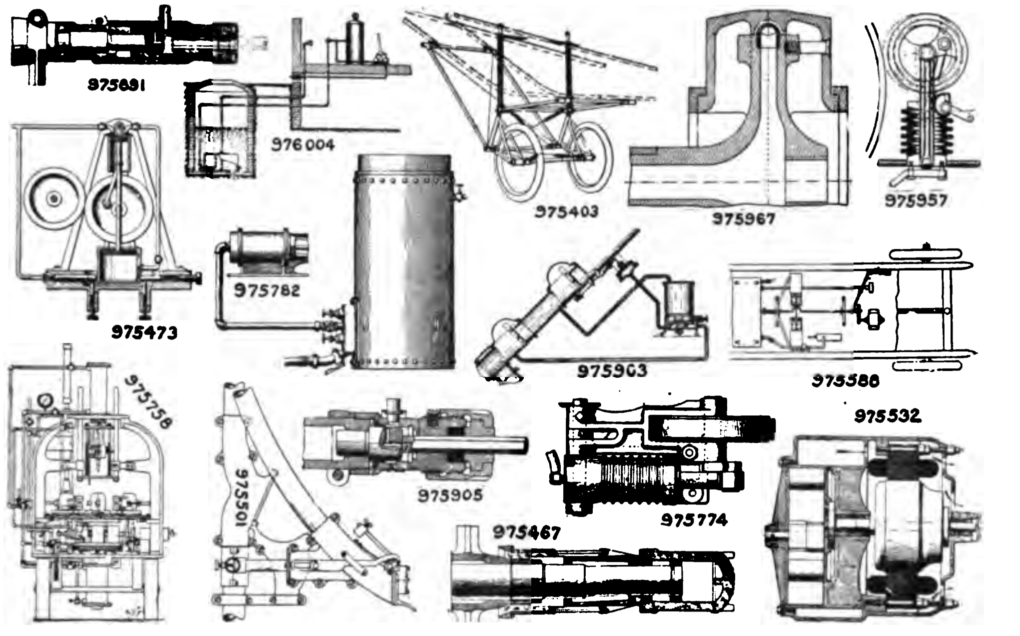
967,873. AIRSHIP. THADDEUS S. HARRIS, Modesto, Ill.

976,876. AEROPLANE. LOUIS ADOLPHE HAYOT, Beanvais, France.

976,966-7. METHOD OF HEATING AIR. GEORGE WESTINGHOUSE, Pittsburg, and ALEXANDER M. GOW, Edgewood, Park, Pa.

976,983. FLUID-PRESSURE MOTOR AND CONTROLLING MECHANISM THEREFOR. WILLIAM H. CAHAL, Chicago, Ill.

976,998. FLUID-OPERATED ROTARY-MOVEMENT-REVERSING MECHANISM. GEORGE A. FOWLER, Denver, Colo.



PNEUMATIC PATENTS NOVEMBER 15.

pan, a tube surrounding the discharge end of the oil pipe, and a steam generator located above the pan, and connected to the tube.

976,671. AIR-BLAST APPARATUS FOR COTTON-GINS. OSMON W. MCDONALD, Rising Star, Tex.

976,688. BOTTLING-MACHINE. ANDERS ANDERSEN PINDSTOFTE, Copenhagen, Denmark.

976,703. DRILLING-MACHINE. ARON G. SEBERG and EDWIN G. SEBERG, Racine, Wis.

976,744. PNEUMATIC-DESPATCH-TUBE APRATUS. JOHN T. NEEDHAM, New York, N. Y.

976,781. APPARATUS FOR PRODUCING CARBURETED AIR. RICHARD BUSCH, Hanover, Germany.

976,818. COMPRESSED-AIR APPARATUS FOR ELEVATING LIQUIDS. LOUIS S. MATHEUS and CHARLES LEINDECKER, Lawrenceburg, Ind.

1. In an apparatus of the character described, the combination with a stand-pipe, of a compressed air inlet pipe extending into the standpipe, a plurality of chambers, pipes connecting said chambers in series, and a connection between the lower end of the compressed air pipe and the lowermost one of said chambers, each of

977,110. PNEUMATIC-DESPATCH-TUBE APPARATUS. JAMES G. MACLAREN, Weehawken, N. J.

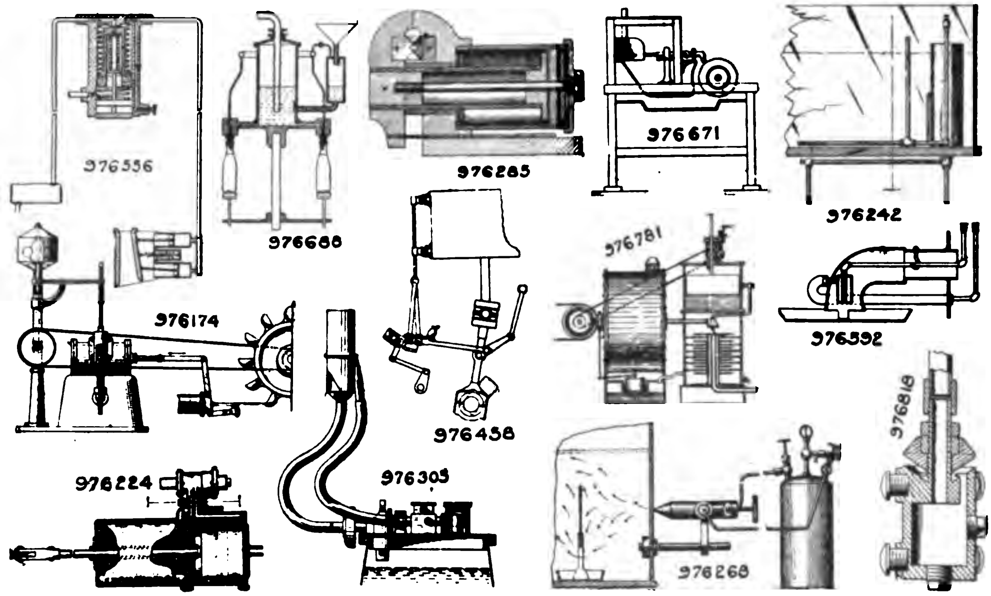
977,160. PNEUMATIC SEPARATOR. FREDERICK A. BRENNER, Milwaukee, Wis.

5. In pneumatic separators, the combination of a forwardly and backwardly reciprocating suction box provided with bottom openings, means for creating suction from said suction box, a rotatable roller located to the rear of the normal forward position of the suction box, and air blowing mechanism to the rear of the roller and constructed to direct blasts of air over the roller and toward the suction box, and thereby serve to separate or disengage surplus sheets of paper from the bottom of the suction box.

977,164. DUPLEX-PRESSURE STRAIGHT-AIR BRAKE. CHRISTOPHER P. CASS, St. Louis, Mo.

977,208. METHOD OF COMBUSTION OF OIL AND GAS MIXTURE. HUDSON MAXIM, New York, N. Y.

1. A process of the character described, consisting in superheating a moving body of com-



Pneumatic Patents November 22.

mingled steam and oil, introducing air into said moving body, subdividing the fluid mixture into a plurality of streams and cooling the latter in proximity to the zone of combustion.

977,274. AIR-PUMP. William A. Cook, New York, N. Y.

977,281. AIR-BRUSH. Thomas A. De Vilbiss, Toledo, Ohio.

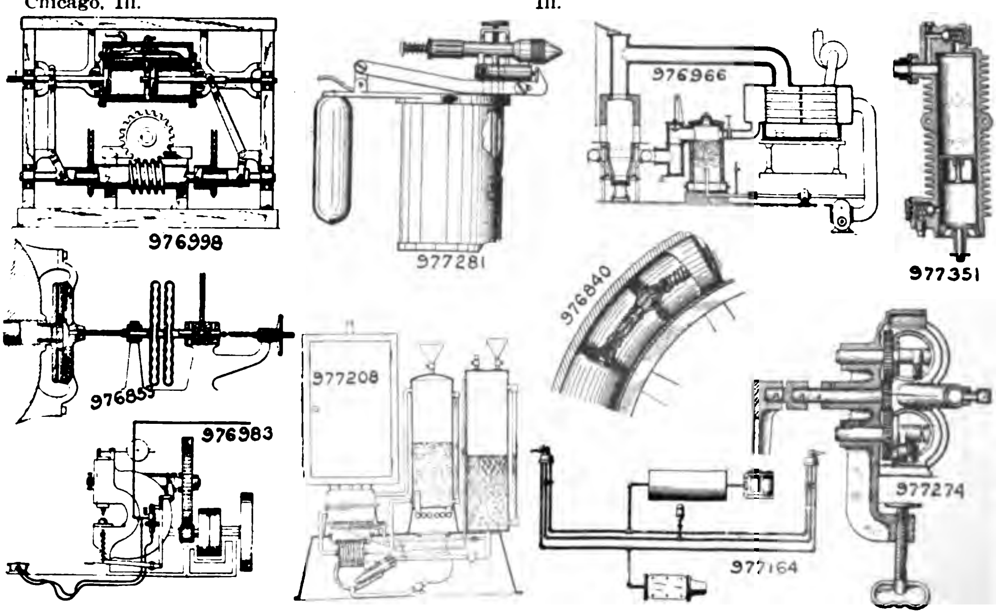
977,335-6. MEANS FOR FILTERING AIR AND PRODUCING OZONE. Samu'l C. Shaffner, Chicago, Ill.

977,338. VACUUM-PUMP. Arthur H. Squier, Philadelphia, Pa.

977,351. POWER TIRE-PUMP. Harold D. Waterhouse, Wollaston, Mass.

977,377. TRIPLE AUXILIARY AIR-VALVE FOR CARBURETERS. Vincent H. Donnelly, Harry B. Koessler and Joseph T. Weinzieri., New Kensington, Pa.

977,380. VACUUM DUST-REMOVER. Charles B. Foster and Wilmot W. Glidden, Oak Park, Ill.



Pneumatic Patents November 29.

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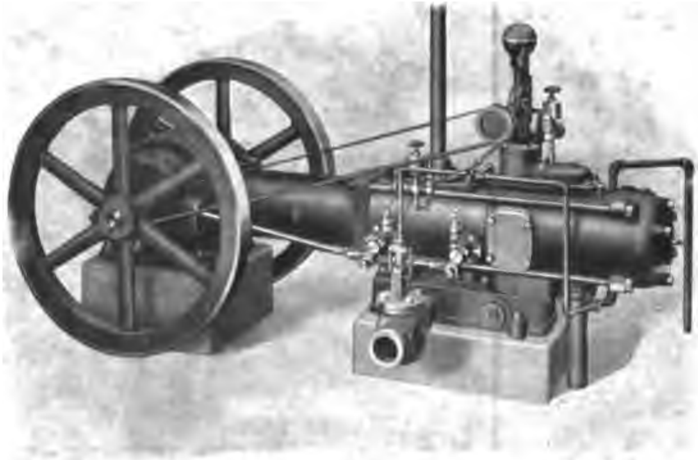

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DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XVI | FEBRUARY, 1911 | No. 2

Published by THE COMPRESSED AIR MAGAZINE CO., Easton, Pa.

NEW YORK, Bowling Green Building LONDON, 165 Queen Victoria Street

Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

The Slogan of the Cameron:—"Character: The Grandest Thing."

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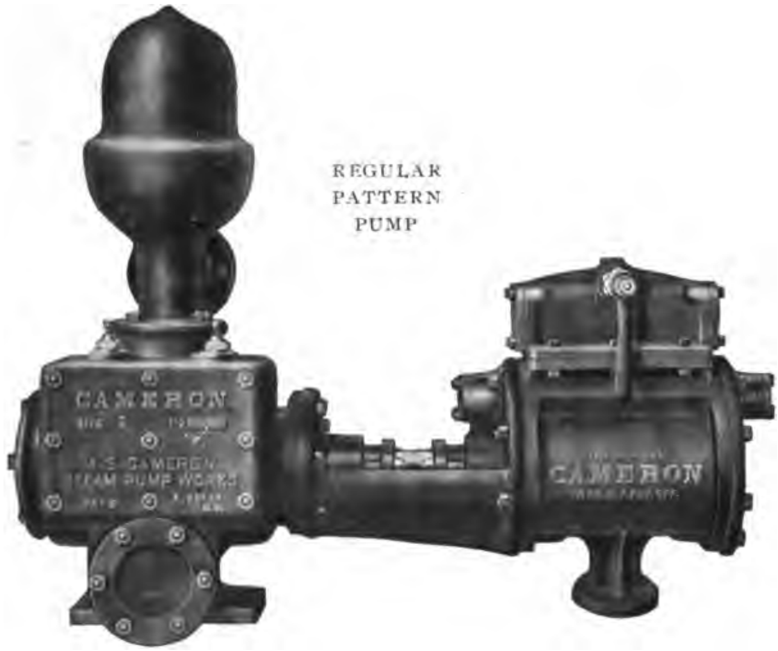

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COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XVI FEBRUARY, 1911 No. 2

FIG. 1. BOTH PORTALS OF TUNNEL NO. 1.

THE SPIRAL TUNNELS OF THE CANADIAN PACIFIC RAILWAY

The completion of two spiral tunnels on the Canadian Pacific Ry., which are a part of the relocated line through the Selkirk Mountains in British Columbia, eliminates one of the steepest grades (4.5 per cent. compensated) on any standard gage railway. The following account of the construction of these tunnels we abstract from an authorized article in a recent issue of *Engineering-Contracting.*

The tunnels are built on 10° curves and a grade of 2.2 per cent., which, in the tunnels, is reduced to 0.06′ per degree of curvature or to a grade of 1.6 per cent. The length of tunnel No. 1, is 3,206 ft. and the length of No. 2 is 2,890 ft. In section the tunnel is 22 ft. 6 ins. wide and 16 ft. 3 ins. high to the springing line, with a semi-circular arch of 11 ft. 3 ins. radius. Where timbering was not necessary these dimensions were somewhat less, but allowed for the placing of a future concrete lining, 2 ft. thick, as shown by the section in Fig. 3.

The tunnels were driven through crystallized limestone which was somewhat uniform in tunnel No. 1, with a dip of 20° to the northeast, but which in tunnel No. 2 was very irregularly stratified. The strike, of course, was made at angles to the face, as each tunnel made a turn of over 230°. Work on tunnel No. 1 was commenced in January, 1908. The work on both tunnels was prosecuted continuously from that time until June, 1910, when the tunnels were completed. Tunnel No. 2 was started a month later and finished a month earlier than tunnel No. 1. An average of 176.9

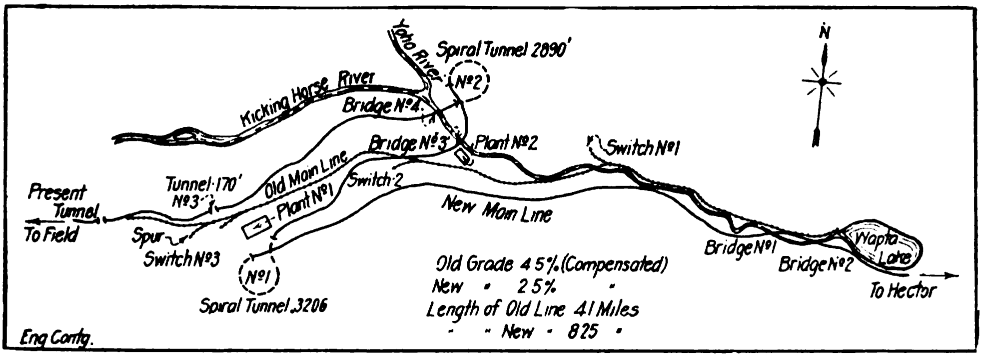


FIG. 2. PLAN OF OLD AND NEW LINE.

ft. per month was made on tunnel No. 1 for 18 months, and 171.3 ft. per month progress was made on tunnel No. 2 for 17 months. Each tunnel was worked with two headings.

It was first intended to do the mucking by hand but after a short trial it was decided to install four Marion shovels for this purpose. These shovels were operated by compressed air and their use necessitated doubling the compressor and boiler capacity of the plant. The plant furnishing compressed air and light to tunnel No. 1 was located near switch No. 3 of the old railway line as shown by Fig. 2. This was about 250 ft. below the elevation of the tunnel portal. The plant for tunnel No. 2 was located at the river about 1,500 ft. from the portal. A list of the entire plant used is as follows:

Boilers:

2 100 hp. (return tubular).

4 80 hp. Jencks locomotive type.

2 100 hp. Jencks locomotive type.

1 100 hp. Brady-Mumphard.

Engines:

1 Comstock Climax engine; 7x10 ins., 25 hp.

1 Comstock Climax engine; 4x5 ins., 4 hp.

1 American hoisting engine with boiler; 7x 10 ins., 25 hp.

1 Little Giant Hoisting engine; 5x7 ins., 8 hp.

Air Compressors:

1 Straight line, Ingersoll-Sergeant (24 and 26½x30 ins.); capacity 1,425 cu. ft. free air per min.

1 Straight line, Ingersoll-Rand (20 and 20 x30 ins.); capacity 1,100 cu. ft. free air per min.

1 Cross-compound American-Rand; air cylinders 22 and 13x16 ins.; steam cylinders 14 and 24x16 ins.; capacity 1,050 cu. ft. of free air per min.

Pumps:

1 Atlantic, 7x4½x6 ins.

8 Fairbanks-Morse duplex; 6 ram pattern; 2 piston plunger pattern; 6x4x6 ins. to 8x5x12 ins.

Generators:

2 Westinghouse d. c., 6 kw., 125 volts.

1 General Electric d. c., 25 kw., 250 volts.

Drills and Shovels:

22 Canadian-Rand Little Giant rock drills.

6 Ingersoll-Sergeant rock drills.

4 No. 20 Marion steam shovels (operated by air).

The effect of the 6,000 ft. elevation above sea level and the cold winter was shown on the mechanical equipment. The effect was in the reduction of the atmospheric pressure about 3 lbs. per sq. in., and a reduction of the temperature. During very cold weather difficulty was experienced by the freezing of the moisture in the air lines. This trouble occurred where the pipes were practically level, but not inside the tunnels. In order to obviate this difficulty additional air receivers were placed in the lines, but they served only partially to overcome it.

The top heading and bench method was used in driving the tunnel. The heading included the area described by the semicircular arch, and the bench included the balance of the tunnel section. Two shifts of 10 hours each were worked each day, with the exception of the shovel crews, who mucked their round. In each heading 6 to 8 drills on four columns were used, with 1 driller and 1 helper for each drill used. Figure 3 shows the approximate location of the drill holes for both timbered and untimbered sections. There were two rows of cut holes about 12 ft. deep. The cut holes were from 2 to 3 ft. from the center line and were "cut" so as nearly to cross the center line. The location of the side holes was varied considerably according to the character of the rock.

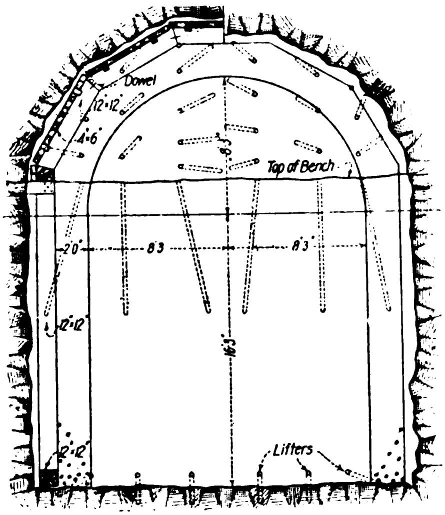


FIG. 3. TUNNEL SECTION.

The bench, which was kept 10 to 12 ft. back from the face of the heading, was drilled with 6 down holes sloped as shown by Fig. 3; also a row of 6 lifter holes, 12 ft. deep, pointed so as to reach about 1 ft. below the sub-grade. The rock was crystallized limestone and very brittle. The center line of the tunnel being, as it was, on a circular arc, the rock strata were encountered at all angles to the drill holes and small pieces broke off inside the holes and jammed the bits. Various shapes of bits were tried, but the use of small pieces of iron, thrown into the hole, proved most effective.

The shovels were used almost entirely for the mucking, with the exception of sufficiently mucking back from the heading to allow the setting up of the drills, and this was done by the drillers and helpers.

The mucking was usually completed by the time the down holes in the bench were drilled and the shovel was then moved back about 150 ft. until the lifter holes were drilled and all holes were fired.

The cut holes were loaded for springing. They were then sprung and fired. The side rounds, the down bench holes, and the lifters were shot at one time. The bench, being kept close to the heading, allowed the muck to be thrown down with that from the bench. The bench was kept as nearly vertical as possible.

The shovels were equipped with special short booms and dipper arms, and shallow dippers for rock work. They were equipped for operation by steam, but the boiler was used as an additional receiver for the compressed air. The shovels were operated on a track close to one side of the tunnel and each was supported on the inner side by a jack. A narrow gage (2 ft.) double track was used for the 4-yd. home-made dump cars, and this track was kept close up to the shovel. At the end of this track, near the bench, it merged into a single track used for loading. Cars came in on one track and went out on the other, requiring about 1 minute for an exchange of single cars. The cars were pulled up grade by horses and ran down grade by gravity.

FIG. 4. UPPER PORTAL NO. 1 TUNNEL.

About 25 per cent. of the tunnels required timbering. When this was done the bench was left about 50 ft. from the heading. The permanent timber plates were put in, each segment was trimmed off and was then lagged and wedged up. Before shooting the bench the wall plate was securely blocked up and the last full length post was protected by old timbers laid against the walls.

When a 50-ft. bench was used the muck from the heading had to be wheeled back in wheelbarrows and dumped over the bench where it could be handled by the shovel. The size of the timber gang varied according to the conditions. Part of the timbering had to be kept close up to the work to support the ground, but for a certain portion it was possible to wait until the excavation had been completed. In this case a "jumbo" car was used to facilitate the handling of timbers and packing. The timbers for the tunnel work were cut from the surrounding mountains.

Water troubles took care of themselves in the headings going up grade, but in the down grade headings sump holes (3x3x3 ft.) had to be made. The sump holes were excavated from time to time as the heading progressed and the water running into these was kept down by pumps operated by compressed air.

The headings all closed within ¾ in. for alinement and the error in closing the grades was practically nothing. The contractors for the entire work were Mcdonnell, Gzowski & Co. of Vancouver, B. C. We are indebted to Mr. C. S. Gzowski, a member of the firm, for the information given.

THE UTILIZATION OF ATMOSPHERIC NITROGEN

BY SAUL DUSHMAN

During the last few years a large number of processes have been devised for the utilization of atmospheric nitrogen. The motives for these processes have been two-fold: both in fertilizers and in explosives nitrogen forms a very important constituent. Nitre or Chili saltpeter has been the substance chiefly used for these purposes in the past; but the nitre beds are gradually becoming exhausted, and the world has come to realize that some other source of fertilizers must be sought for if its food supply is to remain assured. At the same time there exists a continually increasing demand from the manufacturers of explosives, for a concentrated nitric acid.

As far back as 1776, Cavendish, the famous English physicist, discovered that an electric spark passed through a moist mixture of oxygen and nitrogen produces nitric acid, and at least three processes are in commercial operation which are based upon this reaction. In the process devised by Birkeland and Eyde in 1904, a 5,000-volt alternating current is passed between water-cooled copper electrodes and, by means of a magnetic field at right angles to the latter, the arc is spread out into a disc of over two meters in diameter, thus causing almost the whole volume of air in the furnace to be raised instantaneously to a very high temperature. About one per cent. of the air passing through the arc is thus converted into oxides of nitrogen, which are then washed out by passing the gases from the furnaces through a series of towers. There is obtained in this manner a 50 per cent. nitric acid, which is converted into calcium nitrate by neutralizing with lime. The latter is used as a fertilizer directly. The furnaces used by Birkeland and Eyde were originally of 500 k. w. capacity, but subsequently they were replaced by 800 k. w. units, and at the present time it is the intention to replace these by 1,600 k. w. furnaces. In the first commercial installation at Notodden, Norway, only 1,500 k. w. was used; afterwards this was increased to 40,000 k. w. During 1908, the first year of operation, the total income was $536,000, and the net gain, $134,000. Plants have been established at numerous other places in Norway, where water-power is available, and according to most recent reports the Norwegian industry of manufacturing air nitrates is undergoing rapid extensions involving the expenditure of nearly $15,000,000. Not only calcium nitrate, but also more concentrated nitric acid, nitrate of ammonia, nitrate of potash, as well as sodium nitrate are being manufactured at these plants. One of the principal reasons for the success of the process in Norway is undoubtedly the small cost of power which is said to be available at about $5 per horsepower year.

Another process based upon the same fundamental principle is that developed very recently by the Badische Anilin-und Soda-Fabrik. "In this process a continuous arc is produced in a long tube by first bringing electrodes together and then gradually moving them along the tube while the other remains fixed at one end of the tube. The current of air, instead of being passed through this arc, is passed around it through the tube by being forced in at an angle to the main axis of the tube. It is said that the arcs used in this process vary from 35 to 50 feet or more in length, and are maintained continuously for days or even months at a time."

Besides these two processes which are both in successful commercial operation, there is a third process for the oxidation of atmospheric nitrogen which has been devised by H. and G. Pauling, and is working on a large scale near Innsbruck in Tyrol. The electrodes are curved like the electrodes of the so-called horn lightning arresters. The arc is started at the narrowest part between the electrodes by means of a special lighting device. The air current passed through the arc blows it out to a considerable distance and thus increases the volume of air heated to the extremely high temperature at which combination occurs. "The twenty-four furnaces at present installed in this plant have a total capacity of 15,000 h. p. Two other plants, each of 10,000 h. p., for carrying out the same process, are in course of erection, one in Southern France, and the other in Northern Italy."

The process of Frank and Caro for the utilization of atmospheric nitrogen is totally different from any of the above methods. Nitrogen is passed over heated calcium carbide and the result is the formation of a substance having the formula $CaCN_2$ and known as cyanamide. Investigations at numerous agricultural stations have shown that it can be successfully used as a fertilizer, and accordingly a large number of plants are being erected both in Europe and America for its production. The United States Cyanamide Company has a 5,000-tons works at Niagara Falls, Ontario, and is also building another plant in Tennessee. Cyanamide is also of interest on account of the number of interesting derivatives which it is capable of yielding when treated with different reagents. An important reaction is that with steam, leading to the formation of ammonia, which may be subsequently converted into ammonium sulphate.

Still another method for the utilization of atmospheric nitrogen has been devised recently by F. Haber and patented by the Badische Anilin-und Soda-Fabrik. A mixture of nitrogen and hydrogen in the required proportions is maintained at a constant high pressure and heated in presence of a catalytic reagent (such as finely divided iron or osmium) to a temperature which varies between 400 degrees and 800 degrees C. Only about 8 per cent. of the mixture is converted into ammonia, but the power necessary for the compression and circulation of the resulting gases is very small, and it appears very likely that in the near future this process will be exploited industrially.—*Eng. Soc. University of Toronto.*

PROGRESSIVE AIR BRAKE REQUIREMENTS

In a paper before the Franklin Institute on Air Brakes Mr. Walter V. Turner, chief engineer of the Westinghouse Air Brake Co., said, as one of many topics spoken of, that facilities for controlling railroad trains have not advanced relatively as have the requirements, and that, as a mattter of fact, the brake has not kept pace with the developments in locomotion. Even the most efficient brake of today is, at its best, not able to control and stop a train in as short a distance as when the weight and length of the train was less than one-fourth of what it now is. That the stopping distances of modern heavy high-speed trains are not longer than they are, is a source of gratification when it is considered that the length of the train and the volume of air to be handled in controlling the train have rendered the problem vastly more difficult, so far as service control is concerned, and the increase in weight and speeds is such as would require at least twice the distance in which to stop modern high-speed passenger trains, if the old type of brake had to be used.

In one of the earliest brake trials in the history of continuous brake, made on the Midland Railroad near Newark, England, in 1875, a stop was made from 53 miles per hour (the highest that could be obtained) in 18 seconds. [In this time the train at full speed would have run a little over a quarter of a mile, but the actual distance before complete stoppage would, of course, be considerably less than this on account of the gradually diminishing speed.—Ed. C. A. M.] This corresponds to 15.5 foot-tons of work per brake shoe per second. To stop a modern train of heavy Pullman cars from a speed of, say, 75 miles per hour (which can be obtained under favorable conditions) in the same time, namely, 18 seconds, would require about 4½ times as much work per brake shoe per second as in the case of the Midland Railway train. The tremendous significance of this increase in power demanded is but one aspect of the question and is mentioned simply to indicate the nature of the problem which must be solved.

HUMPHREY INTERNAL COMBUSTION PUMP AND AIR COMPRESSOR

The following description of the Humphrey pump and air compressor is from a paper by its inventor, Mr. H. A. Humphrey, before the Manchester (Eng.) Association of Engineers.

The simplest form of Humphrey pump is shown in Fig. 1. Imagine a charge of gas and air to be compressed in the top of chamber C and fired by a sparking plug projecting through the top casting. All valves are closed when the explosion occurs and the increase in pressure drives the water downwards in C, setting the whole column of water in the discharge pipe D in motion. The column attains kinetic energy while work is being done on it by the expanding gases, and may move with considerable velocity when these have reached atmospheric pressure. The motion of the water column cannot be suddenly arrested, hence the pressure in the combustion chamber C tends to fall below that of the atmosphere, the exhaust valve E opens, and also the water valves VV in the supply tank ST. Water rushes in through VV mostly to follow the moving column in pipe D, but partly to rise in C in an effort to reach the same level inside the chamber as exists in ST.

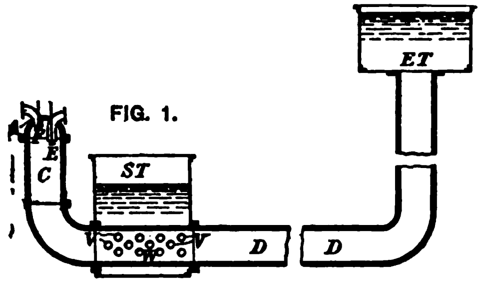
When the kinetic energy of the moving column has expended itself by forcing water into the high-level tank ET it comes to rest, and there being nothing to prevent a return flow, the column starts to move back towards the pump, and gains velocity until the water reaches the level of the exhaust valve, which it shuts by impact. A certain quantity of burnt products is now imprisoned in the cushion space F, and the energy of the moving column is expended in compressing this gas cushion to a greater pressure than that due to the static head of the water in tank ET. Hence a second outward movement of the column results, and when the water reaches the level of valve E the pressure of the space F is again atmospheric, and further movement of the water opens valve A against a light spring, and draws in a fresh charge of gas and air. If there were no friction, the water would fall to the same level as that from which the last upward motion started, but the amount of combustible charge drawn in is slightly less than this movement would represent. Once more the column of water returns under the elevated tank pressure, and compresses the charge of gas and air, which is then ignited to start a fresh cycle of operations.

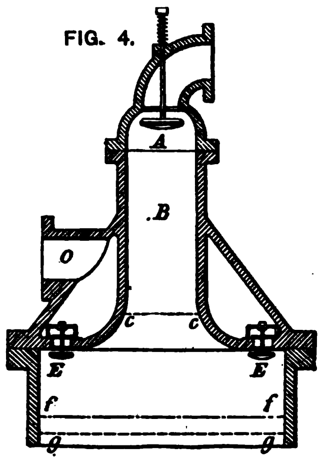
The action of the pump is not altered if, instead of delivering into an elevated tank, it discharges into an air vessel, or into an open-top standpipe or tower, and both these arrangements are useful if a continuous flow from the outlet is desired.

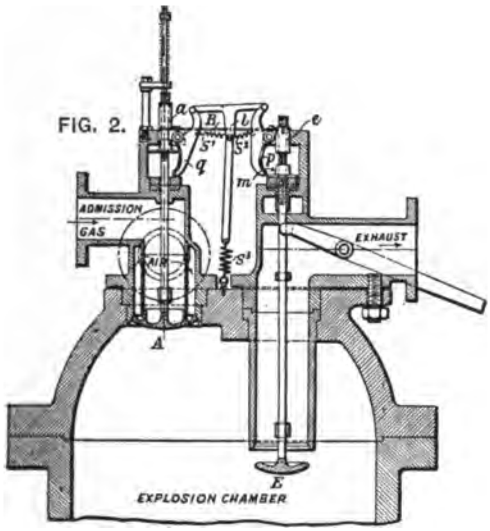
In the simple form of pump the degree of compression of the combustible charge prior to ignition depends on the height to which the water is raised, and exceeds the static equivalent of the head. This is obvious if one remembers that the kinetic energy acquired by the liquid column on its return flow is utilized in compressing the combustible gas, while the compression brings the column to rest.

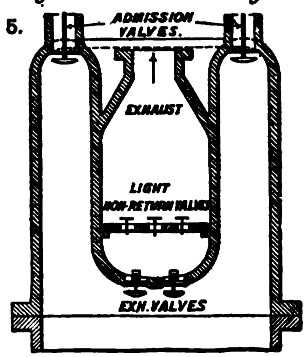
The same considerations enter into the question of the cushion pressure attained, but here we are dealing with the compression of a volume of gaseous fluid which occupies the clearance space only, and the stroke of the water column is greater in proportion, because for the first part of the stroke exhaust products are being expelled, and no compression occurs. The cushion pressure rises rapidly as the height to which the water is lifted increases, and at the maximum lift of about 40 ft. to which the simplest type of pump is limited, it may exceed the explosion pressure when using producer-gas, or may approximately equal the explosion pressure when working with city gas or gasoline.

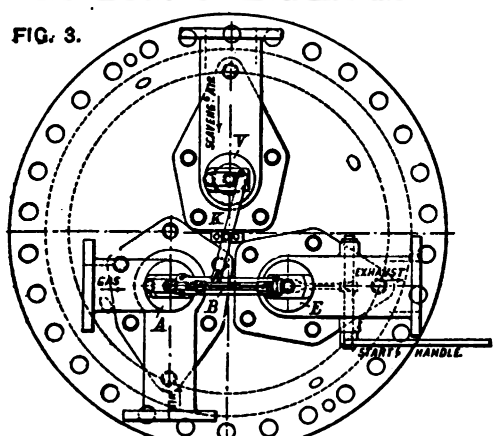
A Humphrey pump was exhibited in operation at the Brussels International Exhibition, and obtained two "highest possible" awards—namely, a Grand Prix in the class for gas-engines, and a Grand Prix in the class for pumps. Its construction is similar to that in Fig. 1, and explanation is not needed till we come to the valve gear shown in Figs. 2 and 3. It will be observed that a bolt B sliding horizontally must lock either the admission-valve A or the exhaust-valve E by engaging under collars *a* or *e*, which are fixed on the stems of their respective valves. Now the bolt is urged right or left, according to whether spring s_1 or s_2 is pulling the hardest, and this again depends on whether the link *l*, to which the springs are attached, has been shifted to the right or left. Suppose the exhaust-valve opened last, then its washer *m*, engaging against cam arm *p*, moves the system *p*, *l*, *q*, so that it leans to the right, in which position it is re-

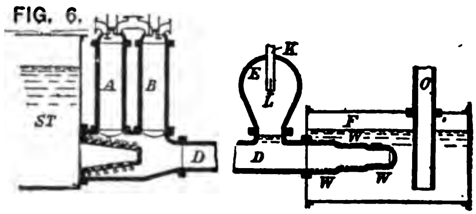


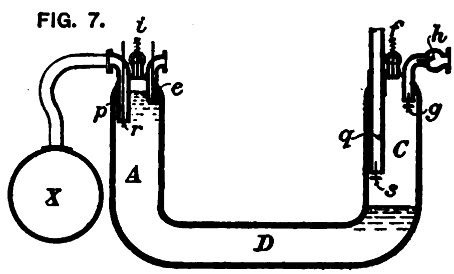












HUMPHREY GAS EXPLOSION PUMPS AND AIR COMPRESSORS.

tained by the tension of spring s_3. This puts tension on spring s_1 and loosens spring s_2; bolt B, therefore, tries to move to the right, but until the exhaust-valve shuts it can only press upon collar *c*. However, when valve E comes on its seat the bolt instantly locks under *e*, and the same motion which holds valve E shut has released valve A, so that next time a suction occurs in the combustion-chamber, A only can open. Precisely the same kind of action occurs when A shuts and is locked and E is released again. Thus valves A and E are automatically allowed to act alternately, the difference between them being that while E remains open till shut by the rising water, A shuts under the action of its supporting spring, so soon as the suction in the chamber permits the spring to lift the valve to its seat.

The scavenging-valve V is shown in the plan of the combustion-head, Fig. 3, and as it operates at the end of each expansion stroke, its locking and release periods correspond with those of the exhaust-valve, and are made simultaneous by a lever pivoted at K, and operated by a pin on the bolt B. If the water could rush in fast enough when the pressure falls to atmosphere, there would be no scavenging action; but the incoming water has to be accelerated, and that just gives rise to a sufficient suction to effect the desired scavenging. In the exhaust outlet there is a light non-return valve, to prevent burnt products being drawn back into the chamber.

Figs. 4 and 5 show alternative arrangements of the top of the combustion chamber for a two-cycle pump requiring no valve gear. The combustion chamber has to be specially shaped, so that the incoming charge, which may be preceded by pure air, displaces the burnt products and mixes as little as possible with them. Thus, in Fig. 4, A is the admission valve at the top of the tall, narrow part of the chamber B, in which the full charge volume extends down to the level *cc*. A number of exhaust valves E lead to a common exhaust outlet O, which may be fitted with a non-return valve, or each exhaust valve may carry a light non-return valve on its spindle, as shown. The level at which expansion reaches atmospheric pressures is, say, *ff*, but this level having been reached by the water, its further movement draws in fresh combustible mixture till it occupies the space down to *cc*, and the liquid level has fallen to *gg*. The column of liquid now returns and drives the exhaust products through the valves E—which had opened by their own weight—until these valves are shut by the water. The kinetic energy acquired by the column is now spent in compressing the fresh charge, which is ignited to start a new cycle. Thus, each outstroke is a working stroke, and no locking gear is required on the valves.

The same cycle applies to Fig. 5, but in this case there is a series of admission valves placed in a ring so as to allow the mixture to enter with a low velocity in order to prevent eddies and mixing with the exhaust products. A higher compression pressure is obtained with this pump than with the simple pump, and consequently higher efficiencies with the same lift.

Fig. 6 shows the arrangement of a double-barrel pump, which has two combustion chambers, A and B, in which explosion occurs alternately. Any Humphrey pump, whether single or double barrel, may be converted into a high-lift pump by means of an air-vessel fitted with valves, and called an "intensifier." The idea is to first allow the water-column to gain velocity, and then to utilize its kinetic energy to (a) compress an elastic fluid, and (b) deliver water under the pressure to which the elastic fluid has been compressed.

In Fig. 6, A and B are the barrels of a two-barrel pump, and at the end of the play-pipe D there are two air-vessels E and F, the latter being large enough to give a continuous flow at outlet O, and to maintain a practically uniform pressure. The smaller air-vessel E is fitted with a downwardly projecting pipe K, open to the atmosphere at the top, and carrying a valve L at its lower extremity, arranged to close under the action of the rising water. The cycle starts with explosion, all valves except L being shut, and the water level as shown. While the water level in E is rising to L, air is merely being discharged into the atmosphere, and as no work is being done by the column of water, it gains speed until valve L is shut by impact. Imprisoned in E there is now a definite quantity of air, which suffers compression until its pressure reaches that at which the high-pressure water-valves W can open, and allow the remaining kinetic energy of the column to force water into F. Valves W close when the column comes to rest, but there remains enough energy in the compressed air in E to give, by expansion, the return flow, which causes exhaust in A and compression of the fresh charge in B to start a fresh cycle. When the water level falls below valve L this valve opens, and air is admitted into E for the rest of the return stroke.

Now it is easy to see that if the pipe K is made vertically adjustable with regard to E, the point of the cyle at which L shuts can be varied, and more or less air entrapped in E at will. But the amount of energy stored in this air will also vary with its quantity, for we assume that the degree of compression remains constant, and is indeed fixed by the pressure maintained in F. Consequently the ratio of the total energy of the working stroke to the energy stored in the compressed air in E can be made anything desired, or, in other words, we can obtain any compression pressure of the new charge in B which we like, and this independent of the water lift. The advantage is obvious, for compression pressures equal to those in modern gas-engines can be employed with a corresponding increase in thermal efficiency. Further, by manipulating the position of pipe K a given pump can be made to meet any conditions as to height of lift, for if the lift increases K can be raised, so that the energy stored in the air in E remains the same, there being now less air, but at a higher pressure.

An important development of the arrangement is shown in Fig. 6, and notice is directed to the fact that at each cycle air is drawn into, and rejected from the vessel E. Let us suppose K to be connected to a supply of combustible mixture instead of opening into the atmosphere, we shall then have an automatic pump for taking in mixture and discharging it under pressure. If the discharge is into a reservoir from which combustion chambers A and B can be supplied, we have at once a means of quickening the cycles and greatly increasing the output of a given size apparatus. It is convenient to replace vessel E by two vessels, one for air and one for gas, so as to maintain the combustible constituents separate until they enter the combustion-chambers. It the first portion of the out-stroke of the water column is allowed to reject the surplus air and gas back to the sources of supply, then the action throughout the cycle is precisely that described when using the single vessel E, except that a larger proportion of the total energy is absorbed in the compression of air and gas, but the excess is given out again during the expansion of the pre-compressed charge in either A or B. The chief advantage arises from the more rapid working, as there is no longer any need to wait for the water-level in A or B to fall under the action of gravity when the charge is being taken in. In fact, the apparatus becomes practically independent of the water-level on the supply side. The 1000-H.P. Humphrey pump now under construction in Germany will operate in the manner just described, the result being that the dimensions are very moderate, and the pump itself occupies no more space than a 1000-H.P. tandem gas-engine.

If the column of water oscillating in the play-pipe of a Humphrey pump is used as a water piston, and caused to rise and fall in an air vessel fitted with suitable valves for the inlet and outlet of air, the combination constitutes an air-compressor of a very efficient type and promising many advantages. Take the case of a single-barrel pump and a single air vessel, shown in Fig. 7. The cycle, which may take two seconds to accomplish, is as follows:

	Pump Chamber. A.	Air Compressor Chamber. C.
1st out-stroke.	Expansion to atmosphere. Intake of scavenging air.	Expulsion of air till water shuts valve *s*. Compression and discharge of compressed air till water shuts valve *g*. Cushion till water comes to rest.
1st in-stroke.	Exhaust till water shuts valve *e*. Cushion till water comes to rest.	Expansion of cushion to atmosphere. Intake of fresh air.
2nd out-stroke.	Expansion of cushion to atmosphere. Intake of combustible charge in excess.	Compression of air, but not sufficient for further delivery.
2nd in-stroke.	Rejection of surplus charge till water shuts valve *r*. Compression of charge till water comes to rest.	Expansion of compressed air.

The flexibility of the air-compressor can now be studied. To begin with the pump side, the level of the inlet valve *e*, and the rejected-charge *r*, are assumed to be variable, although Fig. 7, being merely a diagram, does not show how the pipes carrying these valves are moved vertically. As the level of these two valves controls the amount of charge ignited at each cycle, and the amount of the cushion space, their regulation is all that is required to increase or diminish the energy developed per working stroke. On the compressor side the position of the valves *g* and *s* controls the cycle of operations on this side of the apparatus, and renders it possible to compress a large volume of air to a low pressure, or a smaller volume of air to a high pressure, or to make any intermediate changes which may be desired.

Thus all the conditions of output, up to the full limit of the compressor, may be governed at will, and for all ranges the compression pressure of the new charge may be kept up to the required degree, so that the apparatus works at its maximum efficiency throughout the whole range. The amount of water which oscillates between the chambers should theoretically be altered along with the total capacity per working cycle, but the reason for this is merely to prevent the last portion of each down stroke from being wasted by taking in surplus combustible mixture in one chamber, or surplus air in the other chamber, to an undue extent. If the surplus of the combustible mixture is unnecessarily large, the extra amount rejected will increase the pressure in the reservoir X, and this increase of pressure may be made to automatically govern a water supply, and so bring up the total volume of reciprocating water, or to allow part of the water already in the apparatus to escape, so as just to keep a small amount of excess charge for each cycle, no matter what may be the output of the pump.

THE TURBOCOMPRESSOR

The turboblower and turbocompressor, is a suitable machine for exhausting or compressing large volumes of air or gas. Although only a short time ago it was usually considered to be impossible to make a commercially efficient and serviceable blower of this type for any but the lowest pressures, it is claimed that even at pressures as high as 150 pounds per square inch the new type of turbocompressor is at the very least equal in thermal and mechanical efficiency to the best kind of reciprocating air compressor, whilst from a commercial point of view, the turboblowers or compressors are often preferable on account of advantages attainable through their introduction. The following are some of these advantages:

1. The turboblowers and compressors deliver a steady (non-pulsating) current of air or gas.

2. They run practically without noise at all loads.

3. They are simple in construction, have all parts easily accessible, and are reliable in action.

4. They not only require very little attendance and lubrication when at work, but relatively speaking, a minimum of space for their accommodation.

5. They require a minimum of power to drive; they are also easily governed through a wide range of variation of speed, without materially affecting their economy.

6. They are perfectly balanced both dynamically and in respect of axial thrust.

FIG. 1.

As already stated, turboblowers are adopted for a variety of purposes. It is possible they are preferable to reciprocating engines in all cases where the volume of the air or gas to be handled is sufficiently great, quite irrespective of whether they are required to produce a rise of pressure or a partial vacuum. The turbo compressor, in a like manner, is suitable for all pressures up to 120 pounds per square inch,

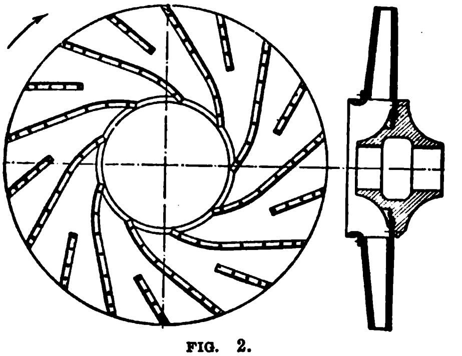


FIG. 2.

if the volume of gas or air to be handled is sufficiently large. Both the blowers and compressors are suited for direct coupling to steam turbines, but they may equally well be driven by electromotors of suitable size and speed.

The impeller shown in Fig. 1 is similar in design and detail, whether intended for a blower or for a compressor. To avoid the high stresses to which it is subjected the im-

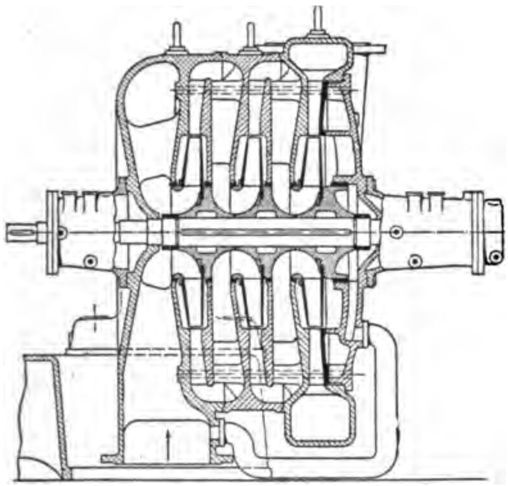


FIG. 3.

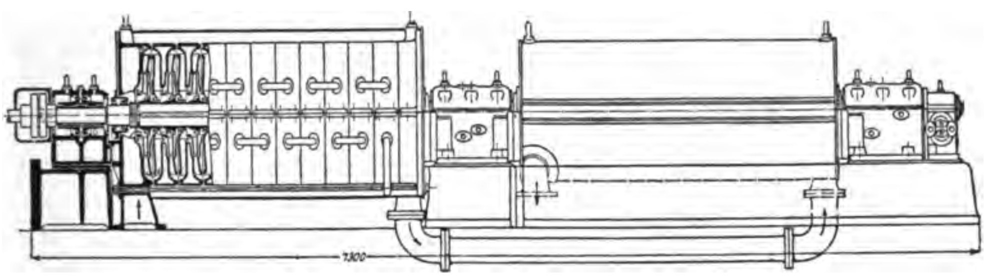


FIG. 4. SECTIONAL ELEVATION OF FIVE CYLINDER TURBOCOMPRESSOR.

peller is built up of those materials which are most suitable for the various parts of the wheel. Thus, the bosses are steel castings, whilst the cheeks are of special steel plates. The latter, as shown in Fig. 2, are conical in cross-section, and attached to the boss in such a manner as to allow free expansion of both cheeks under the influence of centrifugal force. As a result of this construction, the impeller runs true and steady at all speeds, and permits of the running clearances being reduced to a minimum, with the result that internal circulating losses are small.

The housings of these turboblowers and compressors are respectively designed to suit the requirements of the two types of machine. In both cases the housing is fixed at one (the driving) end only, and is free to move with variations of temperature at the other.

In the turboblower shown in Fig. 3 the inlet cover is provided with substantial feet solidly connected to the bedplate. The pressure end and intermediate parts of the casing overhang the bedplate, but are well connected to the inlet cover by vertical, cylindrical, spigot, and faucet joints. The general design is such that all parts of the blower are easily reached for examination or adjustment.

In the case of the turbocompressors, the same general principles of design are followed. As, however, a compressor is usually of considerably greater length than a blower, the two bearings of the former, situated one at each end of the machine, are designed to support the casing as well as the rotor at both ends. Here, too, on account of the greater length of the unit, although the vertical divisions of the casing are maintained, a further horizontal division is introduced, as shown in Fig. 4, so that, after removing the upper half of the housing, each impeller and its corresponding part of the casing are freely accessible for inspection.

The ease with which air may be cooled whilst being compressed in a turbocompressor is to no small extent answerable for the good efficiency of the unit. When reciprocating engines are employed, the effect of water-jackets decreases as the cylinder volume increases; for which reason, if low final temperatures are to be obtained, multistage compressors must be resorted to and intermediate coolers employed. In the case of turbo machinery, the form of the housing and the condition in which the air or gas passes through the machine are both favorable to the efficient use of water-jackets. The rise of temperature can therefore be reduced to a minimum.

The easy and economical method of regulating the delivery and pressure of these blowers compares favorably with the methods—such as by-pass mains and variable clearance volumes, etc.—necessary with some types of blowing machinery. Delivery volume, pressure, and rotary speed vary, as is the case with centrifugal pumps, in fixed proportion to one another; consequently, delivery volume and pressure may be changed by simply varying the rotary speed. At constant speed, volume and pressure may be varied by adjusting the regulating valve usually situated in the suction main. By this means the delivery volume may be varied between its maximum value and zero, the power consumed falling with the reduction of volume, while the efficiency,

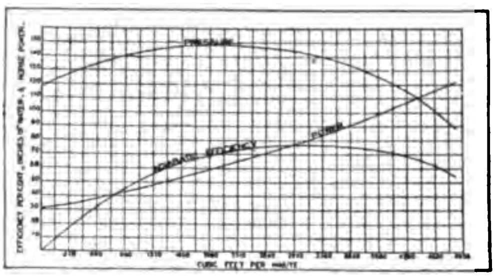


FIG. 5.

as shown in the curve, Fig. 5, is but slightly affected, even by comparatively large changes of volume.

If turbocompressors are directly coupled to steam turbines, a pressure-regulating device can be made to govern the speed of the turbine in such a way as to maintain a constant air or gas pressure in spite of variations of delivered volume. The high efficiency already obtained (78 per cent.) as referred to adiabatic compression, places these turboblowers very favorably in comparison with the best reciprocating blowing engines.

An apparatus known as a solar smelter has been erected outside Johannesburg in South Africa, whose object is to smelt copper, tin, iron, etc., direct out of the ore by means of the heat from a reflector and, in the case of precious metals, even vaporizing them out of the gangue and condensing the vapor The apparatus may also be used in the manufacture of calcium carbide and certain nitrates and in the distillation of oils. Curved mirrors of parabolic cross-section are mounted upon a frame comprising bars, rigidly connected together and to an underframe which is adapted to run upon the wheels around a circular track to allow for the apparent movement of the sun

TOP HEADING AND BOTTOM HEADING METHOD OF ATTACK IN TUNNEL CONSTRUCTION

The method of tunnel construction known as the "top heading and bench" method is in almost universal use in the United States. The reason assigned for this, or rather the general understanding in regard to it, is that this method is both cheaper and safer than any other method of attack.

Throughout Europe the "bottom heading" method of attack in some one of its forms is employed almost universally. European engineers are convinced of the superiority of this method over the "top heading and bench" method employed in America. It may be said, however, that the most convincing arguments in support of the superiority of the European practice are based on the necessity for dealing with the tremendous rock pressures encountered in parts of Europe, and particularly in the Alps, a condition that does not prevail in this country.

ROCK PRESSURES.

These rock pressures are an interesting phenomenon. They make necessary the employment of careful methods of excavation, of timbering, and of lining. In tunnel construction in this country timbering is often necessary to prevent rock falls, which are apparently due to the weight of rock masses that are insecurely attached to the adjacent mountain masses. In the Alps, on the contrary, the phenomenon is one of actual pressure from all sides, a pressure tending to crush in the roofs and sides of a tunnel and to raise the floors. These pressures are not due to a disintegration of the rock masses with consequent tendency to displacement, but are apparently caused by forces imprisoned, we might say, in the formation of the mountains. Experience has shown that these forces are ultimately exhausted in so far as they affect any individual tunnel. This is indicated in the case of the Karawanken tunnel, where the rock pressures, which were of unusual intensity during the early stages of construction, have greatly diminished and now show signs of ceasing entirely. It is evident that a method rendered necessary by such conditions might be highly uneconomical where, as in America, these condition do not exist.

BOTTOM HEADING ADVANTAGES.

With reference to economical considerations it is claimed as an advantage of the "bottom heading" method that all the different working operations in connection with the construction of the tunnel, such as driving the bottom heading and the top heading, excavating the full section and lining the tunnel, are confined to one track which is extended as fast as the bottom heading is driven and remains in one position until construction is completed. At the same time the bottom heading drains the whole tunnel section, and inflowing water is led away in the bottom of the tunnel. Comparison is here made with the straight "top heading" method, in which the top heading is driven complete, and the full section is afterwards excavated. It may be said that this method is only used in tunnels of large size where the adjustment of spoils removal to rate of advance introduces an economic question of more importance than the maintenance of a track in one position. The argument has little force against the "top heading and bench" method, especially where the excavation of the full section follows closely behind the heading, since conditions as to track and drainage are practically the same in the two cases. It therefore appears that the superiority of the bottom heading method is confined to cases where rock pressures exist.

AUSTRIAN METHOD.

The method employed in the construction of the long series of tunnels [see full description in *Engineering-Contracting*, Jan. 4] on what is known as the Second Railway to Trieste, in the Austrian Alps, was, with one exception, what is known as the "Austrian" method which, briefly, is as follows: A bottom heading is driven as an advance heading. Shafts are then excavated from this heading to the top of the tunnel arch. The top heading is then driven, all spoils being dumpeu through the shafts already excavated, and removed through the bottom heading. The full section is then excavated and lined in detached lengths of from 25 to 35 ft. Finally the intermediate sections are excavated and lined. It will be seen that this process has in view at every stage the resistance to rock pressure, great care being taken not to have too much unlined excavation open at any one time.

A variation of the above method is what is known as the "Belgian" method. In this method the top and bottom headings are driven and shafts excavated in the order as given above. Instead, however, of excavating and lining the whole tunnel section, excavation is first made in short lengths for the arch ring alone, and the arch is built, resting on the rock at the level of the springing line. After this is completed the full section is excavated and side walls built under the arches. It will be observed that in this process the greatest precaution is taken against damage from rock pressure, since the arch is put in at the earliest possible stage.

KARAWANKEN TUNNEL.

In the Karawanken tunnel a top heading was driven independently of the bottom heading. This was done because of the presence of fire damp in large quantities, which interfered greatly with the construction of this tunnel. It was not considered safe to excavate shafts from the bottom heading to the arch as was done in the other tunnels, as it was feared that they would serve as pockets for collecting this light gas. The most intense pressures were here encountered, extending over a length of more than a mile. The high cost per foot of this tunnel ($284 per lin. ft.) is doubtless due to the trouble caused by rock pressures, the frequent collapse of timbering and completed lining, and the many interruptions due to inbursts of water. So great were the pressures in this tunnel that the layer of rock, 13 ft. in thickness, lying between the top and bottom headings, was seriously distorted in many places, and heavy bracing was installed to prevent the total collapse of the tunnel.

In a bulletin of the International Railway Congress Association, Mr. F. Hennings, professor of engineering at the Zurick Polytechnic School, advocates the top-cut or high-heading method in the construction of Alpine Tunnels. This was the method used successfully by Rziha in constructing the Czernitz tunnel, where also great pressure was encountered. In this method a bottom heading is first driven, and is then extended upward in two layers to the tunnel arch. The semicircle of the arch is then excavated in segments, bracing by means of crown bars following the excavation closely. This process is then continued downward, the walls of the bottom heading being the last material excavated.

In the methods outlined above the controlling factor is resistance to rock pressure, safety at each stage of the process being carefully provided for. Where rock pressures do not exist, it would seem far more economical to use the "top heading and bench" method as employed in this country.—*Slightly abridged from editorial in Engineering-Contracting.*

LOFTY COOKING

Housewives in the Rocky Mountain region and in other elevated portions of the United States are obliged to solve a few culinary problems that do not trouble women elsewhere.

For example, a woman goes from an Eastern city to live in one of the high valleys of Colorado. She attempts to make a cake and quite naturally uses the recipe to which she has long been accustomed. The cake, instead of acting as it ought, flows over the side of the pan, covers the bottom of the oven and tries to find its way out under the oven door and over the kitchen floor. What remains in the pan, instead of rounding up, appears collapsed.

The trouble is not with the recipe but with the atmospheric pressure, which interferes with cooking in a good many ways. At sea-level, water boils at 212° Fahrenheit. At an elevation of ten hundred and twenty feet it boils at 210°. At Denver, which is one mile above sea-level, water boils at 202°. In the San Luis Valley, at Del Norte, which is seventy-seven hundred and fifty feet up, it boils at 197°. At Leadville, which is nearly two miles above the sea, it boils at 193°.

How is the housewife to boil an egg at Leadville? The answer is that the thing is very hard to accomplish. At all events, she must cook the egg some minutes longer than the time customary in New York or Chicago. It is not the fact of boiling that cooks an egg, but the number of units of temperature employed in the process; hence it takes a good deal longer to cook it at 193° than to bring it to the requisite point of "doneness" in a surrounding fluid medium of 212°.

The trouble with the cake previously mentioned was that the gas generated in it by the baking powder was too strong for it. At sea-level there would have been no trouble, because the pressure of the air on the outside would have been a sufficient restraint; but, the pressure up in the mountains of Colorado being so much less, the gas in the cake made bigger bubbles which tended to run together, until the remaining walls were not sufficient to sustain the weight. Then the cake fell, the pent-up gas escaping through fissures in its outer layer. Incidentally to the process, the gas, insufficiently restrained, caused most of the material of the cake to overflow the sides of the pan.

One naturally asks, What should a woman do under such circumstances? It is very simple. She should either use less baking powder or increase the tenacity of her dough by contributing more albumen in the shape of an additional egg.

COMPRESSED AIR LOCOMOTIVES FOR COAL MINES*

In 1895 the first compressed air locomotive was installed in the anthracite region in the No. 6 colliery of the Susquehanna Coal Co., near Wilkesbarre. Since then this type of locomotive has come into quite general use, due to its simplicity and its rugged characteristics which make it possible to operate it with unskilled men, through wet gangways and under bad roof, and also because it was, and is, the only practical and proven independent locomotive which will operate without fire, smoke, sparks or wires. Today there are about two hundred and seventy-five compressed air locomotives at work in the coal mines of Pennsylvania alone, and about as many more in other States and Canada.

In the past it is the locomotive which has been used when no other would do the work.

If there is gas the air locomotive cannot ignite it.

If there is bad roof, there is nothing essential to the system which will be injured by an ordinary fall.

If the mine is wet, it does no harm except to make the locomotive dirty.

If the bottom heaves, if the track is bad and curves are sharp and derailments frequent, the air locomotive is seldom injured, and its own power is available to assist in cleaning up the wreck to which any other type of locomotive might have set fire.

The features which limited its use to those mines where one or more of the above condi-

*From a paper by C. B. Hodges, before the West Virginia Coal Mining Institute.

tions rendered this locomotive particularly desirable are:

Long tanks to contain a sufficient supply of compressed air, which required more room on curves, and the first cost of the compressors, boilers, pipe lines and charging stations required to supply them with a sufficient quantity of compressed air at convenient points.

Briefly, the essential features of a complete installation of compressed air locomotives are:

1—One or more compressed air locomotives having sufficient tractive force and weight to handle trains of the most economical size and tanks to contain air for the longest possible runs without exceeding the limits of height, width and length which can be economically obtained.

2—One or more air compressors of sufficient capacity to at all times supply the locomotives with sufficient air.

3—One or more charging stations so located that the locomotives will seldom, if ever, be compelled to do special running in order to obtained compressed air as required.

4—A stationary storage system (usually a pipe line) having sufficient volume to equalize the variable rates at which the locomotives may charge, which, taken in connection with the compressors, will insure a satisfactory charge of air for the locomotives whenever they may come to a charging station, and will at the same time provide for connecting up the various charging stations with the compressors.

5—All parts must be combined to form a satisfactory working plant as a whole, and each detail must be carefully worked out to insure sufficient strength to safely sustain the high pressures employed, and also to insure satisfactory operation.

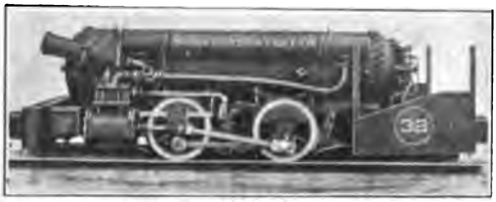
Compressors used to supply air for mine locomotives ordinarily deliver the air to the pipe line at a pressure of 1000 pounds per square inch. This pressure is obtained by compressing in either three or four stages. To compress 100 cubic feet of free air per minute to 1000 pounds pressure in three stages requires about thirty-four horse power; in four stages, thirty-two horse power.

As in even the latest type of compressed air locomotive the air pressure is reduced from 1000 pounds to 250 pounds before the air begins to do any work in the cylinders, there is apparently a very great loss in sufficiently compressing the air to enable a locomotive to make reasonably long runs on one charge. This loss, however, is not so great as the difference of pressure would indicate. To compress 100 cubic feet of air per minute to 250 pounds in two stages requires twenty-three horse power, so that it only requires about ten more horsepower to raise the pressure from 250 to 1,000 pounds or considerably less than one-half additional power to give four times the gage pressure. The reason for this is apparent when the operation of the three-stage compressor is considered.

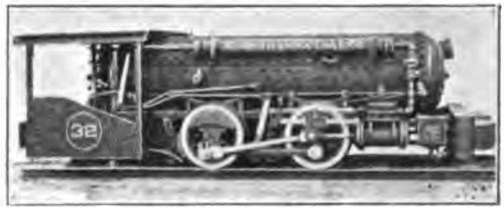
In the first stage the air is compressed to about one-fourth of its volume and to four times its pressure, making the pressure in the first inter-cooler 60 pounds absolute or 45 pounds gauge. In the second stage the volume is again reduced to one-fourth and the pressure increased four times, making the pressure in the second inter-cooler 240 pounds absolute or 225 pounds gauge. In the last cylinder the air is again condensed to one-fourth of its volume and the pressure raised to about 1,000 pounds. In the first stage the volume of the compressing cylinder will be sixteen times that of the high-pressure cylinder and four times that of the intermediate cylinder, and in each case the average pressures are reversely as the volume, so that the total work in each stage is approximately the same.

The three or four-stage compressors as built to-day for producing pressures of from 1,000 to 1,500 pounds are as reliable and satisfactory as machines as are the compressors for 90 pounds which are so widely distributed throughout the mining and industrial world. The high-pressure compressors are provided with speed and pressure governors which will prevent racing under all conditions of service and which will slow down the compressor as the maximum pressure desired is approached and if further reduction in the supply is required, will completely unload or come to a dead stop, if desired. so that no more attention is required for them than should ordinarily be given to a piece of mechanism in continuous motion.

The pipe lines are almost exclusively made from a special quality of wrought iron pipe with extra heavy counterbored sockets for coupling. Each pipe is tested to 1,800 pounds, for a working pressure of 1,000 pounds, and



LEFT HAND SIDE.



RIGHT HAND SIDE.

the ultimate bursting pressure of the pipe varies from 3,500 to 5,000 pounds. In order to provide for access to any joint in the pipe flanged couplings are introduced at intervals of from 200 to 400 feet.

With pipe lines of this character carrying air at 1,000 pounds pressure, the loss due to leakage is practically negligible, and the labor and expense required in maintaining them in this condition is no greater than that required for air lines containing air at 90 pounds pressure, and less than is required to keep a steam line in good condition.

The charging stations consist of a tee in the pipe line or elbow on the end of it, to which is attached a specially designed stop valve with a flexible metallic coupling, which provides sufficient latitude to avoid the delays incident to stopping the locomotive with too great accuracy. With this device the locomotives are ordinarily charged in about one and one-half minutes.

Until 1908 the locomotives were built along substantially the same lines as steam locomotives. The only difference was that one or more heavy steel tanks were substituted for the boiler, and a reducing valve was introduced to maintain a pressure of about 150 pounds at the throttle valve.

In 1908 a new type of compressed air locomotive was offered and has been sold and installed, to the practical exclusion of the older type of single-expansion compressed air locomotive, during the past two years. The first locomotive of this type was built by the H. K. Porter Company and installed in a mine of the Susquehanna Coal Company at Nanticoke, Pennsylvania. Before many tests were made the men running it reported that "it was saving lots of air," and later, comparative tests made by hauling the same cars the same distance over the same piece of track, alternately with the two-stage and then with a single-expansion locomotive of equal capacity, demonstrated that for six separate trips, with variable loads, the average air consumption of the two-stage was fifty-six per cent. of that of the single-expansion locomotive. The increased efficiency was obtained by expanding the compressed air in two successive cylinders, in connection with simply atmospheric interheating during the process of expansion.

This locomotive is shown in four views. The air is stored, at a pressure of eight or nine hundred pounds, in the large cylindrical reservoir, which may be re-charged in one or two minutes from a stationary storage. The air reaches the high-pressure cylinder through a regulating valve, at 250 pounds pressure and atmospheric temperature. From this cylinder it exhausts through an atmospheric interheater, at a pressure of 50 pounds, to the low pressure cylinder.

FRONT END.

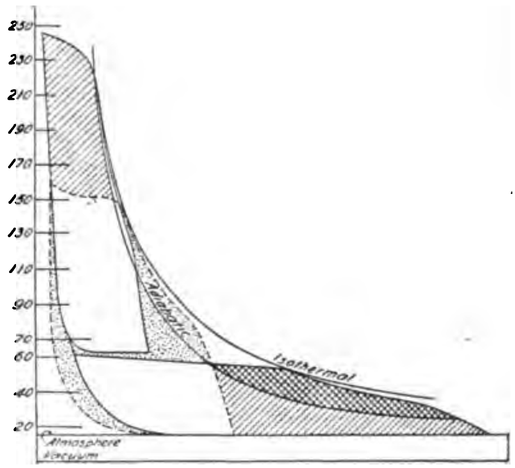
REAR END.

On account of the work done in the high-pressure cylinder (about 20,000 foot-pounds per pound of air), the temperature of the air leaving the high-pressure cylinder is about 140 degrees, Fahrenheit, below that of the atmosphere, rendering the surrounding air an efficient heating medium, which may be readily utilized by means of the inter-heating cylindrical reservoir filled with small tubes, through which the atmospheric air is rapidly drawn by the ejector action of the exhaust from the low-pressure cylinder. In this apparatus nearly all of the heat lost in the high pressure cylinder is restored, expanding the air about thirty-six per cent. and permitting higher initial and lower terminal pressures, with a wider range of expansion—the essential features of economical operation, practically impossible in connection with the single-expansion locomotive, on account of unmanageable refrigeration.

Since the first locomotive of this type was built, about one hundred more have been put in operation in mines, lumber yards and other industrial establishments. Many of these installations were possible only with the new type of locomotive, as with the older type of single-expansion locomotive, the cost of the compressors, boilers and pipe lines would have been too great; or the cost of the power to operate the compressors would have been too high; or the locomotives would have had to be charged too frequently.

The increased efficiency obtained with this type of locomotive has resulted, under ordinary conditions, in reducing the cost of power about 30 per cent., reducing the size of the compressors and boilers thirty per cent., reducing the first cost of the complete installation approximately fifteen per cent., and increased by thirty per cent. the distance which the locomotive will travel on one charge of air.

The combined indicator diagrams show by their area the relative quantities of work obtained from the same amount of compressed air. The area inside of the dotted lines indicates the amount of work obtained from a given quantity of compressed air in the single-expansion locomotive; the area inside of the two indicator diagrams shown in solid lines, the amount of work obtained from the same quantity of air in the new type of two-stage locomotive. The single cross-hatched



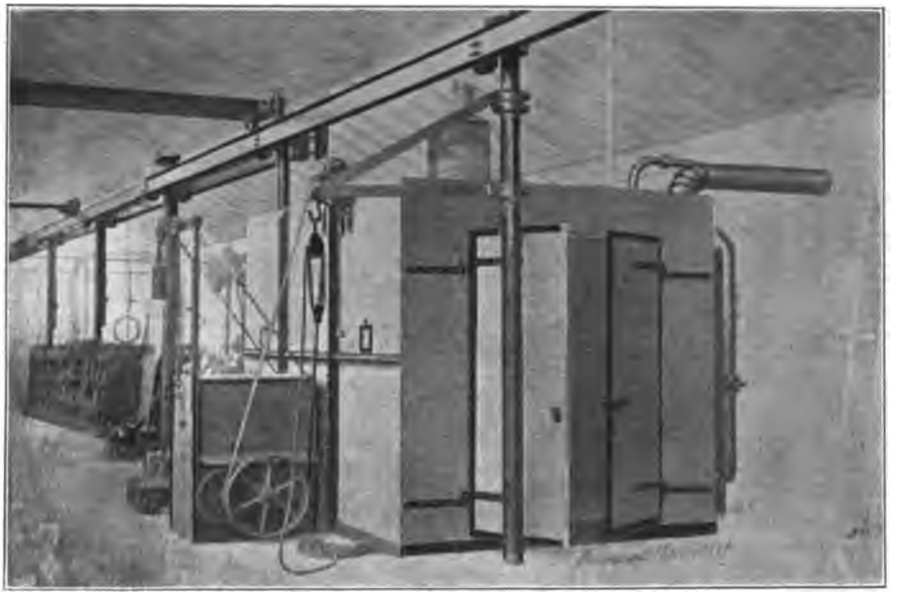
COMBINED INDICATOR DIAGRAMS.

area is the gain due to a wider range of expansion with a higher initial and lower terminal pressure, possible only in connection with the atmospheric inter-heater which prevents unmanageable refrigeration and incidentally adds about eighteen per cent. to the total quantity of work done by the air by expanding it in the process of re-heating to a sufficient extent to increase the area of the low-pressure card by the quantity indicated by the double cross-hatched. area. The stippled area indicates the losses due to the impossibility of always haivng the valve gear of the two cylinders exactly adjusted to obtain the most economical results.

The durability of the pipe lines under mining conditions is a feature of compressed air haulage which at times has been questioned. The life of wrought iron pipe in a mine will of course, vary with local conditions. As a matter of experience, pipe lines were installed in the shaft and gangways of the colliery of the Susquehanna Coal Company at Glen Lyon, Pennsylvania, in 1895, and are still conveying the air to the charging stations for the operation of the locomotives. The same is true of pipe lines installed in the Rolling Mill Mines of the Cambria Steel Company, at Johnstown, Pennsylvania. These lines were installed in 1898. Still another case is that of the Carbon Mine of the Keystone Coal & Coke Co., where pipe was installed in the Gangways in 1897 and is still a part of the piping system which furnishes air to eight compressed air locomotives for the Carbon and

Greensburg No. 2 Mines which jointly receive a supply from the central compressing plant. These instances are merely representative cases of which the writer has definite and recent knowledge.

While having been more or less intimately connected with the subject of compressed air haulage in general throughout the United States and Canada for the past fifteen years, I have known of but one case of replacing a pipe line on account of deterioration due to rusting, acids or any other cause.



A SHOT BLAST TUMBLER INSTALLATION.

THE BEGINNINGS OF SUGAR

It almost gives one a fit of melancholy to sit down and try to picture to himself the alarming state of affairs which must have existed in the good old days when Rome was mistress of the world, and the art and culture of Greece were civilizing her mistress and there was no sugar. Of course there was honey, but what of honey in comparison with the possibilities of sugar? Think of a toddy without sugar, and imagine if you can what a milk punch sweetened with honey would taste like. Your heart almost bleeds for laughing at jovial old Horace as you picture him to yourself sitting under his own vine and fig tree among a small company of the brilliant lights of those palmy days, ladling out his old Falernian punch, sugarless and lemonless, while the thought of old Diogenes lolling in his tub without so much as a penny stick of peppermint to tickle his philosophical palate, and the valorous Anthony paying court to the divine coquette of Egypt without the customary bonbons makes you murmur in mournful numbers: "Was life worth living then, anyhow?" And yet such was the case in those days and all days up to the middle of the middle ages, although the exact date of the invention of sugar hides itself in the dim uncertain regions of myth and legend.

SHOT-BLAST TUMBLING BARRELS

The Mathewson sand blast rattler appliances supplied by the Tilghman Patent Sand Blast Company, Ltd., Broadheath, near Manchester, England, have been employed for the cleaning of castings, etc., for some little time. They are intended for comparatively small castings, larger pieces than, say, 50 pounds weight, being dealt with in the sand-blast room. It is not a sand blast that is used, small chilled-iron shot from 1-40 inch to 1-60 inch diameter being employed.

Fig. 1, which illustrates a barrel plant at the side of a sand-blast room in the works of the Tilghman Company, shows a rattler driven by belt off an overhead motor. The blast itself is taken into one or both ends of the barrel and this is about half filled with castings.

With the rotation of the barrel the castings are regularly turned over, presenting new surfaces to the action of the air-propelled shot. As the barrel moves quite slowly, two to four turns a minute being made, even light castings are not broken by the action. The castings are fed into the barrel through a sliding door and perforations allow the dust and shot, etc., to escape through a hopper so as to meet a current of air. This drives the lighter sand

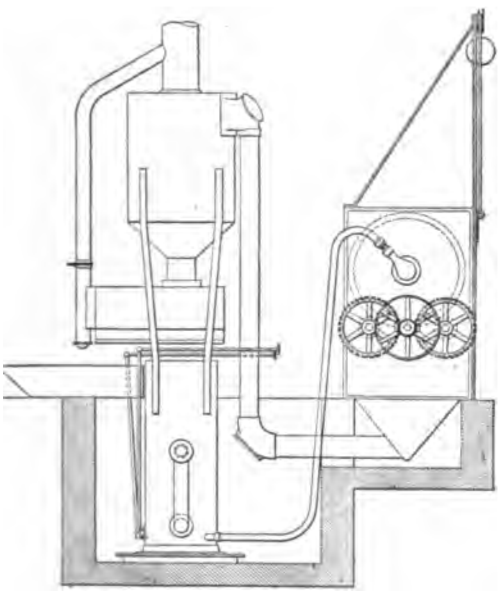


FIG. 2.

away, while the shot falls into a hopper ready for use again.

Fig. 2 illustrates the outfit with sand elevator, separator and air sieve. An exhauster, not shown, maintains a partial vacuum (about 3½ inches water gage) in the tumbling barrel so that any leakage is inward. The sand, etc., is thus drawn to the separator. Shot is used because it does not break up so readily as sand and therefore causes less dust. The castings may be cleaned right down to the metal and a considerable saving in machining cost can readily be claimed.

The plant is built in a number of sizes and continuous tumbling barrels also are supplied, the castings being fed in at one end and passing out at the other after being subjected to the action of four or more separate shot blasts, according to the length of the barrel.

Actual figures are given showing that this process is not only more thorough and efficient but also cheaper than hand work.

THE AIR SUPPLY.

The makers recommend a large volume at low pressure. The reason will be found in the air velocities corresponding to the different pressures. The work done, of course, depends on the velocity of the shot, and short pipes are used. Now, to make a comparison, through a pipe say three diameters long, the velocity at 10 pounds pressure is about 535 feet, a second; at 14.7 pounds, 634 feet; at 29.4 pounds, 656 feet; and at 73.5 pounds only 658 feet. The figures are taken from a well known textbook. It will be plain that after about 15 pounds pressure the velocity rises very slowly. Obviously loss in pressure reduction, from high to low, should be avoided. The firm, therefore, recommend from 5 to 25 or 30 pounds per square inch as a suitable pressure for the air supply. Condensed from *American Machinist.*

AUTOMATIC STABILITY OF A BIPLANE

Lieut. J. W. Dunne recently gave an exhibition of his automatic stability biplane at the Royal Aero Club's flying ground in the Isle of Shippey close to the Thames estuary, Orville Wright being an interested spectator.

Lieut. Dunne made two flights of seven and eight miles, and the interest of the performance lay in the fact that the aviator was able as he flew to take his hands off the control levers and to write notes, which he showed to Mr. Wright in proof of his claim that he has solved the problem of automatic stability.

Lieut. Dunne's machine is a fairly heavy one and is shaped much like a snow plough with the sides open. It has neither tail nor rudder and depends for its steering power on two small flaps at the rear edge of the upper planes. With these the airman brings his machine around to the right or left with perfect ease, keeping at the same time on an even keel.

Aid to air pilots is to be offered by the Blue Hill Observatory, outside of Boston. Experts there are at work on a series of air-current charts, the material for which has been accumulating at the observatory for years.

LOSS OF HEAD IN TRANSMISSION THROUGH PIPES.

Initial Pressure, 75 Pounds, Gage.						Initial Pressure, 90 Pounds, Gage.						Initial Pressure, 105 Pounds, Gage.					
Free Air per Minute, Cubic Feet.	Flow in Pipe per Minute, Feet.	Length of Pipe in Feet				Free Air per Minute, Cubic Feet.	Flow in Pipe per Minute, Feet.	Length of Pipe in Feet.				Free Air per Minute, Cubic Feet.	Flow in Pipe per Minute, Feet.	Length of Pipe in Feet.			
1-inch Pipe.																	
		100	200	300	400			100	200	300	400			100	200	300	400
12.5	385	0.05	0.09	0.13	0.17	12.5	330	0.04	0.08	0.11	0.15	12.5	289	0.03	0.06	0.10	0.13
25	771	0.18	0.35	0.53	0.70	25	661	0.15	0.30	0.45	0.59	25	578	0.12	0.25	0.40	0.52
50	1543	0.69	1.40	2.11	2.83	50	1322	0.59	1.19	1.81	2.41	50	1157	0.52	1.05	1.56	2.10
75	2314	1.58	3.18	4.82	6.49	75	1984	1.35	2.72	4.10	5.51	75	1736	1.10	2.25	3.40	4.68
100	3086	2.82	5.74	8.76	11.89	100	2645	2.41	4.88	7.41	10.00	100	2313	2.11	4.25	6.42	8.65
1¼-inch Pipe.																	
		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		250	500	750	1000			250	500	750	1000			250	500	750	1000
25	339	0.06	0.12	0.18	0.23	25	291	0.05	0.10	0.15	0.20	25	254	0.04	0.08	0.12	0.17
50	679	0.23	0.46	0.69	0.92	50	582	0.19	0.39	0.59	0.79	50	510	0.17	0.33	0.50	0.68
100	1358	0.92	1.85	2.79	3.74	100	1164	0.79	1.58	2.38	3.18	100	1019	0.69	1.38	2.07	2.76
150	2037	2.08	4.22	6.39	8.64	150	1746	1.78	3.59	5.43	7.30	150	1528	1.53	3.14	4.65	6.32
200	2716	3.74	7.64	11.73	16.08	200	2328	3.18	6.47	9.87	13.39	200	2037	2.76	5.56	8.51	11.54
2-inch Pipe.																	
		Length of Pipe in Feet.						Length of Pipe in Feet						Length of Pipe in Feet.			
		200	500	1000	2000			200	500	1000	2000			200	500	1000	2000
100	764	0.17	0.43	0.87	1.75	100	656	0.15	0.37	0.75	1.50	100	573	0.13	0.32	0.65	1.30
150	1146	0.39	0.98	1.97	3.99	150	982	0.34	0.83	1.69	3.40	150	859	0.29	0.74	1.47	2.95
200	1528	0.69	1.75	3.54	7.24	200	1310	0.59	1.51	3.02	6.48	200	1146	0.53	1.32	2.64	5.28
250	1910	1.09	2.31	5.60	11.60	250	1637	0.93	1.97	4.76	9.75	250	1433	0.83	2.09	4.17	8.35
300	2292	1.57	4.92	8.18	17.28	200	1965	1.35	3.46	6.92	14.37	300	1719	1.22	3.06	6.13	12.25

COMPRESSED AIR TRANSMISSION TABLES*

BY FRANK RICHARDS.

The accompanying tables of pressure losses during the flow of compressed air through pipes were computed by what may be termed the Rix-Johnson formula. J. E. Johnson, Jr., gave Church's familiar formula in a simplified form in the *American Machinist,* July 27, 1899, which was, in substance, as follows:

$$R=\frac{K\ V^2L}{D^5}$$

where

V=Volume of free air in cubic feet per minute;

L=Length of pipe in feet;

D=Diameter of pipe in inches;

K=A numerical constant, which Johnson fixed as 0.0006;

R=Difference between the squares of the initial and terminal absolute pressures in pounds per square inch; that is, $p^2_1—p^2_2$.

I have reason to believe that this formula is now used in this country more generally than any other in practical compressed-air work.

E. A. Rix, of San Francisco, uses Johnson's formula with 0.0005 for the value of K. In my own practice I have found it more convenient to use the reciprocal of this value of K, that is, 2000, and transfer it to the divisor, where in actual numerical operations it almost invariably disappears at once by cancellation. I also find it more convenient for my pencil habit to use small letters instead of capitals; hence my working formula takes the form,

$$p^2_1—p^2_2=\frac{v^2\ l}{2000\ d^5}$$

This, of course, may be transformed to suit the special requirements, as:

$$l=\frac{2000\ d^5\ (p^2_1-p^2_2)}{v^2}$$

$$v=\sqrt{\frac{2000\ d^5\ (p^2_1-p^2_2)}{l}}$$

$$d^5=\frac{v^2\ l}{2000\ (p^2_1-p^2_2)}$$

Computations in this line do not invite, not hardly permit, micrometrical precision, and refinements are out of place; hence it is quite permissible and very convenient to use 15 pounds for the normal atmospheric pressure, and this has been done in computing the tables herein given. A single example of the process will suffice.

Let there be 5000 feet of 8-inch pipe, through which it is desired to transmit 4000 cubic feet of free air per minute at an initial pressure of

*Copyright, 1910, by Frank Richards.

LOSS OF HEAD IN TRANSMISSION THROUGH PIPES.

2½-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet						Length of Pipe in Feet			
		1000	1500	2000	2500			1000	1500	2000	2500			1000	1500	2000	2500
100	489	0.29	0.44	0.59	0.73	100	419	0.25	0.38	0.51	0.62	100	367	0.22	0.32	0.43	0.55
200	978	1.16	1.74	2.32	2.89	200	838	0.98	1.47	1.96	2.47	200	734	0.86	1.29	1.73	2.15
300	1467	2 6	3.91	5.25	6.64	300	1257	2.22	3.34	4.45	5.64	300	1100	1.94	2.88	3.87	4.95
400	1956	4.64	6.96	9.30	12.20	400	1676	3.98	6.00	8.00	10.25	400	1467	3.45	5.18	7.00	8.86
500	2450	7.30	10.00	15.10	18.90	500	2100	6.25	9.38	12.56	15.72	500	1838	5.45	8.30	11.15	14.17

3-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet			
		1000	1500	2000	2500			1000	1500	2000	2500			1000	1500	2000	2500
100	339	0.12	0.17	0.23	0.29	100	291	0.10	0.15	0.20	0.25	100	254	0.09	0.13	0.17	0.22
200	679	0.46	0.69	0.92	1.15	200	582	0.39	0.59	0.79	0.99	200	509	0.35	0.53	0.69	0.87
400	1358	1.86	2.79	3.75	4.69	400	1164	1.58	2.39	3.19	3.99	400	1019	1.41	2.12	2.76	3.48
600	2037	4.21	6.39	8.65	10.81	600	1746	3.59	5.43	7.31	9.14	600	1528	3.13	4.83	6.48	8.16
800	2716	7.64	11.74	16.11	20.15	800	2328	6.47	9.87	13.43	16.79	800	2037	5.74	8.72	11.78	14.65

4-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		1000	1500	2000	2500			1000	1500	2000	2500			1000	1500	2000	2500
250	477	0.17	0.26	0.34	0.43	250	409	0.15	0.24	0.29	0.37	250	358	0.12	0.19	0.26	0.32
500	955	0.68	1.02	1.37	1.71	500	818	0.58	0.82	1.17	1.47	500	716	0.51	0.76	1.02	1.28
750	1432	1.54	2.32	3.10	3.89	750	1227	1.31	1.98	2.65	3.32	750	1074	1.15	1.73	2.31	2.89
1000	1910	2.76	4.17	5.60	7.08	1000	1637	2.35	3.55	4.76	3.98	1000	1433	2.05	3.09	4.14	5.20
1250	2387	4.34	6.52	8.91	11.29	1250	2046	3.49	5.59	7.53	9.51	1250	1790	3.22	4.86	6.53	8.22

6-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		1000	2500	5000	10,000			1000	2500	5000	10,000			1000	2500	5000	10,000
1000	849	0.36	0.89	1.81	3.65	1000	727	0.31	0.77	1.54	3.10	1000	637	0.27	0.67	1.34	2.70
1500	1273	0.81	2.04	4.12	8.46	1500	1091	0.63	1.74	3.51	7.15	1500	955	0.61	1.51	3.04	6.16
2000	1698	1.44	3.64	7.45	15.64	2000	1454	1.23	3.10	6.31	13.05	2000	1274	1.08	2.70	5.46	11.19
2500	2122	2.26	5.75	11.93	26.14	2500	1817	1.93	4.89	10.07	21.25	2500	1591	1.69	4.27	8.69	18.12
3000	2547	3.28	8.45	17.86		3000	2181	2.79	7.14	14.84		3000	1910	[illegible]	[illegible]	14.33	27.05

8-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		1000	2500	5000	10,000			1000	2500	5000	10,000			1000	2500	5000	10,000
2000	954	0.34	0.85	1.71	3.46	2000	818	0.29	0.73	1.47	2.95	2000	716	0.26	0.64	1.28	2.57
3000	1432	0.77	1.92	3.89	7.97	3000	1227	0.66	1.64	3.32	6.75	3000	1074	0.57	1.44	2.90	5.87
4000	1909	1.37	3.46	7.06	14.77	4000	1636	1.17	2.95	5.98	12.35	4000	1432	1.02	2.57	5.20	10.65
5000	2386	2.15	5.46	11.29	24.51	5000	2045	1.83	4.64	9.51	20.06	5000	1790	1.60	4.04	8.23	17.61
6000	2864	3.10	7.98	16.83		6000	2454	2.65	6.75	14.00		6000	2148	2.31	5.86	12.06	26.16

10-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		2500	5000	7500	10,000			2500	5000	7500	10,000			2500	5000	7500	10,000
1000	313	0.06	0.14	0.21	0.28	1000	268	0.05	0.12	0.18	0.24	1000	235	0.05	0.11	0.16	0.21
2000	627	0.27	0.56	0.84	1.12	2000	537	0.24	0.48	0.72	0.95	2000	470	0.21	0.42	0.63	0.84
4000	1254	1.11	2.25	3.37	4.56	4000	1075	0.95	1.92	2.88	3.88	4000	941	0.84	1.68	2.53	3.38
6000	1881	2.52	5.15	7.73	10.62	6000	1612	2.16	4.38	6.57	8.95	6000	1411	1.89	3.81	5.76	7.75
6000	2508	4.54	9.37	14.06	20.06	8000	2150	3.86	7.82	11.73	16.54	8000	1881	3.38	6.87	10.46	14.17

12-INCH PIPE.

		Length of Pipe in Feet.						Length of Pipe in Feet.						Length of Pipe in Feet.			
		2500	5000	7500	10,000			2500	5000	7500	10,000			2500	5000	7500	10,000
2,500	530	0.17	0.35	0.52	0.68	2,500	455	0.15	0.30	0.45	0.59	2,500	398	0.13	0.27	0.39	0.53
5,000	1061	0.70	1.41	2.11	2.84	5,000	910	0.62	1.21	1.81	2.42	5,000	796	0.53	1.05	1.58	2.11
7,500	1591	1.59	3.15	4.73	6.45	7,500	1365	1.35	2.69	4.03	5.53	7,500	1193	1.18	2.37	3.59	4.81
10,000	2122	2.83	5.77	8.66	11.95	10,000	1820	2.40	4.89	7.34	10.05	10,000	1591	2.11	4.27	6.46	8.69
12,500	2652	4.45	9.19	13.79	19.59	12,500	2275	3.79	7.76	11.64	16.19	12,500	1989	3.32	6.73	10.23	13.88

105 pounds gage, or 120 pounds absolute. What will be the terminal pressure and the loss of head? The pressure here assumed is not unusual in the best practice of the present day.

Note that d^5 (8^5) is 32,768, and p^2_1 (120^2) is 14,400. Substituting these values the statement and solution is as follows:

$$\frac{4000^2 \times 5000}{2000 \times 32{,}768} = 1220 = p^2_1 - p^2_2 = 14{,}400 - p^2_2$$

Then,

$$p^2_2 = 14{,}400 - 1220 = 13{,}180$$

and

$$p_2 = 114.80 \textit{ pounds}$$

absolute terminal pressure; hence the loss of pressure is,

$$120 - 114.80 = 5.20 \textit{ pounds.}$$

The foregoing example shows what may be considered a suitable rate of pipe transmission, or a flow which should not be much exceeded in practice. The free air in this case being

4000 cubic feet per minute, and the initial absolute pressure being 8 atmospheres, the actual volume, assuming that aftercoolers are used and that the air is at normal temperature, will be only 500 cubic feet per minute. The volume content of an 8-inch pipe is 0.349 cubic feet per foot of length; therefore the rate of flow will be

$$500 \div 0.349 = 1432 \textit{ feet}$$

per minute. A handy limit figure to keep in mind is the round number 1500 feet per minute.

The loss of pressure will be a little more than proportional to the squares of the volumes of free air. That is, if in this case the volume of free air had been doubled, making 8000 cubic feet instead of 4000 cubic feet, the loss of head would have been 22.44 pounds instead of $5.20 \times 4 = 20.80$ pounds.

It is worth while to note how the pressure loss is diminished as the pressure is increased, due to the reduction of volume. Thus, in 1000 feet of 1-inch pipe, transmitting 50 cubic feet of free air per minute, the pressure losses for increasing initial pressures would be as follows:

Initial Pressures.	Loss of Press.
45 pounds gage	11.52 pounds.
60 pounds gage	8.86 pounds.
75 pounds gage	7.24 pounds.
90 pounds gage	6.14 pounds.
105 pounds gage	5.33 pounds.
120 pounds gage	4.71 pounds.
135 pounds gage	4.23 pounds.
150 pounds gage	3.83 pounds.

Of course, no tables can be compiled which will cover the various requirements of compressed-air practice, but the figures herein given may at least furnish a working idea of the probabilities, and may be of service in a general way in preliminary estimates, or may serve to detect errors or inconsistencies which are apt to occur in the most careful figuring. No precise agreement with actual practice can be expected, as conditions which affect the result are so numerous.—*Power and the Engineer.*

BEAVER DAM-AGES

A land company at Stanhope, N. J., recently decided to construct an artificial pond in a section which was being developed, and in building the dam the engineers tore down a dam which had been built at the same spot by beavers. The engineers' work was completed only a short time ago; the beavers in the meantime had remained in seclusion so long that they had been entirely forgotten. A few days later, however, there appeared another and a larger dam of beaver manufacture, below the masonry dam, and before the men awoke to what was going on their new masonry dam was entirely submerged. Inasmuch as the beavers have made a larger pond than the engineers had planned, the latter are said to be inclined to pass by the slight on their work and to accept the gift.

The New Jersey engineers may believe that beaver dams are a good thing, but out near Steamboat Springs, Colo., according to another press report, there is a certain rancher who has a different opinion. Beavers on his ranch have dammed up his irrigation ditch so that the flow of water through his land has been stopped. Not long ago they filled the ditch with such a strong dam that it took two men an hour to demolish it and permit the water to flow unobstructed. The very next night the beavers did another construction job only a few yards from the first. That also was demolished, but to no avail, as the beavers immediately erected another dam. As a final resort, the rancher applied to the State Game Commission for permission to kill the beavers, claiming that unless this was done they would next be damming up Bear River and would thus deprive a number of other farmers of waters necessary for irrigation.

The Canadian Pacific Railway is experiencing difficulty at different places between White River and Cartier on account of beaver dams being erected and flooding its lands. At one place a dam was erected in the centre of a culvert, and part of the filling had to be removed in order to do away with it. When this was done the beavers built another a little further down the stream, and this also had to be removed on account of the backwater.

It seems to be the general opinion that the Government should declare an open season for a year and give the Indians and settlers a chance to dispose of the surplus beaver and otter.

A centrifugal milk tester burst Dec. 29, in the laboratory of the New York State College of Agriculture at Ithaca, N. Y. An instructor and four students were injured.

COMPRESSED AIR MAGAZINE

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CONTENTS

COMPRESSED AIR FOR MINE HOISTING

It is getting to be now quite generally realized by engineers that for the larger problems of power transmission compressed air offers often the best ultimate solution, and accordingly we find it being adopted in many places in extensive open air operations for driving isolated pumps, hoists and other machines for which heretofore steam has been the only power thought of. The wisdom of such employment, as, for instance, on the Panama Canal, the N. Y. State Barge Canal, in various dam and waterworks constructions, quarries, etc., cannot be questioned. One important characteristic of compressed air is that it costs practically nothing except when it is actually doing work. There is no loss by condensation or heat radiation and there need not be any appreciable loss by leakage, and it can be stored in at least sufficient volume to be instantly ready for work of an intermittent character.

It was therefore entirely to be expected and should come to no one as a surprise that some of the larger copper mining companies are now preparing to use compressed air for driving their large mine hoists. While this is of course a new departure, or the extension of compressed air service into a new and important line of employment, it is not at all to be regarded as a blind experiment. Engineers in these days know what they are doing. Experience has assured them in advance that economy, reliability and convenience are to be secured, although the actual figures can only be determined by the records made.

The companies we have now in mind are the Anaconda Copper Company at Butte, Montana, and the Miami Copper Company of Arizona. The ultimate source of power for the Miami Company in this case will be steam generated by oil fuel, which in turn will generate electric current, the latter driving the compressors and also other machinery, the air being used as usual for rock drills and the usual deep mining equipment as well as for the main shaft hoists. The air for the mine hoisting engines will be preheated and also heated again between the compound cylinders, which of course will greatly reduce the volume of air required or the actual power consumption. The previous records of these companies as to hoisting and other service, which, it is understood, have been kept with care will give reliable data for comparison with these later and more elaborate methods.

DISASTROUS AIR-GAS EXPLOSION

An unusual and a phenomenally disastrous gas explosion occurred Dec. 19 at the battery house of substation No. 1 of the New York Central and Hudson River R. R. Company's new Grand Central station terminal in New York city. There is a large storage here of Pintsch gas kept for supplying the train lighting service, and a train not under control broke off a main gas pipe at a considerable distance from the reservoirs, so that gas was escaping for about a half an hour before it was shut off. It is estimated that 14,000 cubic feet of gas escaped and mixed with air under the battery house and this explosive mixture was by some means ignited, wrecking the building and extending its destructive effect for a considerable distance around, a passing trolley car being wrecked and several of its passengers killed.

There have been of course many escapes of gas in much greater volume than this through accidents to gas holders or otherwise, but the gas has usually been free to rise in the air and no disaster has resulted. The capacious mixing chamber which existed in this case in the station excavation under the building and the igniting spark, say from an electric wire, at the opportune moment comprise a combination which sufficiently accounts for the disaster.

Engineering News presents an interesting computation showing the possible force of explosions of air-gas mixtures. It says:

Suppose we take a volume of 100 cu. ft. of gas of 600 B. T. U. per cu. ft. calorific power. When mixed with air in the proportions for most violent explosion the mixture could be contained in a small room about 12 ft. cube. The total heat units in this gas would be 60,000 B. T. U. and the total foot-pounds of potential energy would be 60,000 x 772=46,-320,000 ft.-lbs. If this gas were exploded in small quantities behind a piston in a gas engine cylinder, something like 15 to 25 per cent. of this could actually be obtained as mechanical energy; and given proper mixture, something like this energy will actually be generated when the gas is exploded in a confined or partially confined space and will be exerted against any obstacle. This means that only 100 cu. ft. of gas exploding when mixed with air may have a potential destructive power of over 10,000,000 ft.-lbs.; or it could lift a structure weighing a thousand tons to a height of 5 ft.

AVIATION

Monthly publications are much too slow to keep the public informed of the new records, the incidents and especially the accidents in aviation and it is seldom that Compressed Air Magazine attempts to give any "news" in this line.

A height record of 11,474 feet was reported to have been made by Archibald Hoxsey on Dec. 26, at Los Angeles, Cal., with a Wright biplane flyer.

What is claimed as a world record for length of flight with a passenger was made by Lieut. Camerman, near Paris, on Dec. 21, 355 miles being covered in 5 hours and 55 minutes without alighting. A Bleriot monoplane was used.

An amateur aviator, Cecil S. Grace, on Dec. 22, attempted to make a trip by aeroplane from Dover to Calais and return. The first half was safely made, but on the return the machine disappeared in the fog and no trace has been found.

On Dec. 28, at Issy, France, an aviator named Laffant and a passenger were killed.

John B. Moisant, who was the first to fly across the English Channel with a passenger, and who snatched the $10,000 prize from Claude Graham-White by his flight around the Statue of Liberty in October, fell with his monoplane at New Orleans on the last day of 1910 and was killed.

On the same day Archibald Hoxsey, whose height record of a few days before is mentioned above, fell with his biplane at Los Angeles and was killed.

Both these men were trying to make new records. On the day before Hoxsey had flown to a height of 10,000 ft., passing over Mount Wilson, the highest peak of the mountain range which rims the valley in which the cities of the "Orange Belt" lie.

Lieut. Caumont, of the French Army Aviation Corp, fell from a height of 60 feet at Versailles on Dec. 30, while trying a new monoplane, dying a few hours after the accident.

A distance record for aeroplane flight in 1910 was made by Maurice Taberteau. In a continuous flight of 7 hours 45 min., 362.7 miles were covered.

TRADE PUBLICATIONS

George Oldham & Son Co., Frankford, Philadelphia, Pa. Catalog C. 52 pages and cover, 6x9 inches. Describes Pneumatic Tools and Appliances, and shows them in use.

Temple-Ingersoll Electric-Air Rock Drills, Instructions for Installing and Operating with Duplicate Part Lists, Ingersoll-Rand Company, 11 Broadway, New York, 36 pages and cover, 6x9 inches.

Bentz System Company, Newark, N. Y., 20 pages and cover, 6x9 inches. Describes apparatus for air-washing, ventilating and heating purposes, with full page half-tones of buildings where it is installed.

Buffalo Forge Company, Buffalo, N. Y. General Catalogue No. 178. 304 pages, 6x9 inches. Describes and gives full details of the variety of machinery manufactured, forges, blowers, blacksmith's and boilermaker's tools, woodworker's tools, etc.

Blaisdell Machinery Company, Bradford, Pa., The Blaisdell Automatic Sewage Ejector Catalogue 50 pages, 6x9 inches. This ejector is operated either by air or steam. Its mode of operation and details of installation are described with some fine photos of prominent buildings in which it is used.

Ingersoll-Rand Company, 11 Broadway, New York. Class "PB" Duplex Power Driven Air Compressors, Form No. 3007, 24 pages, 6x9 inches. This class of machines are described in detail with tables of principal dimensions. The drive is either by belt or rope, and compression is either single or two stage with efficient intercooling and close regulation of output.

Baldwin Locomotive Works, Philadelphia, Pa., Record No. 68. 36 pages and cover, 6x9 inches. Mallet Articulated Locomotives. These novel and interesting machines are described and beautifully illustrated, the largest type having two complete engines with compound cylinders and four pairs of drivers to each or eight pairs of drivers to the complete locomotive with a total weight, with tender, of 700,000 lbs. and a tractive force of 96,000 lbs.

The Bristol Company, Waterbury, Conn. Bristol's Recording Gages, 48 pages, 8x10½ inches. This catalogue not only describes and illustrates a great variety of gages but gives a much greater ranger of graduations for different lines of service, reaching all pressures from a perfect vacuum to the highest obtainable, with readings in inches of water, inches of mercury, ounces or pounds per square inch, atmospheres, etc., with all possible graduations under the metric system also.

A MANUFACTURER'S LIBRARY

The Commercial Bureau Company has an elegant and spacious apartment in the Hudson Terminal Building, 50 Church street, New York, which is fully equipped as a Manufacturer's Record or Reference Library. It is free to all who wish to consult matter on file. Out of town visitors are invited to use the library for headquarters. There are free desks or rooms for the temporary use of Manufacturers or buyers, with all the usual facilities for business.

ROCK TEMPERATURES AND DEPTH

Attempts are being made to compare and reconcile the temperatures at different depths in different parts of the earth.

At Witwatersrand mines (South Africa) rock temperatures were taken at intervals of 1000 feet showing temperatures varying from 68.75 degrees F. at 1,000 ft., to 102.35 degrees at 8000 ft., or a general rate of increase of 1 degree for each 250 ft. of depth.

In the Lake Superior copper mining field the rate of increase is given as 1 degree for each 209 ft of depth.

At the St. John Del Rey mine, Minas Gares, Brazil, an average increase is shown of 1 degree for approximately every 156 ft. of depth down to a depth of 4024 ft., the rock at that depth having a temperature of 95 degrees F.

At Bendigo, Victoria, Australia, the rock temperature is given as 110 degrees F., at a depth of 4000 ft., and that of issuing water at the same depth as 114 degrees F. At the Adelbert mine in Bohemia, where silver-lead ores are mined, the rock temperature is 113 degrees F. at a depth of 3600 ft. At the Kalgoorlie mines, Australia, observed rock temperatures show practically no variation between 1400 ft. and 2300 ft., the temperature at each point being given as 84 degrees F. At two intermediate points (1700 ft. and 2000 ft.) 83 degrees F. is recorded.

The easiest and most obvious conclusion from these figures is that no general rule can be given for the increase of rock temperature, with depth, the increase being determined by local conditions. When, however, it is remembered that the greatest depth given above, 8000 ft., is only 0.0003 of the earth's radius no reliable average could be expected. The general fact of the increase of temperature is all that we are sure of.

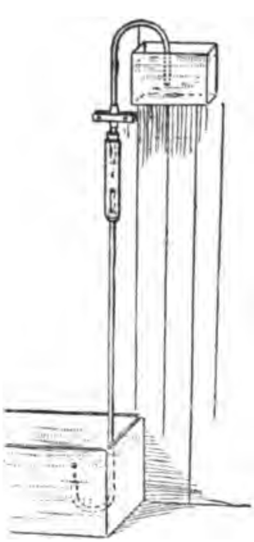


FIG. 1.

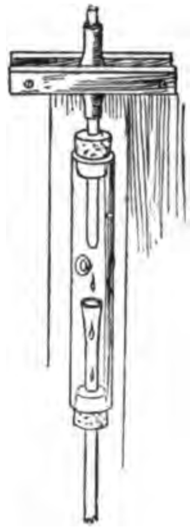


FIG. 2.

AERATING WATER FOR AQUARIUM AND OTHER USES

A simple way of producing air pressure sufficient to aerate water is by the use of a siphon as shown in Fig. 1. The siphon is made of glass tubes, the longer pieces being bent on one end as shown. The air receiver and regulating device are attached to the top end of the lower tube, as shown in Fig. 2. The receiver or air inlet is the most important part. It is made of a glass tube, ¾ in. diameter and 5 in. long. A hole is filed or blown through one side of the glass for the admission of air. The ends of the smaller glass tubes are passed through corks having a diameter to fit the ends of this larger tube. The ends of these tubes should be so adjusted that the continuous drops of water from the upper will fall into the tube below. The succession of air bubbles thus imprisoned are driven down the tube and into the tank below.

The regulator is placed in the tube or siphon above the air receiver. Its purpose is to retard the flow of water from the siphon above and make it drop rapidly. It consists of a rubber connecting tube with two flat pieces of wood clamped over the center and adjusted with screws. The apparatus is started by clamping the rubber tube tightly and then exhausting the air in the siphon tube, then placing the end in the upper reservoir and releasing the clamp until the water begins to drop. If the reservoir is kept filled from the tank, the device will work for any length of time.—*Popular Mechanics.*

PNEUMATIC BOILER-TUBE SCALER

There is now being manufactured in Birmingham, England, a pneumatic tube scaler. This scaler consists of a special pneumatic hammer of a size to permit it to pass easily through the tubes. At the end that enters are fitted six vibratory cutters, arranged in a circle around a central ram and anchored by lugs to an internal collar at the front end of the tool, the interior of the cutter circle being coned to receive the blows of the coned fore end of the piston or hammer. The device is valveless and the ram is its only moving part. It is designed to give from 2,000 to 3,000 strokes per minute, and it is said that it can be regulated to anything within that range by the pressure of air employed; that it requires an average working pressure of 80 pounds, and that by throttling the supply the blows may be regulated to suit any particular degree of hardness or thickness of the scale. In operation the longitudinal blows of the hammer shank cause the cutters to deliver corresponding circumferential blows against the lining of scale on the interior of the tubes. The separated scale is blown ahead by the exhaust air. The tools vary in size from ¾ to 7 inches in diameter. The design of the tools varies somewhat for other uses of a similar kind.—*Consular Reports.*

ELECTRIC AIR HEATERS FOR ROCK DRILLS

R. G. Mackie, in the Journal of the Transvaal Institute of Mechanical Engineers discusses the use of small electric air heaters. He says:

The air temperature at the drills would be higher, and the expansive effect of the hot air used to advantage. The compound rock drill would then have an increased economy over the single-cylinder drill; the exhaust temperature would probably be low enough as to not affect the temperature of the mine, and these drills would, in all probability, be more used. The radiation losses would be more easily maintained, as the expansion and contraction would only take place in comparatively small pipes. In the case of large rigid pipes with heaters for the entire air supply, the expansion effect of the hot air would cause much trouble, and expensive expansive joints and bends would have to be inserted in the mains. Unless these large mains were covered with some non-conductor of heat, the radiation losses would be great, thus tending to increase the mine temperature, so that everything is in favor of small heaters close to the work.

The quantity of heat available from an electric current which passes through a high resistance is proportional to the current squared multiplied by the resistance, or C^2R. By raising the temperature of the air, the amount of work it is capable of performing becomes proportionally greater, and when a cheap electrical supply is placed at the disposal of the mines the re-heating of compressed air under ground will, I hope, become economical.

A SUBMARINE ENDURANCE TEST

How long crews of submarines can remain under water without a renewal of air was sought to be determined by a somewhat unpleasant experiment to which the men of the Danish submarine boat Dykkeren (Diver) have been subjected. The crew numbered eleven, and for these 65 cubic meters of air was available. An adult, scientists say, needs half a cubic meter of air an hour, but it was found that in an enclosed space air deteriorates so rapidly that a calculation based on this figure does not hold good.

The Dykkeren remained under water for twelve hours, but only nine of these the crew passed in comparative comfort. After that the vitiated atmosphere necessitated quicker and quicker breathing to provide the necessary amount of oxygen, and the sailors became seized with a gradually growing sense of terror. They held out bravely, but toward the end they found themselves unable to speak except by a supreme effort of will.

Then the order was given to ascend, and the men tumbled over each other in their anxiety to get at the fresh air. Eye-witnesses say that they lay about the deck gasping like fish out of water. The quick return to normal conditions had bad effects, for the sudden incursion of fresh air into the lungs caused a very painful burning sensation which did not leave them for some time.

SKILL OF OIL WELL DRILLERS

Drilling oil wells is a business concerning which technical literature has had little to say. In general, the work has been in charge of mechanics rather than engineers, and there are so many ways in which a driller can either help or hinder the work that the men have generally been given a free hand. Usually, too, when a field is under development speed is all-important. Competent drill-men have had neither time nor inclination to write of their work. It should be remembered that the drill crew works in the dark. It is impossible either to see the bit at work or to examine the hole when completed and determine just what was the difficulty. Among other notable things accomplished under these conditions, are the handling of a free-swinging column of eight-inch pipe half to three-quarters of a mile long; passing such a pipe to one side and around broken casing or tools in the bottom and continuing the hole; cementing off heavy flows of water nearly a mile below the surface; picking up from the bottom broken tools; underreaming so as to advance casing, and many other equally striking things. In California, wells have been completed where the pipe was broken and passed seven times, and yet a casing was landed successfully at the bottom. The technical achievements of the oil-men deserve more notice than they have received.—*Mining and Scientific Press.*

NOTES

Calumet & Hecla's recovery of copper from its conglomerate lode is now only 29 lbs. to the ton, just about half what it was 10 years ago, and the cost of getting ore to the surface has steadily increased with depth.

With a nozzle 1⅜ inches in diameter and a pressure of 100 pounds, a stream of water can be thrown vertically 103 feet, or horizontally 96 feet and will discharge 674 gallons of water per minute.

Those interested in the conservation of natural resources will be encouraged by English press accounts of the extension of the Yorkshire coalfields, which indicate that they have 35,000,000,000 more tons of coal available for mining than was supposed.

The roar of the air exhaust of a Cameron sinking pump which is used to unwater the shaft of the Butte-Alex Scott Copper Company at Butte, Mont., has been eliminated by passing the spent air through a check valve into the water or discharge column.

Baccarat, France, has the honor of producing the first glass that is unbreakable. The new process has been successfully applied to the manufacture of lamp chimneys for use in coal mines containing much firedamp. The glass makers of Baccarat have also succeeded in increasing the elasticity of the glass.

New York is the center of the great piano industry of the world. In the year, 1909, the output of pianos alone was valued at over $25, 000,000; representing 180,000 instruments. Every conceivable class of musical instrument is manufactured in this city. The two largest piano factories in the world are located in "Little Old New York."

The most highly civilized people on earth use the largest quantities of sugar per capita. The consumption of sugar increases with the wealth and refinement of a nation. England and the United States use sugar in much larger quantities than any other country in the world. The average consumption of sugar per capita with the people named is more than seventy-five pounds per year.

In a large colliery district close to Manchester a great number of miners travel by train to and from their work. On arriving at the station the smokers, and that means practically every one, stick their pipes into various corners and holes of the platform woodwork. There they remain till going back time, when each man always finds his pipe just as he left it.

The official records show that eighty-two million dollars worth ($82,000,000) of merchandise originating in the United States crossed the Isthmus in 1909, which sum, it may be assumed, will be much increased as soon as the Canal is opened, saying nothing of what will be coming to the United States over the same route.

It has always been thought that the disintegration of stone was the result of heat and cold and corrosion caused by the weather. A scientist has proved that it is really caused by a germ, and, when stone is treated with an insecticide the disintegration ceases. All this leads to the inevitable conclusion that there is either vegetable or animal life in the stones, and if in stone where does life cease?

The Baltimore & Ohio Railroad has erected a new double-track steel bridge over the Cheat River at Rowlesburg, W. Va. The bridge, consisting of two spans of 115 and 125 feet, respectively, was put together nearby, and when all was ready, hydraulic machinery was employed, the old bridges were removed and the new bridge was rolled into place, all within 20 minutes, and without delay to traffic.

Grouting the surface of concrete in order to make it smooth, leaves it subject to unequal wear, owing to the lack of uniformity in the degree of hardness in such a thin layer of cement. The "set" of a thin sheet of cement is not the same as that of a large mass. For this reason the tops of concrete blocks for setting heavy machinery should not be made "true" by grouting, but by dressing down after the block has set, in the same way as the surface of a stone would be finished.

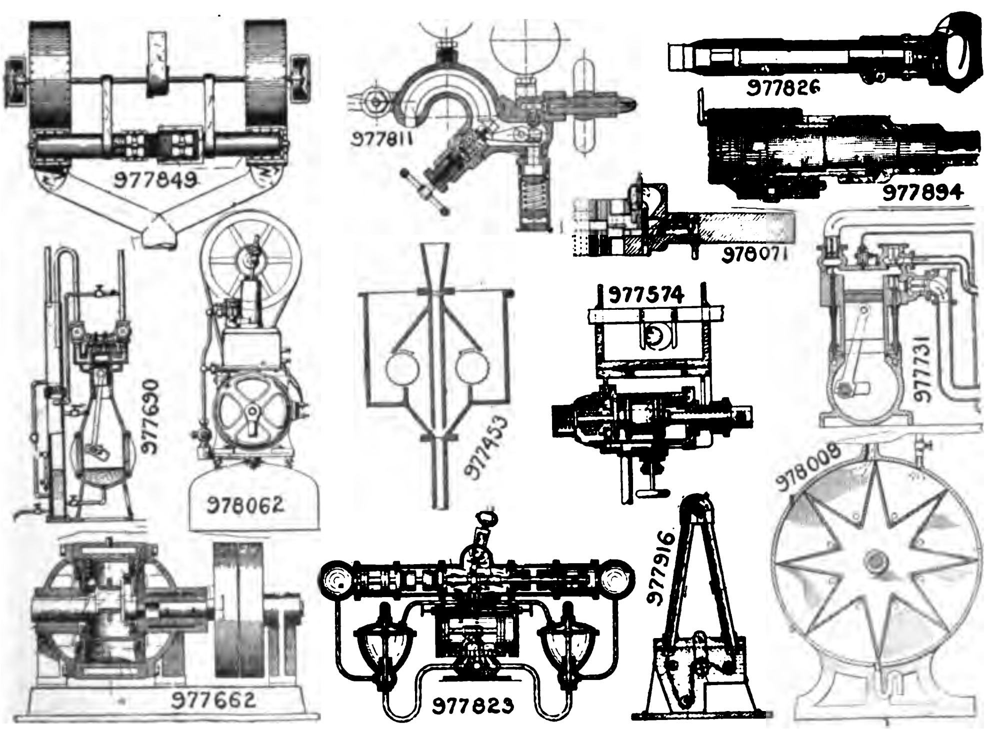
The Pennsylvania Railroad is said to be considering the installation at Union Station, Pittsburg, of a device for registering automatically the number of passengers passing through the trainshed gates. The apparatus comprises a stream of compressed air which plays continuously across the passageway and holds open a circuit, except when it is interrupted by the body of the person traversing the passageway. These interruptions register the number of persons passing.

Sir William Ramsey stated recently that the cost of radium was now $2,100,000 per ounce, which is slightly less than a year ago, when, in an address at the laying of the cornerstone of the radium factory at Limehouse, he said that the value of the substance was $2,500,000 an ounce, which was at the rate of $90 per milligramme. In January, 1910, the price was said to be $3,000,000 an ounce. About a year ago there was only a quarter of a pound of radium in the whole world, and the quantity is not much greater at the present time.

Official tests of the many valuable hardwoods native to Western Australia have made known the extraordinary properties of yate, believed to be the strongest of all known woods. Its average tensile strength is 24,000 pounds to the square inch, equalling that of good cast iron. But many specimens are much stronger, and one was tested up to seventeen and a half tons to the square inch, which is equal to the tensile strength of wrought iron. The tree grows to a maximum height of 100 feet, and has sometimes a diameter of 2½ or even 3 feet."

The consumption of silver in the photo graphic industry is probably seldom thought of, but it is likely that at least 4,000,000 oz. are annually consumed in this industry. George Eastman, of the Eastman Kodak Company, says: "We are now using about 125,000 oz. of silver bullion per month. We have no accurate means of estimating the total amount of silver used in our industry in the country, or in the world, but should imagine that altogether it would aggregate several times this amount." This use of silver so disperses it that it is not recoverable under present practice.

Notwithstanding its new tunnels under both the Hudson and East Rivers, the Pennsylvania Railroad has under consideration the construction of an East River bridge. This was made known in a letter from Vice-president Samuel Rea, as read before the Municipal Art Society, of New York. "I hope that before very long," he writes, "our company will be actively engaged in the construction of the bridge across the East River, and we will take all steps in our power to make this bridge not only impressive because of its proportions, but beautiful in its design, and a monumental feature of the City of New York."



PNEUMATIC PATENTS, DECEMBER 6.

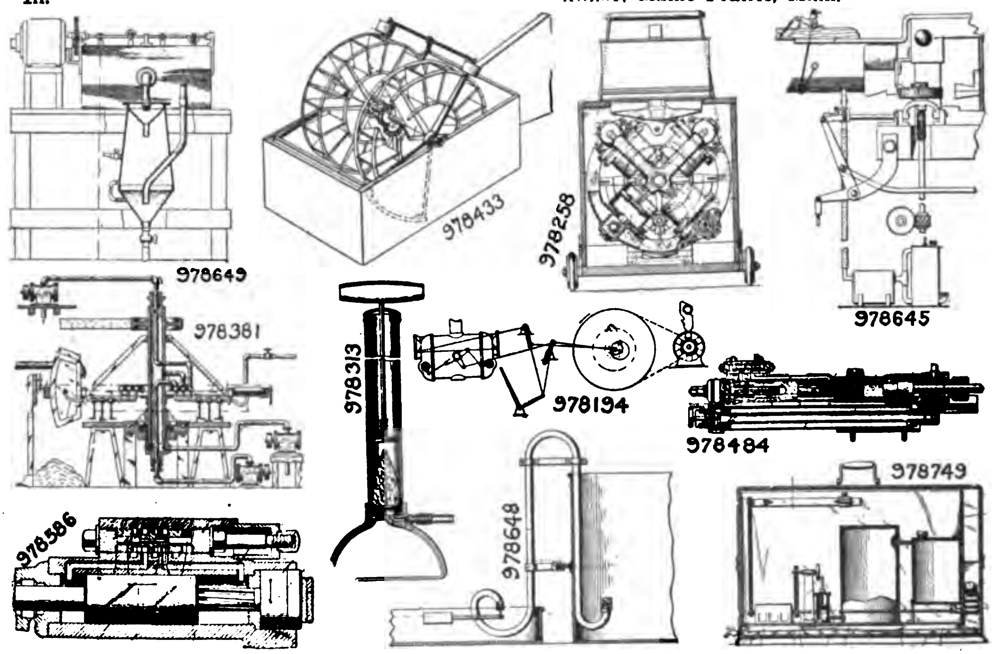
LATEST U. S. PATENTS

Full specifications and drawings cf any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 6.

977,453. SAND-BLAST DEVICE. ALBERT JORN, Jr., Waukegan, Ill.
977,528. AEROPLANE. AUGUSTUS F. W. MACMANUS, San Antonio, Tex.
977,549. COMBINED AIR-RIFLE, RUBBER BALL, AND POP-GUN. ERNEST S. ROE, Plymouth, Mich.
977,555. OCEAN - AIRSHIP. REINHOLD SCHMIECHEN, Ledyard, Iowa.
977,574. FLUID-ACTUATED MOTOR. JOHN S WARD, Chicago, Ill.
977,662. COMPRESSOR. JOHN LEVEY, Chicago, Ill.

said piston structure in opposite directions, said means comprising a pair of pressure-controlled valves, and pressure connections for said pressure-controlled valves.
977,826. PNEUMATIC TOOL. REINHOLD A. NORLING, Aurora, Ill.
977,849. PNEUMATIC ELEVATOR. GEORGE BERNERT and JACOB BERNERT, South Germantown, Wis.
977,856. AIR-BRAKE SYSTEM. JOHN DILLANDER, Temple, Tex.
977,894. PNEUMATIC DRILL. JONAS L. MITCHELL, Denver, Colo.
977,916. AIR-PUMP. SAMUEL R. WILLIAMS, Oberlin, Ohio.
977,997. FLYING-MACHINE. EDWARD BERTHOLF, Watkins, N. Y.
978,008. AIR-COOLING APPARATUS. GENNARO DRAMIS, Brooklyn, N. Y.
978,062. AIR-COMPRESSING APPARATUS. PERCY RUSSELL, New York, N. Y., and ADOLPH W. SCHRAMM, Riverton, N. J.
978,071. PNEUMATIC COUPLING. DAVID B. STANLEY, Maine Prairie, Minn.



PNEUMATIC PATENTS, DECEMBER 13.

977,690. GAS-PUMP. ALFRED S. WHITE, Chicago, Ill.
977,731. THERMODYNAMIC MACHINE. JOSEPH EMILE HAENNIG, Belfort, France.

1. In the transformation of heat into motive force, the process which consists in successively compressing, heating, expanding and cooling a part of a motive fluid, driving a motor by the expanding of said part of the motive fluid, and submitting another part to vaporization and then to condensation, by communication of heat units from it to said first part.

977,811. PRESSURE-REGULATOR. JACQUES MANDET, Paris, France.
977,823. CONTROLLING-VALVE FOR PUMPING SYSTEMS. FRANCIS S. MILLER, Indianapolis, Ind.

1. A controller for air lift systems comprising a main valve, a piston structure for shifting the same, a valve controlling the flow of motive fluid to said piston structure, a piston structure connected with said second valve, and means for controlling the flow of motive fluid to and from

DECEMBER 13.

978,167. PORTABLE VACUUM-CLEANER. CADWALLADER W. KELSEY, Philadelphia, Pa.
978,194. MOTOR-COMPRESSOR. BRUNO V. NORDBERG, Milwaukee, Wis.

1. In a motor-compressor the combination of an alternator, a synchronous motor, and an engine provided with means for converting it from a compressor into a motor and vice versa, and having a power transmitting connection with said synchronous motor.

978,198. PNEUMATIC-DESPATCH-TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.
978,258. AIR-PUMPING APPARATUS. ERNEST L. B. ZIMMER, Minneapolis, Minn.
978,271-2. PNEUMATIC - DESPATCH - TUBE APPARATUS. JAMES T. COWLEY, Boston, Mass.
978,313. PUMP FOR MEDICATING AIR. JAMES A. LEE, Bellsville, Ohio.

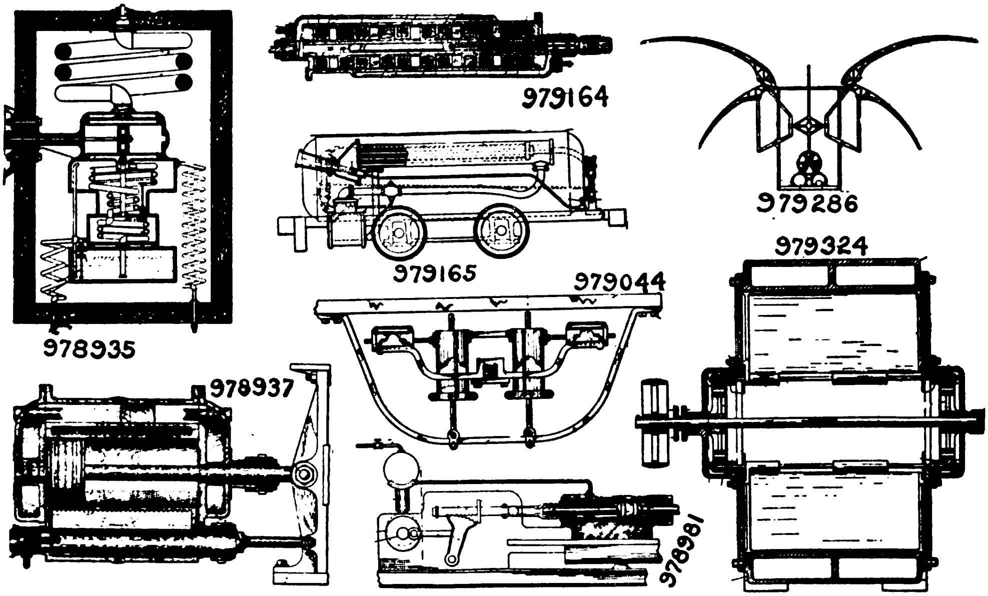
978,381. SUCTION-FILTER. HARRY E. KIER, Colorado Springs, Colo.
978,433. WINDMILL. JOHN W. COLEMAN, Madrid, Iowa.
978,484. FLUID - PRESSURE - OPERATED TOOL. WILLIAM PRELLWITZ, Easton, Pa.
978,561. FUME-PRODUCING DEVICE. PETERSON H. CHERRY, Los Angeles, Cal.

3. A fume producing device comprising a receptacle for containing the fume producing material and a pneumatic device connected thereto to draw air into or expel it from the receptacle, said pneumatic device composing a closed case communicating with said receptacle and having a portion movable inwardly and outwardly to vary the volume within the case, a coil spring within the case, and a stud extending within said spring and serving as a guide therefor and as a stop for the movable portion of the case.

978,579. AIR-VALVE. PAUL J. GREBEL and WILLIAM J. THEIS, Chicago, Ill.
978,586. ROCK-DRILL. CHARLES A. HULTQUIST, Bisbee, Ariz.
978,642. AIR-RESERVOIR FOR MINES. PATRICK QUINN, Forbes Road, Pa.
978,645. PNEUMATIC SELECTOR FOR SHORT-WEFT LOOMS. HENRY E. RATHBUN, Worcester, Mass.
978,935. MECHANISM FOR LIQUEFYING AIR AND SEPARATING SAME INTO OXYGEN AND NITROGEN. JAMES F. PLACE, Glen Ridge, N. J.
978,937. COMPRESSOR. GEORGE H. REYNOLDS, Mansfield Depot, Conn.
978,981. ROCK-DRILL. GEORGE R. BENNETT, Denver, Colo.
979,044. PNEUMATIC SPRING. IGNATIUS J. STADELMANN, Los Angeles, Cal.
979,164. ELECTROPNEUMATIC TOOL. JOHN TEN EYCK HILLHOUSE, New York, N. Y.
979,165. COMPOUND COMPRESSED-AIR ENGINE. CHARLES B. HODGES, Pittsburg, Pa.
979,210-1. VACUUM CLEANING APPARATUS. LEMUEL WILLIAM SERRELL, Plainfield, N. J.
979,286. AERIAL NAVIGATOR. ROSCOE C. GORE, Tecumseh, Nebr.
979,324. BLOWER OR PUMP. FRANK J. MINER, Detroit, Mich.

DECEMBER 27.

979,435. VACUUM STEAM-ENGINE. CHARLES COMSTOCK, West Stockbridge, Mass.
979,436. VACUUM SUPPORTING DEVICE. JULIAN E. CORBIN, Alameda, Cal.



PNEUMATIC PATENTS, DECEMBER 20.

978,648. SIPHON FEEDING MECHANISM. EDWIN A. RHOADS, Goodland, Kans.
978,649. VACUUM CLEANING APPARATUS. LYMAN R. ROBERTS, Rutherford, N. J.
978,749. CLEANING-MACHINE. JOHN N. HOLLIS, Macon, Ga.

1. An apparatus of the class described, a casing, a motor supported upon the bottom of the casing, an air storage tank, a fluid receptacle in communication with the tank whereby the contents will be maintained under pressure, a pump communicating with the storage tank for supplying air thereto, a hollow rotatable tool shaft communicating with said fluid receptacle, and driven connections between the motor, pump and shaft whereby the said pump and shaft will be simultaneously operated.

DECEMBER 20.

978,916. PNEUMATIC CLEANER. FRANK J. MATCHETTE, Milwaukee, Wis.
979,472. FLYING-MACHINE. FRED GOEHNER, Buffalo, N. Y.
979,579. UTILIZING WASTE HEAT OF COMPRESSORS. FRANK SHUMAN, Philadelphia, Pa.

1. The mode herein described of utilizing waste heat of compressors, said mode consisting in causing the exhaust motive power fluid of the compressor engine to heat one portion of a power-developing agent having a relatively low boiling point, and causing the compressed fluid to heat to a higher temperature another portion of said agent.

979,617. PNEUMATIC RIVETING - TOOL. CHRISTOPHER WEATHERSON, Chicago, Ill.
979,788. VACUUM APPARATUS. EDWARD P. NOYES, Winchester, Mass.

2. Vacuum apparatus comprising an automatic internal-combustion motor adapted to mechanically pump its combustion-air charge, an anteriorly-extended air-suction pipe having a plurality of suction inlets one of which is pro-

vided with means for applying the motor suction to the performance of external work, and throttle-valves for the respective inlets controllable at will.

979,837. CONDUCTOR'S VALVE FOR FLUID-PRESSURE BRAKES AND SIGNALS. CLYDE C. FARMER, Chicago, Ill.

979,867. AUTOMATIC CHEMICAL AIR-LIFT. AUGUST LONG, Bayonne, N. J.

979,899. LINE-THREADING DEVICE. FRANK N. STEIGLEDER, Richmond, Va.

1. In a line threading device, the combination of a fluid pressure supply pipe having an opening therein and provided with a discharge nozzle, a bracket mounted upon the exterior of said pipe in proximity to said opening, a reel journaled upon said bracket, a line wound upon the reel and extending through said opening into the pipe and thence through the pipe and externally through the nozzle, and a traveler connected with the free end of said line, said traveler comprising a flexible stem carrying radially flexible disks.

979,929. COMBINED AUTOMATIC AND INDEPENDENT RAKE. CHRISTOPHER P. CASS, Maplewood, Mo.

979,938. AUTOMATIC EMERGENCY-BRAKE FOR AUTOMOBILES. EMIL EISELT, Baltimore, Md.

1. An automatic emergency-brake for automobiles comprising, an air-tank, an air-cylinder having its inner end communicating with the air-tank and having a closed outer end, a piston movable in said cylinder, a brake operatively connected to the piston, a passage communicating with said closed outer end, and an emergency-valve in said passage, said cylinder being provided near its ends with air orifices communicating with the air-tank.

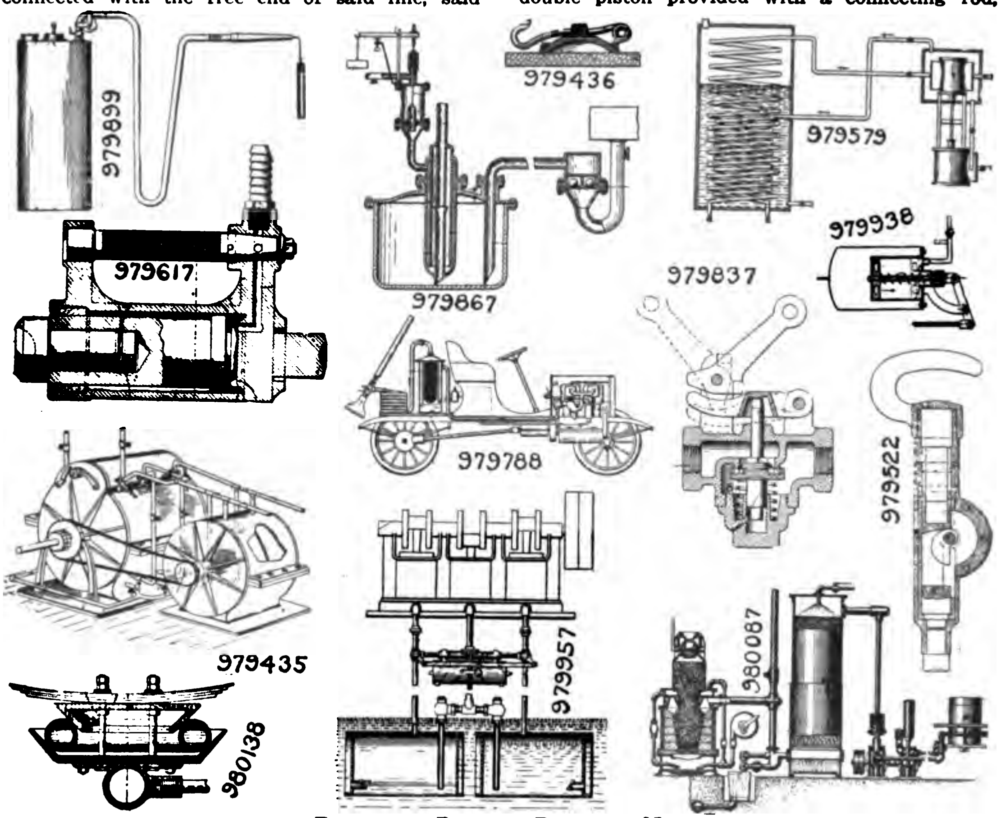
979,957. LIQUID-ELEVATING APPARATUS. GEORGE HARTFORD IRWIN, JOHN PERCIVAL CULLON, and FREDERICK KNOWLSON, Lindsay, Ontario, Canada.

1. The combination with an air compressor and two compression tanks arranged to be submerged in a body of water, of pipes connecting each tank with the air compressor, a flap valve at the bottom of each tank, a discharge pipe leading from each tank, a three-way faucet located on each pipe connecting the tanks with the compressor provided with suitable operating arms and designed to be one reversely set to the other, an independent pipe leading from the compressor, a controlling valve communicating with this pipe comprising a cylinder provided with an upward extension having a longitudinal passage-way with a central enlargement opposite the independent pipe and ball valve therein, and vertically disposed end passage-ways and double piston provided with a connecting rod, and spindles having passage-ways leading therethrough, tubular bosses formed on the ends of the cylinders into which the spindles extend, a pin extending from the connecting bar of the piston through a slot in the cylinder, an arm connected to the pin and a cross bar connecting the arms of the faucets to the arm on the pin and branch pipes leading from the cylindrical passage-way in the upper extension of the cylinder to the faucets as and for the purpose specified.

980,087. METHOD OF GENERATING HIGH TEMPERATURES. WILLIAM CHRISTIAN FINCK, Elizabeth, N. J.

980,138. PNEUMATIC CUSHION FOR VEHICLES. GEORGE J. BANCROFT, Denver, Colo.

980,172. WINDMILL. WILLIAM P. BRETT, Decatur, Ill.



PNEUMATIC PATENTS, DECEMBER 27.

CLASSIFIED BUYERS' GUIDE

Air Cylinder Oil.
- Atlantic Refining Co.
- Borne, Scrymser Co.
- Chicago Pneumatic Tool Co.
- Continental Oil Co.
- Fiske Bros'. Refining Co.
- Galigher Machinery Co.
- Standard Oil Co.
- Vacuum Oil Co.

Air Lift Pumps.
- Chicago Pneum. Tool Co.
- Curtis & Co., Mfg. Co.
- Galigher Machinery Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- McKiernan-Terry Drill Co.
- Westinghouse Air Brake Co.

Air Gauges.
- Galigher Machinery Co.
- McKiernan-Terry Drill Co.
- Westinghouse Air Brake Co.

Air Receivers.
- Baldwin Locomotive Works.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Curtis & Co., Mfg. Co.
- Gardner Compressor Mfg. Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- Janney, Steinmetz & Co.
- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Stearns-Roger Mfg. Co.
- Sullivan Machinery Co.
- Westinghouse Air Brake Co.

Air Tanks.
- Baldwin Locomotive Works.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Galigher Machinery Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- Janney, Steinmetz & Co.
- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Westinghouse Air Brake Co.

Aftercoolers, Air.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Galigher Machinery Co.
- Ingersoll-Rand Co.
- McKiernan-Terry Drill Co.
- Porter Co., H. K.
- Stearns-Roger Mfg. Co.
- Sullivan Machinery Co.

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- Republic Rubber Co.
- Edw. R. Ladew.

Belt Dressings.
- Jos. Dixon Crucible Co.

Blowers.
- Cameron Stm.Pump Wks,A.S.
- Chicago Pneumatic Tool Co.
- Galigher Machinery Co.

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AMERICAN METAL HOSE

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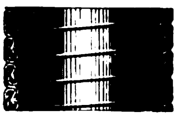

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COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XVI MARCH, 1911 No. 3

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Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

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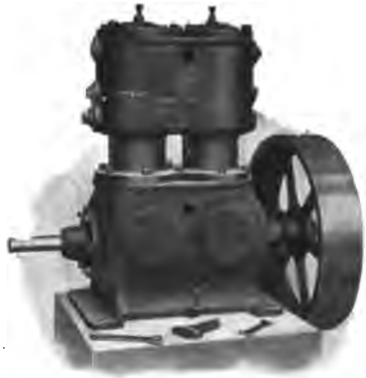

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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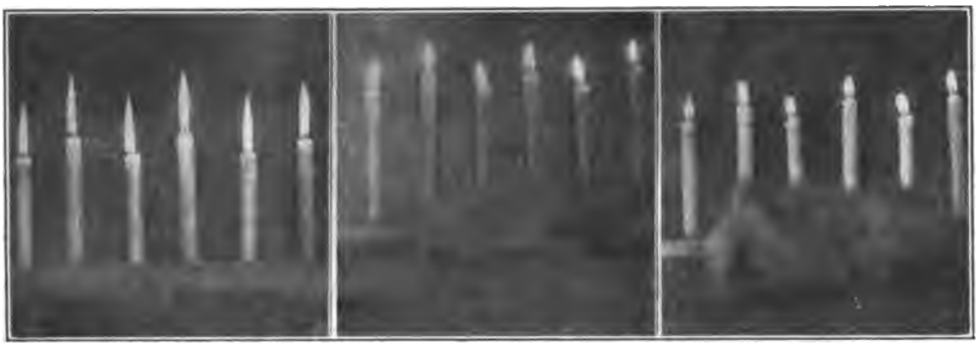

FIG. 1 FIG. 2. FIG. 3

CANDLE TESTS OF AIR FROM A HYDRAULIC COMPRESSOR*

BY F. W. MC NAIR AND G. A. KOENIG.

The recent discussion of the conditions in certain mines at Cobalt due to the use of air compressed hydraulically, may lend interest to an investigation made by the writers in March, 1907, at the Victoria mine, Ontonagon county, Mich. It will be remembered that a Taylor hydraulic compressor of the same type as that at Cobalt supplies compressed air at this mine.

Difficulty was experienced with the lights, and we were commissioned to examine the conditions produced, not only in relation to the lighting, but also with regard to persons who might work in such air.

The fact that water in intimate contact with air not only dissolves it, but takes up a greater percentage of its oxygen than of its nitrogen, has long been known. Over 50 years ago a French chemist proposed to get air for blast furnace use which would be richer in oxygen than normal air by the method of solution in water. Each successive solution will render the dissolved air richer in oxygen. Since the hydraulic air compressor delivers, not the air dissolved, but what is left, it follows that the air delivered must be poorer in oxygen than normal air.

Naturally the matter of first interest was the oxygen content of the "compressor air," next, whether its deficiency in oxygen was alone responsible for the action of the candles, which were said to burn in the mine from two to four times as long as under usual conditions, and lastly, the discovery of any deleterious effect on persons working in such air.

Determinations by means of a Hempel pipette, charged with thin sticks of phosphorus, showed an oxygen content of 17.7 volumes to the 100 volumes of compressor air, whereas in 100 volumes of normal air there are about 21.0 volumes of oxygen. A recently published

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*Paper read before Section D of the American Association for Advancement of Science at the Minneapolis meeting.

analysis of the air from the Cobalt compressor gives 17.7 volumes of oxygen to 100 of air, which agrees with the determination at Victoria. This is what may be expected from a single solution. If, out of 100 volumes of normal air, the water extracts 2.15 volumes of nitrogen and 4.47 volumes of oxygen, the ratio of solution will be that given in the text books, and the resulting percentage of oxygen will be that found by us. It would at first seem doubtful that this shortage of 3.3 volumes of oxygen could cause the reported trouble with the lights.

At the time of our investigation the Victoria mine operated a single shaft which was in the neighborhood of 1,500 ft. deep, and in the plane of the lode. Some of the drifts were long, one breast being as much as 1,200 ft. from the shaft. As the mill was not yet completed, but little stoping had been done, and the total volume of the excavation was small compared to the average of the Lake copper mines. It should be noted, however, that the volume was large compared to that of any mine at Cobalt.

Air from the hydraulic compressor had been used throughout the mine for several months to operate drills, and to ventilate in the usual manner after blasting. While the upper part of the mine drew some air from a shallow shaft used for ventilation, it was altogether probable that the main portion below was entirely filled with compressor air.

To investigate the action of the lights six candles were chosen, three from each of the two kinds we found in use at the mine, one make being supposedly harder than the other. The six were carried throughout the tests without discovering any difference between them. As far as possible the observations were recorded photographically. To secure uniformity in observation, a T-shaped frame, or stand, 3 ft. wide by 6 ft. long, was constructed of 6-in. boards. It was laid flat, and on the cross-arm the candles were spaced 6 ins. between centers. The camera was placed at the end of the long arm btween guide marks. The candles were first lighted and observed on surface to get at the normal rate of burning, which was judged by the height and general appearance of the flame, together with the cup at the bottom of the wick. The flame condition in normal air is well shown by Fig. 1, taken in a room-temperature of 54 degrees at the Michigan College of Mines, after the observations at the mine.

On lighting these same candles underground, a marked difference in their burning was recognized, and, after observing their performance in different situations, it was easy to accept the statement of the length of time a candle would burn in the mine. The flame was in every case lower than normal and much more blunt. The "tail," partly of semi-luminous and partly of sooty carbon, so characteristic of the flame in normal air, was as a rule wholly absent. The cup was only meagerly supplied with melted max and showed a frozen appearance around the edge. We also remarked the ease with which a candle could be extinguished by a sudden sidewise movement.

Two examples of the photographs obtained in the mine are shown. Fig. 2 shows the appearance of the candles at the breast of the west drift on the 9th level. Before they were lighted air was blown from the hose for about 15 minutes to clear out fumes from a recent blast. Fig. 3 gives the most conclusive evidence of the effect of the compressor air obtained in the mine. For three-quarters of an hour a wide open 2-in. main delivered the air under 70 lbs. pressure at the breast of the 8th level west.. The candles were then placed, and the photograph taken. These flames were undoubtedly in the purest possible compressor air. Their shortness and bluntness is evident. It is worthy of note that while they were being photographed an acetylene flame burned brightly some 2 ft. away from them, burning at its maximum the entire time.

But one more step was necessary to finish the demonstration. In the laboratory one of the six candles was placed in a box with glass front, to which was supplied alternately normal air and an imitation compressor air, having the observed percentage of oxygen, but made in the laboratory. We could reproduce all of the phenomena of slow combustion, low flame and frozen appearance of the cup as observed in the mine. Fig. 4 shows the experiment in normal air, and Fig. 5 in the imitation compressor air. The flame in the latter case is less blunt than observed in the mine, owing to the stronger upward current, due to the more confined space, and possibly, owing partly to the higher temperature of the space.

Evidently the deficiency of oxygen in the compressor air is wholly responsible for the difficulty with the candles. The lower oxy-

FIG. 4

FIG. 5

gen content allows only a slower combustion, heat is supplied more slowly, the temperature remains lower, the wax melts at a slower rate, and is liquid over a smaller area. The acetylene flame, using an already gaseous fuel, is not so dependent on the rate at which heat is supplied, and so suffers no visible diminution.

Regarding the effect of this air on persons working in it, conclusive evidence is not so easily obtained. It is possible that the rate of breathing might be increased. The psychological obstacles in determining this at the mine were so great that it seemed futile to experiment. No one had complained of working in the air. There was a feeling, indeed, that it was better than the air previously supplied from the steam compressor. With senses alert and a keen desire to observe any such phenomenon, we were wholly unable to discover any effect on ourselves which could be ascribed to the composition of the air. Whether our exertions were mild or violent, our experiences were in no wise out of the ordinary.

It is interesting to note that this solution of air lowers what might otherwise be the efficiency of the hydraulic compressor. Tests made on the Victoria compressor by Professors Hood and Speer, of the Michigan College of Mines, shows, that if all the air drawn in at the intake were delivered compressed to 114-lb. gage, the compressor when absorbing 1961 hp. would show an efficiency of 82 per cent. If we assume, as above, that 6.6 volumes out of each 100 drawn in are diverted, the efficiency cannot be above 76.6 per cent.

Frizell, in his book, "Water Power," gives an elaborate and interesting deduction of the efficiency of such a compressor, based on theoretical considerations, and obtains a figure of under 70 per cent.

The engineer who first gets a commission to make a complete test of this compressor will, when his task is finished, be in a position to give some very interesting and important information.

THE ATMOSPHERE BENDS EARTH'S SHELL

The inventor of the seismograph, primarily for the study of earthquakes, has led to the discovery of the astonishing sensitiveness of the crust of the globe to forces that might have been thought too insignificant to cause distortion. Among these forces is the alteration in the pressure of the atmosphere during the passage of storms, causing a perceptible tilting of large areas of ground. A curious case of such tilting has been recorded in Japan. A storm passing over the sea east of Tokyo caused the bordering land to tilt downward, notwithstanding the fact that atmospheric pressure is lessened within a storm area. This is explained by the fact that the sea rises with release of atmospheric pressure, and the accumulation of water more than sufficed to counterbalance the decrease in weight of the air.

DANGER FROM WATER IN AIR FOR CONVERTERS

BY A. R. MC KENZIE.

If air at a higher temperature and saturated with water vapor is compressed, and while being conveyed for any distance has its temperature materially lowered, there is bound to be a condensation of moisture. In the compression of air for converter work, under such conditions, there is an element of danger presented. During my experience in copper converting at least two glaring instances of this phenomenon have come to my notice.

An exaggerated case occurred about four years ago at a smeltery at a high altitude. The power house at this plant was about 1000 ft. away on the same level as the blast furnace feed floor. From the power house the converter main passed through a tunnel in the brow of the terrace to within 70 ft. of the furnace building, whence it passed diagonally across to the outside of the converter crane track, when it entered the converter building, and from there it was curved downward to the level of the mouth of the converters, when they were in the upright position in the stalls. Before reaching the converters the pipe was enlarged to a diameter of about five feet, which served the purpose of a receiver or reservoir. The connection to each converter was made from the side of this reservoir, which ran along behind the converter smoke boxes.

One rainy day, about two o'clock in the afternoon, four months after the plant had been in operation, I noticed water coming out of some tuyeres which were leaking air around the ball valves. I immediately had all the converters shut down in order to ascertain the source of this water. On account of the rainy weather, my first supposition was that the water had got to the intake of the compressor and was being pumped to the converters with the air, but I soon discovered that such was not the case. I next made an examination of the five-foot reservoir by tapping it with a hammer. From the sound I judged it was full of water up to the outlets, where the side connections were made to the converters. A scaffold was hurriedly built and an air-power drill set in place. In a few minutes a stream of water was running from an inch hole in the bottom of the reservoir, the total amount of water drained from this pipe amounting to about 100 bbl. Afterward I had this hole fitted with a 1-in. drain pipe, with a valve which was kept slightly open to prevent a recurrence of what had taken place.

In the design of converter plants, care should be taken not to tap the converter air main from the bottom, for in case one of the converter stalls should be shut down for any length of time, the air pipe leading from the air main to the stall might fill with water, and in again putting this stall in operation, there would be danger of an explosion unless the collected water were removed. The difference in temperature between a hot engine room, where a number of machines are running, and the outside atmosphere, is so great, especially in cold weather, that condensation of moisture in the pipes goes on rapidly, and may become a source of danger in any case unless special means of drainage are provided. It may be thought that, in plants in continuous operation, enough water would never come through the main to cause an explosion, even without any special means of drainage, but the following may be assumed to show that such danger exists.

Suppose that one or two converters have been running for some time, and that some condensation of water has taken place in the air main. Then, should the number of converters be increased to four or five, as frequently happens in meeting changing requirements of production, etc., the volume of air passing per minute will be perhaps doubled, tending to form waves and to sweep it into the connecting pipes, whence it will pass into the converters and cause an explosion. During intermittent operation there is no question of the danger. Some years ago, at another plant at which I was employed, a stall which had long been idle was again put into service. The converter was connected in place and charged, without examining the piping, which had slowly collected condensation water back of the valve. On turning into the stack and putting on the air, this water was carried into the tuyeres and blew the converter bottom to pieces.—*Eng. and Min. Journal.*

Only two "horse-powers" are recognized in engineering: the unit of 33,000 foot-pounds per minute and the unit of 4,500 kilogramme-meters per minute, which is 32,549 foot-pounds, and is known as the metric or French horse-power.

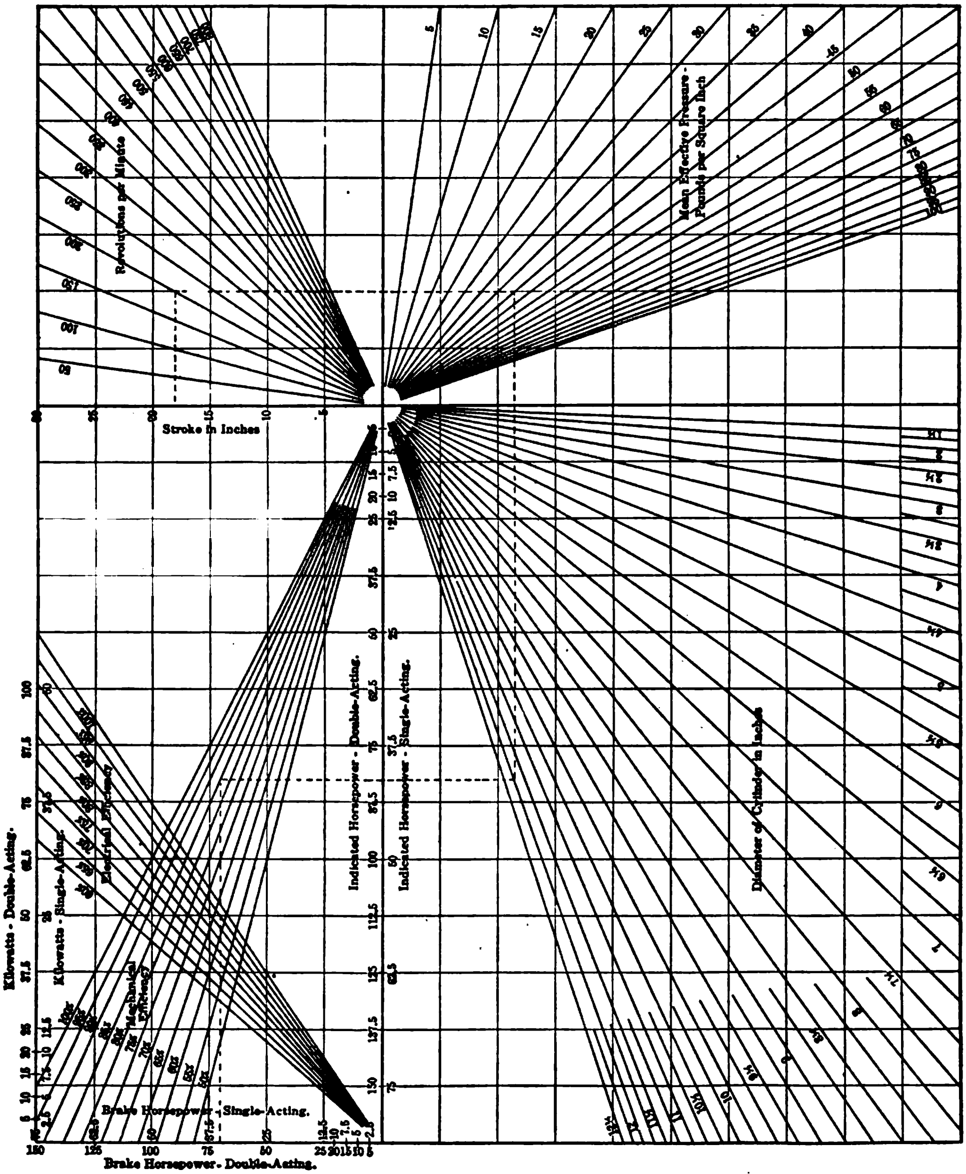


FIG. 1. HORSEPOWERS OF ENGINES UP TO 12½x30-INCH SIZES

ENGINE AND COMPRESSOR POWER CHARTS

BY T. M. CHANCE.

One of the most frequent calculations made by mechanical engineers is the horsepower of engines and compressors. When rough estimates of the power delivered by an engine of certain dimensions are hurriedly made, errors often occur from the improper use of the formulas or quantities under consideration. For example, it often happens that the number of revolutions is used as the value of the quantity N in the formula

$$\frac{PLAN}{33{,}000}$$

instead of the number of strokes per minute, and in a double-acting engine this gives a result only one-half as large as that which should be obtained. Similar errors, as well as arithmetical inaccuracies not due to ignorance, are of common occurrence and may lead to large discrepancies in the subsequent result. It occurred to the writer that if a curve, or a series of curves, could be devised which would show at a glance the indicated brake and electrical output of an engine of any size, stroke, mean effective pressure and revolutions per minute, it would be exceedingly convenient and useful to engineers.

In the accompanying diagrams the horsepower rating is based upon the formula

$$\frac{PLAN}{33{,}000} = I.\ h.\ p.$$

Where,

P=Mean effective pressure in pounds per square inch;

L=Stroke in feet;

A=Area of the piston in square inches;

N=Number of strokes per minute (twice the number of revolutions).

And,

I. h. p.×m=Brake horsepower;

B. h. p.×e=Kilowott ratings;

Where,

m=Mechanial efficiency of the engine,

e=Total efficiency of the generator.

In the diagram the stroke of the engine is laid off in inches instead of feet, and the diameter is similarly measured, the inch being the most convenient unit for this purpose. It should be noted that the horsepower varies directly with the area of the cylinder, that is, as the square of the diameter; hence the diameters must be spaced proportionately to their squares, since they graphically represent the areas of the cylinders.

The diagram is here given on two scales: Fig. 1 to be used for engines up 12½ inches cylinder diameter and 30 inch stroke; Fig. 2 including engines up to 25 inches cylinder diameter and 60 inch stroke.

Referring to Fig. 1, suppose it is required to compute the horsepower of a 12x18 inch engine working under 40 pounds mean effective pressure and running at 200 revolutions per minute, the dotted line indicates the steps taken in the solution of the problem. Reading up the scale of "Stroke in Inches" to 18 inches, follow horizontally across to the intersection of this line with the diagonal line marked 200 on the scale of "Revolutions per Minute;" from this intersection drop vertically downward until the diagonal line marked 40 on the scale of "Mean Effective Pressures" is crossed; follow horizontally across from this point to the line marked 12 inches on the "Diameter in Inches" scale and, running vertically upward from this intersection to the scale of "Indicated Horsepower, Double Acting," the result is found to be 82.5 indicated horsepower. If it is desired to find the horsepower of the engine running single acting, it will be found to read 41.25 indicated horsepower on the lower scale of "Indicated Horsepower, Single Acting."

If the brake horsepower and kilowatt capacity of the engine is desired, assuming 85 per cent. mechanical efficiency and 95 per cent, generator efficiency, read vertically upward along the 82.5 indicated horsepower line to its intersection with the diagonal line marked 85 per cent. on the scale of "Mechanical Efficiency;" the horizontal line passing through this point shows the brake horsepower to be 70 on the scale marked "Brake Horsepower, Double Acting." To determine the electrical output, follow vertically upward from the intersection of this horizontal line with the line passing through 95 per cent. on the scale of "Electrical Efficiency" and read 50 kilowatts on the scale marked "Kilowatts, Double Acting." The same use may be made of the single-acting scales for the brake horsepower and kilowatts output as was done in the case of the indicated horsepower.

Where refinement in the calculations is desired, the decrease in power due to the reduction in effective area of the piston on account of the piston rod and tail rod, if the latter is used, must be computed. This is easily done with these diagrams by considering the piston rod and tail rod as two single-acting engines, having a cylinder diameter equal to that of the rods and working in opposition to the engine. When the piston rod and tail rod are of the same diameter they may be considered as one engine, running double acting. Therefore, if the decrease in power caused by the piston rod of a 100-brake horsepower engine amounted to 2 brake horsepower, the actual brake horsepower delivered by the engine would be 98.

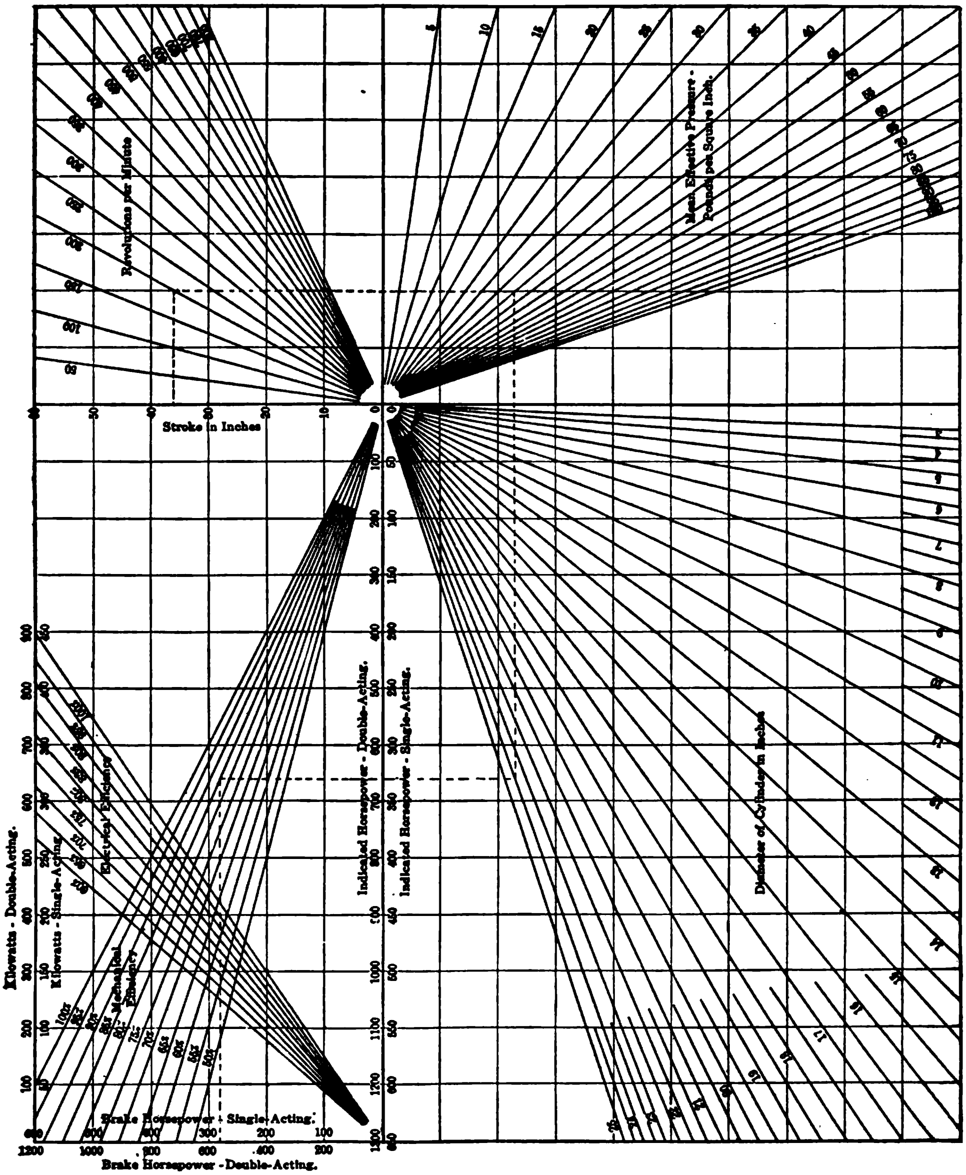


FIG. 2. HORSEPOWERS OF ENGINES UP TO 25x60-INCH SIZES

The diagrams are also useful in calculating c(ompressor dimensions. For example a compressor is to be installed to develop 660 indicated horsepower; the stroke of the compressor is 36 inches, the mean effective pressure 40 pounds, and the diameter of the cylinder 24 inches; find the number of revolutions. The dotted line in Fig. 2 indicates the steps take in the solution of this problem. Starting with 660 on the scale of "Indicated Horsepower, Double Acting," drop vertically downward to the diagonal line marked 24 on the scale of "Cylinder Diameter in Inches." From this intersection follow horizontally across to the diagonal line marked 40 on the scale of "Mean Effective Pressures" and from this point run vertically upward to the intersection with the horizontal line passing through 36 inches on the scale of "Stroke in Inches." A diagonal line passing through this intersection and the common center of all the diagonal lines gives the number of revolutions, on the scale of "Revolutions per Minute," which in this case is 200.

The diagram may also be used to directly calculate the dimensions and power of gas or oil engines, if of the two-stroke type, as the horsepower of engines of this type is computed by the same formula as that used in steam-engine calculations; hence,

$$I.\ h.\ p. = \frac{PLAN}{33{,}000}, \text{ for double-acting engines}$$

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 2} \text{ for single-acting engines}$$

In the case of four-stroke engines the result obtained by the use of the diagram must be divided by two, as the four-stroke engine receives but half as many impulses as the two-stroke machine, during the same number of revolutions; that is,

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 2} \text{ for double-acting engines}$$

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 4} \text{ for single-acting engines}$$

When determining the dimensions of a four-stroke engine it should be remembered that the principle dimensions of a four-stroke engine and those of a two-stroke engine of twice the power are identical; hence, read twice the power of the machine under consideration on the horsepower or kilowatt scales and proceed as if the dimensions of a two-stroke engine of that power were being computed.—*Power and the Engineer.*

The deepest gold mine in the world not long since was that of the New Chum Railway company at Bendigo, Australia, down 4,120 ft. but this has now taken second place, the shaft on the Victoria Consolidated, also at Bendigo, having reached 4,600 and going to 5,000 ft. This is deeper now than that of the deepest gold mine in America, the Kennedy, at Jackson, California, by more than 1,000 feet.

SUBMARINE DIVERS IN MINES

The use of divers is a comparative novelty in the West, therefore the following account from letters of Herbert A. Wilcox, superintendent of the smuggler Mining Co., at Aspen, Colo., and W. J. Stevenson, manager of the Helena shaft, at Leadville, Colo., dealing with the work of two submarine divers in repairing submerged pumps at their respective operations, is of interest.

In describing the work at Aspen, Mr. Wilcox says that the collar of the Free Silver shaft, which is 1,196 feet deep, is 8,036 feet above sea level. The first connection underground is 848 feet below the collar and is with the ninth level of the Smuggler Mine. Below the nnith level, at intervals of 116 feet each, are the tenth, eleventh, and twelfth levels, the latter being at the bottom of the shaft. The mine below the ninth level has been under water for 12 years except for a few months in 1902 when it was unwatered to the eleventh level for exploration work.

At the lowest level, the shaft bottom, is a Jeanesville 32"×14"×48" duplex plunger pump which, when the mine was allowed to fill 12 years ago, was left with connections arranged that it might be started under water with compressed air. This pump has not been in operation since that date except during the brief period of exploratory work in 1902.

When the present unwatering was contemplated it was found impossible to operate this pump, and its action led the management to believe that its packing had failed. As the inflow of water was great and the shaft small, it was found impracticable to unwater with sinking pumps. Although the flow of water at the eleventh level was at the rate of 1,500 gallons per minute it was lowered to this point by means of Pohle air lifts and Starrett air pumps delivery to the regular station pumps at the ninth level. As the mine equipment was insufficient to lower the water beyond the eleventh level, Messrs. Fred. Johnson, diver, and George Peterson, tender, were called from New York, arriving in Aspen on October 17. On October 23, when the water was 103 feet deep, its surface being 6,943 feet above tide, the diver, after several attempts, reported his inability to work in this depth at the altitude, although at sea level he could work in 120 to 130 feet of water.

A station pump was then installed at the eleventh level and, with this and the Pohle and Starrett pumps in the shaft, the water was lowered to within 71 feet of the bottom by November 16, when the diver returned to work. During the next 10 days, while the diver was making the repairs, the water was held at a depth of from 71 to 65 feet. After the long submergence the packing in the water plungers was found to be in fairly good condition, but that in the steam end was entirely gone, and the piston rods were found to be very rough. By November 26 additional packing had been placed in the water end and all the glands tightened, the steam end had been repacked throughout, the rods smoothed, all nuts carefully gone over and tightened, and jam nuts added where it was necessary.

The pump was started the next day on a mixture of steam and compressed air and has been running ever since with a piston speed of 120 to 136 feet per minute, with the exception of one shut-down of 4 days and several others of a few hours each, none of which, however, was due to any failure of the pump. The diver examined the pump on December 2, and again on the 14th, each time finding it advisable to add more packing to the steam end and to tighten the glands. At the date of Mr. Wilcox's letter, December 18, the pump was working nicely, and as there was but 10 feet of water in the station, he expected to recover the main pump in a few days.

Mr. Johnson had only been in Aspen 6 days when the preliminary trials were made. In diving in 103 feet of water he complained of shortness of breath, panting, and inability to exert himself without immediate and complete exhaustion, and described his sensations as being the same as when working at sea-level at greater depths. Mr. Johnson estimated the effect of the altitude to be equivalent to that of about 27 feet of water at sea level. While the repairs were being made Mr. Johnson had no occasion to work under a greater pressure than 71 feet of water, and while not certain, does not believe he could work in mountain regions at as great depth as at sea level, even after becoming accustomed to the altitude.

Immediately after leaving Aspen, Messrs. Johnson and Peterson went to the Helena shaft, in Iowa Gulch, Leadville, the collar of which has an elevation of very nearly 11,000 feet, considerably above that of the Free Silver shaft at the former town. In describing the work at the Helena, Mr. W. J. Stevenson, the manager, says that when the mine was closed down some months ago the valves of the station pump at the 500-foot level were left closed and consequently had to be opened before the pump could be started and the lower portion of the shaft unwatered.

The Helena shaft consists of two 4'×8' compartments, in one of which are the pipe lines connected with the pumps, and which are supported by the stulls. Mr. Johnson at first attempted to lower himself in the pipe compartment, but was stopped by a pair of misplaced stulls just above the pump, and was unable to get between them and the side of the shaft. A second attempt was made to get down through the hoisting compartment, in which a Starrett air pump was working. This pump works entirely under water, and at the Helena shaft had been so placed that the exhaust took place about 2 feet above the top of the pump. This attempt also resulted in failure, as each time the diver got within about 4 feet of the exhaust he was blown back by the force of the air.

Unfortunately, a Cameron sinking pump had been wedged across the hoisting compartment, just below the station, so that ordinary sinking pumps could not be lowered. After several attempts, the pipes to give the necessary submergence for an ordinary air lift, were pushed past the obstructions, and when the water had been lowered to a depth of 50 feet Mr. Johnson was able to descend and open the valves in the station pump.

It will be noted that the surface of the water under which the diver worked was at Leadville 10,450 feet, and at Aspen 6,943 feet. This difference of 3,507 feet must have had some effect upon the ability of the diver to work, but Mr. Stevenson is of the opinion that the men labored under no greater disadvantage than would any one unaccustomed to the altitude.

While the work required of the diver at Aspen was much greater than at Leadville, in each instance most important service was rendered, and portions of the mine per force abandoned or only recoverable after long delay and great expense for new machinery, were cheaply made available for development. As Mr. Stevenson justly says, the remarkable feature is that the divers work entirely in the dark, guided only by their sense of touch and a thorough knowledge of their work.—*Mines and Minerals.*

SOAPSUDS TO LAY THE DUST IN COAL MINES

Dr. Thornton, Professor of Electrical Engineering at Armstrong, College, Newcastle, England, has made some interesting experiments in connection with the laying of coal dust in mines. Water has no binding effect upon the coal dust; when the moisture has dried up, and when the dust has become dry again, in the event of spraying being neglected, it returns to its former powdery state. In some mines calcium chloride has been tried; but while this has certain advantages in the way of binding properties, it converts the wetted substance into an unpleasant, sticky mixture. Professor Thornton has gone to work to find something which might offer more satisfactory results, and his experiments have led him to the belief that an efficacious spraying mixture can be made with soap and water. Dr. Thornton demonstrated the excellent binding properties of the mixture of soap and water, and, further, he showed by the experiments that the whole question of the wetting of the dust was one of surface tension of the liquid used, and that the water alone did not readily and entirely wet the coal dust, unless used in very large quantites. The mixture of soap and water, however, completely wetted the dust, and turned it into a liquified form of mud, of which the chief component was coal dust. Therefore, whilst with water alone, as shown by the French experiments, ten times the weight in proportion to the amount of coal dust is required to wet the dust, with the use of a soap solution a much less quantity of spraying liquid would be required, and the result would be much more satisfactory than with the water.

Important as this is, it is not the most important point of Dr. Thornton's suggestion. His demonstrations showed that coal dust which had been sprayed with water and then re-dried could be easily blown into the air, but coal dust which had been sprayed with the soap solution dried in a form more closely resembling a distemper than anything else, and this could not be blown into the air. It could be loosened from the surface upon which it had been placed for the purposes of the experiment, only by rubbing with the fingers. In carrying out the experiments the quantities of coal dust used were far in excess of the quantities found on a proportionate surface in the pit, and the consequence was that owing to the extra thickness of the dust it could be more readily loosened with the fingers than would be the case with a thinner layer, such as would be met with in practice, as Dr. Thornton has previously found out by experiment.

The results of these experiments go to show that if a percentage of soap was mixed with the spraying water the coal dust would receive a thorough wetting, and in the case of an explosion, even though it had become dry, it would still adhere to the surfaces upon which it had become deposited, and would not become food for the fire. There would consequently be less likelihood of the fire spreading through the workings than if coal dust were present in the air. Professor Thornton pointed out that the quantity of soap which was necessary, so far as the experiments indicated, was not great. Any kind of soap could be used for the process, and it was very probable that some of the by-products and residues obtained in the manufacture of soap would serve the purpose equally well. The best effects in the experiments were obtained with a fine spray.

SINKING AND STEERING A DEEP CONCRETE SHAFT

For the following account of the sinking of a deep shaft at Hibbing, Minn., with the accompanying illustration we are indebted to *Engineering-Contracting*. Many interesting devices were employed upon this work, among which was the method used for plumbing the shaft as it was sunk, by means of eccentric or overhung loading. The half tone shows a system of trussed supports built out for loading the shaft on one side. The method has the effect of a cantilever and reduces the load necessary to accomplish the desired effect.

The work at Hibbing is being done by the Foundation Co. of Chicago. It is of special note because the shaft has been sunk 164 ft. below water level, or in all, 185 ft. below the surface of the ground.

The friction of the outside surface of the concrete shaft with the ground through which it is sunk varies from 250 lbs. to 1,200 lbs. per sq. ft. of surface, depending upon the character of the soil. The friction is greatest in sand and quicksand and least in clay.

CANTILEVER FOR TRIMMING CAISSON.

For reducing the friction, water jets are run down between the shaft and the soil at short distances apart around the circumference of the shaft.

The shaft is 29 ft. in diameter with a rectangular cageway 10 ft. - 10 in. x 14 ft.- 10 in.

The shaft is made circular because of the saving in surface friction over that which would obtain with a rectangular shaft of the same size.

The outside forms were of steel plate placed in 5 ft. sections. Three sections were used for ordinary sinking, the bottom section being removed and placed at the top as fast as the concreted sections were sunk.

The inside forms were of wood, made in 5 ft. sections using a set of 6x6 in. dressed timbers braced across the corners with 3x6 in. pieces. The 6x6 in. timbers were tied at the corners with 4x1½ in. iron straps. The timber sets were placed at 30 in. centers and 2 in. sheeting was used. The rectangular opening was made 4 in. wider and longer than was required by the plans in order to care for any small inaccuracy due to the shaft being out of plumb when bed rock was reached.

In sinking the shaft the excavation was at first carried on through the cageway by using the clam shell bucket attached to the derrick. When the excavation had proceeded to a depth at which it was impracticable to dig with the clam shell a Moran lock was installed and the work was carried on under the pneumatic process. Air pressure was not put on until the shaft had reached a depth of about 166 ft. An air pressure of 47 lbs. per sq. in was used, and 40 min. shifts were worked.

[The above maximum air pressure was reached or slightly exceeded, in sinking the foundations for the new Municipal Building in New York, as described in our issue of July, 1910. In that case there was an actual head of water at the caisson corresponding to the air pressure within, or actually 112 feet. In the above case the water could not have had the effective head at the work of 164 feet as mentioned above, as that would have required an air pressure of about 72 pounds. Ed. C. A. M.]

AN ADDED TERROR OF WAR

An aviator near San Francisco took up with him as a passenger in his aeroplane, an ordnance officer of the United States Army, and the latter dropped from a height a specially prepared hand-bomb which exploded with terrific violence upon striking the earth. An examination of the vicinity where the bomb struck proved that a shell of this description, when exploded, scatters in all directions the materials of which the shell is constructed, as well as those with which it is filled, and that it would be very destructive of life within a radius of many feet. It is fair to assume that this dropping of explosive bombs from the sky must have a powerful "moral" effect, as they call it, upon armies in the field, since it is a terror which cannot be ran away from and against which there can be no real protection.

VACUUM STRIPPERS FOR CARDING ENGINES

When the cotton spinner receives the raw cotton, it contains a number of impurities, such as broken leaf, seeds, sand, etc. The heavier impurities are got rid of in the scutching processes, which are carried out in machinery specially designed to prevent the dust getting into the atmosphere. When the raw cotton has gone through this process, it passes to the carding engine where, by means of wired cards, the cotton fibres are arranged in parallel order and the cleansing process previously referred to is completed. A large proportion of the foreign material lodges in the card clothing of the cylinders and flats, and which have to be periodically cleaned. The cleansing process is universally known as "stripping," and is accomplished by means of a wire brush which is caused to revolve, and is brought in contact with the card clothing from which it drags out the matted mixtures of cotton fibre, fluff, and dirt, The process, although effective, does not comply with the requirements of the hygienic conditions which are now considered essential in cotton mills on account of the amount of dust which is given off, irrespective of the wear and tear of the bearings of the machinery caused by the introduction of grit.

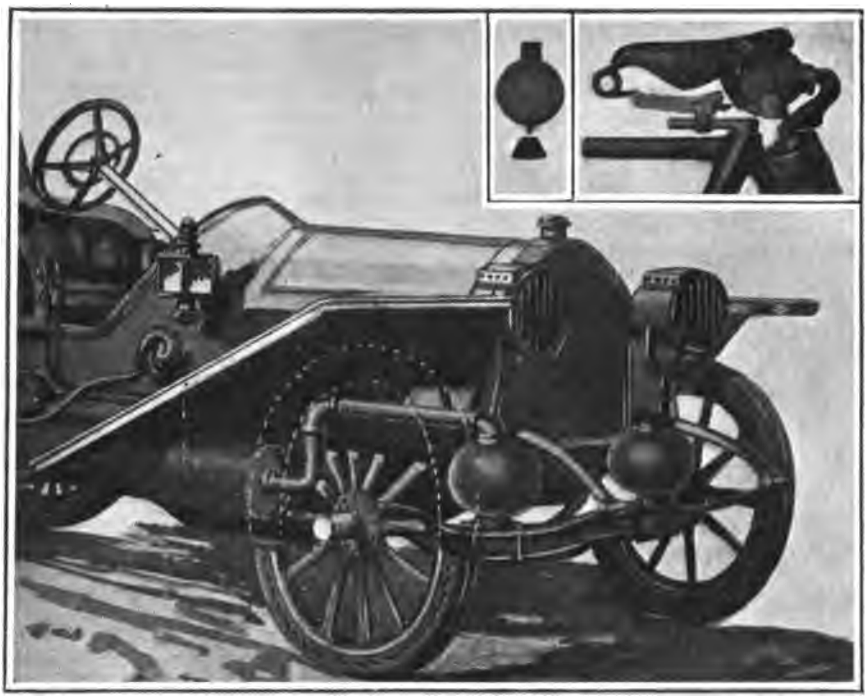
Inventors are busy attempting to devise some satisfactory appliance to obviate the defects referred to, and Cook and Co., Exchange street, Manchester, are introducing a system which does away with the brush altogether. It depends, for its successful action, upon a high vacuum, the stripping operation being performed by means of nozzles travelling across the faces of the cylinders and doffers. The end of the nozzle comes within about 1-16 in. of the wire clothing, and the inrush of air, brought about by a central air pump, draws into the nozzles all the material which is held by the wires. The strips, dirt, etc., are carried away through iron piping 1½ in. internal diameter to a suitable receptacle where they are collected, no dust being given off in the operation. One advantage claimed for this system is that the cards can be stripped while working, which results in increased production. Another advantage possessed by this apparatus is that it enables the mill owner to do away with the locking motions for the carding engine doors which are required by the Government inspectors.

The nozzle is a permanent fixture upon each carding machine, and is mounted on suitable traversing mechanism, the point of the nozzle running along a narraw slot cut in the back plate. The doffer nozzle is fixed in a similar cross-traversing device working above the doffer comb, but in the latter arrangement the whole mechanism is portable, so that it can be carried about from machine to machine. For the doffer nozzle mechanism the usual grinding brackets are used, while special brackets are necessary to receive the cylinder nozzle and its mechanism. In both cases the mechanism is actuated by a rope pulley driven from a convenient pulley on the card. The central receiver for the strips is a large cylindrical receptacle, 10 ft. high by 3 ft. 6 in. diameter, made perfectly air-tight, and provided with a suitable door for clearing out the deposited material. It contains a cloth filter bag to prevent dust being drawn into the pump cylinders. From the receiving chamber a main pipe, 1½ in. in diameter, is run round the card-room, and on this at suitable intervals branches are provided, to which one end of a flexible tube is attached the other end during stripping being connected to the cylinder or doffer nozzle on the card.—*The Engineer*, London.

REHEATING IN MINES

In a paper read before the Transvaal Institute of Mechanical Engineers, Oct., 1910, R. G. Mackie says: "the reheating of compressed air underground and close to its work will receive more attention in the future than has been given to it in the past. Having to burn coal, coke and other combustibles underground, and the undesirability of introducing anything which is going to increase the temperature of the mine, has been the greatest objection to the reheating of compressed air in the mines. When the underground application of cheap electricity becomes general, the question of reheating air by electrical appliances is bound to be seriously considered. The reheating of the air should be done as near to its work as possible to reduce losses caused by radiation in the pipes between the heater and the drill. Less radiation means less interference with the mine temperature and increased expansive energy of the air."

The reheating suggestion is correct, but it is quite generally understood that even cheap electricity is not cheap when employed for heating purposes.



PNEUMATIC SPRINGS EOR AUTOS.

A PNEUMATIC CUSHION SUBSTITUTE FOR AN AUTOMOBILE SPRING

There has recently been invented by a California mining engineer a novel substitute for springs and shock absorbers on automobiles. This is a pneumatic cushion which appears to have advantages, because it permits the use of solid tires.

The inventor of this new device has found it impossible not only to construct a pneumatic shock absorber, but so to arrange this that it takes the place of the spring itself, while at the same time preventing any rebound.

In its present state this pneumatic cushion consists simply of a round rubber bulb six or eight inches in diameter, having an open neck at its upper end, and a small projection at its lower. This projection fits into a hole in a conical wood block that is secured to the axle of the automobile, while the neck of the bulb is set into a pipe fitting attached to the body of the machine. This pipe, of about 1½ inches diameter, connects to a tank having a capacity of 2,000 cubic inches. Four such bulbs replace the springs of an automobile. In fitting them to a car, the leaves of the springs are removed with the exception of the outer heavy leaf, which is used for steadying purposes. All four tubes are connected by separate pipes to the tank.

The action of the bulb is as follows: When a wheel of the car passes over an obstruction, the bottom of the bulb resting upon the cone-shaped block is pushed inward, and the surface of contact of the bulb with the block is increased. The heavier the blow, the more the block sinks in; consequently, there is a continuously increasing supporting area within the bulb upon which the air acts, the air being under a compression of about 20 pounds to the square inch in the bulb, the pipe line, and the tank. As a result of the increasing flattened area in the bottom of the bulb under a heavy shock, there is a cushioning effect that increases with the blow, and when the initial shock has been absorbed, there is no rebound, since the air in the bulb, piping, and tank has not been appreciably compressed. The cushion acts upon the same principle as the pneumatic tire, since the supporting area is increased when the bulb is flattened, in much the same way as it is with the tire; but in this case there is no increase in air pressure, owing to heating of the air, and consequently no liability of bursting.

The air cushion makes it possible to use solid tires upon all commercial vehicles no matter what the size, as well as upon pleasure cars where it is desired to dispense with the costly pneumatic. The life of a good solid tire is easily double that of a pneumatic. For heavy work eight 12-inch bulbs, using an air pressure of 80 pounds and deformed to 8 inches vertical diameter, will sustain a weight of 15 tons and have a maximum carrying capacity of 24 tons, while 16-inch cushions will carry minimum and maximum loads of 30 and 48 tons, respectively. The rubber bulbs that have been tested in actual use are 8 inches in diameter with a 1 3-4 inch orifice at the neck. They are made up of six layers of canvas imbedded in a 3-8 inch thick rubber wall. They have shown no signs of wear in a 5,000-miles test.

The minimum load that is placed upon four 8-inch cushions is 1,400 pounds, with an air pressure of 30 pounds per square inch and a total contact area of 48 square inches at the bottom of the bulbs. The maximum load these 8-inch bulbs will stand with the same air pressure, is 4,320 pounds. This would increase the contact area to 144 square inches, and flatten out the bulbs to about 5 inches vertical diameter, but there would still be two or three inches for further vertical movement in case of a sudden shock or blow. The air pressure in the bulb determines the strain upon the walls, and as this air pressure never increases perceptibly, it can be seen that the strain is not very great.—*Scientific American.*

TWENTY-FIVE TONS OF ICE PER TON OF COAL

An English plant of the combined compression and absorption machine type has been unusually successful. Messrs. Ransomes & Napier, Ltd., of London and Ipswich, have put in for the Northeastern Ice Co., of Aberdeen, Scotland, a new plant. The old one consisted of two 20-ton, one 30-ton and one 50-ton compression machines. In place of the two 20-ton machines two 65-ton absorption machines were installed, giv- a total of 210 tons per day. The absorption machines were worked on exhaust steam from the triple expansion engine operating the 50-ton compression machine. The same engine drives all the auxiliaries, including the dynamos for the electric lighting plant. A can plant was put in in place of the cell system formerly used. The new plant was tested in September last, 30-ton compression machine shut down, with these results:

Output of absorption machines.	135 tons.
" " compression machine	55 "
Total,	190 tons.
Steam consumption per hour..	5,800 lbs.
Temperature of cooling water..	55 deg. F.
Quantity of coal (slack at $3.37 per ton) used per day for entire plant, including all auxiliaries	7½ tons.

This gives 25 tons of ice per ton of coal for entire plant and 18 to 1 for absorption plant and auxiliaries. The new ice tank is not insulated at all and by insulating it in the usual manner the owners expect to get 30 tons of ice per ton of coal for the entire plant.—*Ice Trade Journal.*

AN EXPLOSION CAUSED BY HOT GREESE

It is not at all uncommon, in fact it is usual in a Lake Superior mine to see a miner stand over an open tool box containing dynamite and caps, select what powder he wants, and count out his caps, meanwhile heedlessly allowing the hot grease from his sunshine lamp to fall promiscously where it will. Apparently he is utterly oblivious to the fact that one of those hot drops of grease might easily explode a cap if it should happen to fall on the right spot. A most flagrant example of the old adage—"Familiarity breeds contempt." Nevertheless the unexpected sometimes happens. Apropos of this, I remember having had pointed out to me a particular spot on the hanging-wall of a certain drift in the old Osceola mine. The story goes that a miner left his stope to get powder and caps from his tool box, shortly after which a loud explosion was heard. Upon examination the miner was discovered in small pieces spread over the hanging-wall not far from the spot where his tool box had previously stood but of which there was no sign.

Another custom in vogue is a careless habit among the drill boys. Upon being sent by the miners to bring powder and caps, they will stuff eight or nine sticks of powder, possibly more, together with a partly filled box of caps, into their shirt, the latter being partly open in front. Thus equipped they will climb into a stope, or down a winze, or perhaps run several lifts on the ladders. As far as I know there is nothing to prevent the cap box from dropping out of their shirt fronts if they should happen to lean too far forward. One misstep and—enough said.—*Correspondence Engincering and Mining Journal.*

SOUND CHARACTERISTICS

BY HUDSON MAXIM.

There are four, and only four, properties of sounds, whether oral or mechanical, and these are loudness, duration, pitch and tone color, the latter being sometimes called timbre. As I have shown in my recent book "The Science of Poetry and the Philosophy of Language," loudness and duration are quantitative properties, and pitch and tone color are qualitative properties.

I have carefully considered the comparative value of the automobile warning signals, and I think the sharp warning sound made by the Klaxon incomparably better than the musical, groaning, wailing or siren sounds made by others. The reason is that the Klaxon has a genuine warning note, while musical sounds possess no warning properties. Neither do mournful or wailing sounds warn. Thus they naturally produce the opposite effect.

We all know that it must naturally take more energy to make a loud sound than a low one, and more energy to make a sound for a longer period than for a shorter one. Consequently, loudness and duration, being representative of the energy consumed in producing a sound, have come to indicate the importance of the sound.

Pitch always varies with the tenseness of the feelings, in accordance with muscular tension. Hence pitch has come to indicate the degree of tenseness of the feelings of men and lower animals.

The tone color, or timbre, indicates the quality of the sound; in other words, it indicates the wave mixture or how the waves of sound are commingled. Different instruments always produce sounds of different tone-colors, and the tone-color always varies with variations in the character of the same instrument producing a sound. If a fiddle string be pulled strongly to one side and released it sets up waves of compression and rarefaction in the atmosphere. The longer the distance through which the string travels in its vibrations the larger are the sound waves and the louder the sound, other things being equal. The more rapidly the string vibrates from side to side the higher will be the pitch. The string not only vibrates as a whole, but it vibrates in segments upon itself. In other words, it trembles, and this trembling sets up smaller sound waves which, traveling upon and mingling with the large and fundamental waves produced by the string as a whole, give the fundamental waves or fundamental tones their tone-colors. The tone colors produced by a steel string, a catgut string and a silk string are all necessarily different from one another.

Now, as the oral instrument of men and of the lower animals constantly varies in shape with the character of the emotions inducing utterance, each different emotion produces sounds of a corresponding tone-color, and we have come to associate the different tone-colors in oral sounds with the emotions prompting the utterance. It is by means of the tone-colors in oral sounds, and by them alone, that we are enabled to tell whether the emotions of the speaker are painful or pleasurable, and also whether or not the speaker is uttering a warning cry or making a coaxing or wooing call.

Though warning sounds may differ widely in certain respects, there is one common characteristic possessed by them—they are harsh and untuneful; they are not pleasant to the ear. The warning growl of the dog, the cry of the fowl that voices danger, the warning snarl of a pair of tigers fighting over a piece of meat are not pleasant, or musical, or wooing sounds.

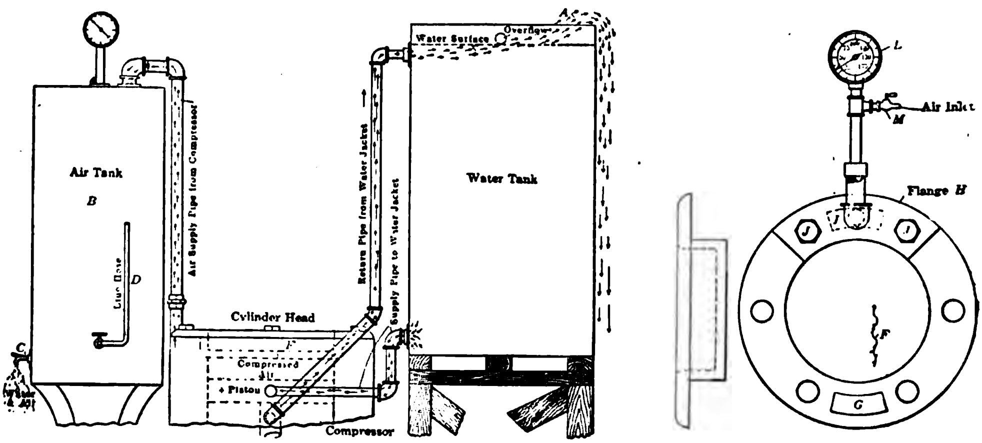
A wooing or musical sound is as inappropriate to the uses of the automibilist as would be a feather instead of a club to drive away an angry dog. It is the tone of the voice, far more than what is said, that calls a dog to us or drives him away from us. All animals are repelled by repellent sounds and attracted by attractive sounds. A musical sound made by an automobile horn tells a falsehood to the pedestrian whom it is expected to warn. ¶It indicates that there is no danger when danger is most imminent.

I have tried many kinds of horns and made a serious study of this question, and I have found that to clear the way there is nothing like the Klaxon, with its harsh, untuneful warning.

Try it on the dog. Try to call a dog by telling him in a loud, harsh, warning voice to come to you, and also to try to send him from you by employing sweet, musical, wooing sounds.

the line hose *D* to the pneumatic riveting gun and hampered the workman. The water had to be let out of cock *C* at intervals of two hours.

As there was water in the air tank, and water spray, apparently caused by air, in the water tank, it meant there must be a leak somewhere between the water jacket and the cylinder. The machine had been examined for just such trouble only a week previous and a place was found that looked like a crack in the cylinder head. This was



CRACK IN CYLINDER HEAD.

A CRACK IN AN AIR COMPRESSOR CYLINDER HEAD

In visiting a shop recently we arrived at the engine room. This contained one 25-horsepower gas engine, and an air compressor, for operating pneumatic riveting machines and drills, that was rated at 80 pounds pressure constant flow. There was also a compressed-air tank, and a 300-gallon water tank to supply the water jacket of the compressor with water. The layout will be seen in Fig. 1.

While inspecting these it was noticed that at every compression-stroke of the piston in the air compressor a small spray of water would shoot diagonally across the surface of the water at the top of tank, and slop over the side; see *A*, Fig. 1. We asked about the cause of this but they did not really know. On opening the relief cock *C* on air tank *B* I noticed a lot of water coming out. This accumulated in the bottom of the air tank, and was driven with the air through

tested by filling the water jacket of the cylinder head with water but as the crack was hardly 0.001 of an inch wide no water would run out.

We, therefore, tested the cylinder head under air pressure and found that the crack, as shown at *F*, leaked enough to cause the trouble.

The method of testing the cylinder head is shown in Fig. 2. The inlet hole *G* was plugged up. Then flange *H* was made to cover hole *I* and this was secured tight with bolts *JJ* after a gasket was placed underneath. Connections for a ½-inch pipe were fitted into the flange and an air-pressure gage was attached to the end of the pipe; a tee *M* being fitted underneath it to admit the air.

The head was then filled with water to within ½ inch of the top and air was pumped into it. When the gage indicated 30 pounds pressure the water came trickling out through the crack, shown at *F*. This showed why water accumulated in the air tank. At every suction stroke the water would be sucked from the crack into the air cylinder, whereas, at the compression stroke the air would enter the crack with 80 pounds pressure behind it. It then followed the easiest way out, which was the return pipe, and thereby caused the water spray at *A*.

The crack was closed with an oxy-acetylene welding apparatus and the cylinder head was immediately put back in the compressor. It is now doing good work, minus water in the air tank, and stray air currents that disturb the surface of the water tank.—*American Machinist.*

[The connection, in Fig. 2, between the air pipe and the water chamber of the cylinder head, where the test pressure was applied, is not readily discoverable. As to the accumulation of water in the air receiver, did not the writer know that water always is deposited there by normal compressed air, and that a "relief cock," as he calls it, is always provided to relieve the receiver of the water which is sure to accumulate? As the crack in the cylinder head would not leak water until a pressure of 30 lbs. was applied, and as the pressure of water in the jacket, as we must infer from the sketch, was not more than 2 or 3 lbs., how could any of it get into the air cylinder? It is quite possible that the crack would allow a little air to escape into the water when the high pressure occurred, but if with such a rush or in any such quantity as suggested by the sketch, how could any of it have been delivered to the air receiver? It is interesting to know of the repair of the head by oxy-acetylene welding, and shows how familiar and handy the process is becoming. A little use of oxy-acetylene upon the sketches and description above might have made a perfectly satisfactory job all around. Ed. C. A. M.]

Polaris, the north star, probably the star most familiar to all surveyors and to most other persons, is really three stars, though appearing as one, even through ordinary telescopes. By means of the great Lick telescope it was learned some time since that it is comprised of three distinct stars which revolve about each other.

DANGERS FROM HIGH AIR VELOCITIES IN MINES*

By Nile Robinson.

At the close of the fiscal year ended June 30, 1909, the chief of the Department of Mines of West Virginia, reported 50,567 men who were employed in underground work. The number is growing larger every year. Responsibility for the welfare and safety of this great army rests upon the inspectors appointed by the state and the owners of the mines; and it is pleasing to record the fact that they are working for the security of both men and property in perfect harmony.

Within a comparatively recent period the mining industry has undergone almost a complete revolution, changing from hand mining to machines, from animal haulage to electric motors, from fire-baskets to fans. The introduction of a new feature in any line of employment may cause inconvenience and possible loss of life until those who are to govern the innovation become masters of its power; but where the danger is self-evident precautionary measures are quickly adopted and security may soon be obtained. Occasionally a danger is concealed under a benevolent guise, and for a long time may remain undiscovered, because unsought. Is it possible that, in our efforts to secure so-called "perfect ventilation" through the introduction of powerful fans we have gone to an extreme, and have developed a hazard where we hoped to obtain a blessing? Is it possible that a mine can be over-supplied with pure, fresh air? Nearly all laymen, and probably a majority of operators, will hold that too much air cannot be delivered underground; and in acting upon that attractive belief hundreds of fans throughout the country are being driven to the capacity limit.

For the purpose of opening a discussion on this important subject of ventilation the writer will start with the declaration that no mine, unless it is generating gas, should be given more air at any time than is required by law; that is, "No less than 100 cubic feet of air per minute for each and every person employed in such mine"—delivered, of course, at his working place.

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*Paper read before the West Virginia Mining Association, Washington, D. C., December 16, 1910.

When air beyond the legal requirement is driven through a mine the surplus will serve no useful purpose whatever, and may constitute a positive danger.

The principal risk is due to the increase that must be made in velocity to handle the waste air. This is especially objectionable in dusty mines, where a high air speed will keep the fine dust in suspension and in perfect readiness for inflammation from a powder explosion. In this connection President William N. Page, in September, 1908, addressed a letter to the operators of West Virginia, pointing out the dangers from over-ventilation, as follows:

It is a physical impossibility to moisten dust to the point of safety in high velocity currents.

I know of no disaster remotely attributable to dust where high pressure fans were not employed. Until a comparatively recent date all explosions were attributed to fire-damp; and to guard against this danger we have created a new danger in the enormous volumes of air traveling at high velocities through restricted channels, which pick up every particle of dust within reach and keep it in suspension.

The compilation of mining records was undertaken by the State of West Virginia in 1883, and a study of the annual reports from that year to, and including, 1909—the last published—will show a relationship between underground fatalities and the change in method of ventilation that is entitled to serious consideration. Here are some figures gleaned from these reports:

Total number of men killed by explosions of gas, powder, blasts and dust.

1883-1889	7 years	42 men
1890-1894	5 years	18 men
1895-1899	5 years	24 men
1900-1904	5 years	136 men
1905-1909	5 years	799 men

A certain percentage of these accidents can be attributed to causes that are in no way related to the air supply, but they are small compared with the heavy losses from explosion in which dust was the principal factor.

In the 17 years preceding 1899 there were only 84 fatalities—a period when fans were beginning to come into use. During the 10 years following 1899 the records show that 935 men were killed, practically all in mines with fans.

There is no invention connected with the mining industry that can contribute more to the safety and comfort of the men engaged in underground work than a properly regulated fan. We have only words of the highest praise for this method of ventilation, and what is here written is simply against the abuse, not against the use, of an invaluable aid in mining.

CHANGES IN THE METHOD OF VENTILATION.

Year.	Total No. of mines.	No. using furnaces, natural vent, etc.	No. using Fans.	Pct. Fans.
1897	221	144	77	34.7
1899	253	137	116	45.8
1904	584	263	321	55.
1909	795	284	611	77.

Almost without exception every serious accident caused by dust in recent years has occurred in a mine ventilated by a powerful fan. It is not unusual to find a strong uniform air current sweeping through a mine every hour of the day and night year after year, regardless of weather conditions and number of men employed.

The unwisdom of this practice is apparent when consideration is given to the fluctuating action of the air upon its admission to the mine. At one time it will deposit its moisture until beads of water appear upon every square foot of exposed surface, perhaps weakening the roof and causing decay in timber. At other seasons a reverse action takes place, and thousands of gallons of water will be withdrawn, leaving many tons of fine coal-dust, dried as in a furnace, and ready for ignition upon the propagation of any unusual flame.

An excess of moisture may weaken a roof and cause a heavy annual loss of life through accidents to individuals, and a very dry mine may become seriously dangerous from its liability to combustion. Each extreme carries a hazard that, in a majority of instances, is assumed without necessity.

A high air velocity holds fine, dry dust in suspension in thousands of eddies behind projecting timbers and in room necks, alcoves and roof arches, where it is in position to originate a disaster or give an opportunity for the widespreading of an explosion that, under true operating conditions, would be localized. In a number of high velocity mines the deaths from pneumonia have exceeded the fatalities from ordinary accidents; and we can trace scores of non-fatal injuries to collisions on mains through the inability of workmen to maintain lights while traveling against strong air currents.

An earnest appeal is therefore made to the operators of the country, and especially to the Bureau of Mines, for a thorough investigation of the dangers that seem to be inseparable from an excessive inflow of air, particularly when it is driven underground at a high velocity.

Observations made by the Fairmont Coal Co. from June 1, 1908, to June 1, 1909—see Bulletin 425, United States Geological Survey —indicate that an ordinary mine, ventilated with 150,000 cubic feet of air per minute, will lose over 200,000 gallons of water per month at this season of the year.

We are now entering the winter period, when this moisture exhaustion is at the maximum. Fully believing that air in excess means a loss in moisture and a needless increase in danger, let me urge a reduction in fan velocity whenever it is possible. Economize in air, and only send underground a sufficient amount to satisfy the needs of the men who are at work until all questions relating to ventilation can be determined through scientific investigation by the Bureau of Mines, our numerous schools of mines and associations of mining engineers.

LUNG DISEASES OF MINERS

Dr. Crumpston, a commissioner of the West Australian government, appointed to investigate the causes of lung diseases among the miners of the country, has recently presented a carefully prepared report. He is said to have visited every mining district in the State and to have examined 2,050 miners, 1,805 of whom were actually at work when the examination took place. Dr. Crumpston had very carefully collated statistics, dealing with lung disease for the past decade, and from these it appears that tuberculosis of the lungs among miners has steadily increased, while pneumonia has decreased. At alll ages, between 25 and 60, the percentage of deaths is higher among miners than among the general population.

An important factor in producing the excess of deaths from respiratory disease is fibrosis. What is commonly styled miners' phthisis is thus designated by the commissioner, who thus differentiates between it and lung tuberculosis. His investigations show that in West Australia it is exceptional for these different diseases to coexist. He found among the 1,805 miners whom he examined at work that 33 per cent. of the machine miners were suffering from early fibrosis, against 7 per cent. of the non-machine miners, 3 per cent. of the truckers, and 24 per cent. of the dry treatment hands. Intermediate fibrosis was found among both machine and non-machine men, but late fibrosis only among machine men. Lung tuberculosis was present in twenty-eight cases. Tuberculosis was to be regarded as an infectious rather than industrial disease. He found no evidence of mine infection, and concluded that the disease was contracted directly by one man from another without any indirect agent.

Measures for the eradication of tuberculosis among miners should not stop short at the exclusion of infected men from the mines, but should include segregation of the tuberculosis persons who come into close association with miners. Fibrosis, which was due solely to the continuous inhalation of fine mineral dust, was so prevalent in the early stages as to demand serious consideration. The high percentage could not be attributed to the importation of cases from other states. Its effects were to diminish the area of lung tissue available for blood purification, and the amount of air and blood which could reach the lungs for the development of the fibrous tissues, but it did not necessarily cease when the patient was removed from the dusty environment. A mere temporary cessation of work among dust was, therefore, not of any value.

AIR BRAKE PROGRESS

The following, taken from records of high speed stops, will give an idea of the advancement in air brake efficiency. In the year 1878 a stop was made from a speed of 60 miles an hour in 1,130 ft., but weights of rolling stock increased to such an extent that the average train of 1900 could not be stopped from a speed of 60 miles an hour in less than 1,400 ft. by the quick-action brake, but the high-speed brake stopped this train in 1,050 ft. In 1908, under conditions in which the high-speed brake stopped a train of cars from a speed of 70 miles an hour in 1,900 ft., the L. N. equipment stopped the train in 1,680 ft., and in the year of

1909, when heavier locomotives and cars running at speeds of 60 miles an hour could not be stopped by any air-brake in less than 1,300 to 1,500 ft., the P. C. equipment stopped the train in 1,100 ft. All of the foregoing refers to emergency stops on level tracks and the work of the P. C. equipment is regarded as marvelous by air-brake men; but if the problem is regarded as merely a matter of miles an hour, records will show that trains were stopped from speeds of 60 miles per hour in 1,020 ft. in the year 1875, but stopping a modern train with the brake of 1875 would be an entirely different matter.—*Locomotive Engineering.*

MOVING PICTURE OF A FLYING BULLET

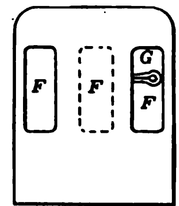
A cinematograph apparatus which takes pictures with intervals of one five-thousandth of a second has been invented by Dr. Cranz of the Military Academy of Berlin. A striking example of the power of the apparatus shows a bullet fired at a bladder of water that is hung on a string.

The eye only sees a little smoke from the pistol and a couple of holes in the bladder, from which the water runs; but when this is cinematographed and the film is shown slowly a very interesting series of operations can be watched.

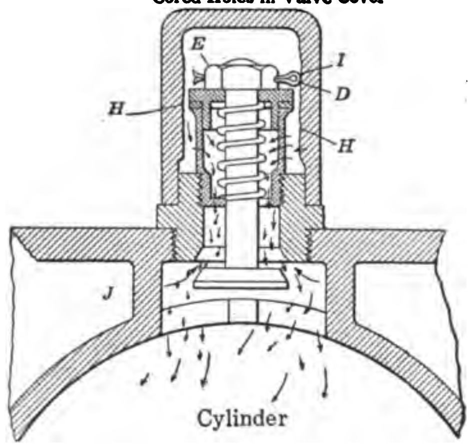
First the bullet is seen approaching. It is traveling 1,000 feet a second, but it seems to move quite deliberately. In front of it and extending a long way above and below it is a dim line, bent sharply immediately before the bullet. A bullet can no more pass through air than a vessel can through water without making a wave; and this is the air wave. It is made visible on account of its different density, just as the waves in air are seen above a chimney or over hot ground.

Behind the bullet come scattered grains of the powder that have not been burned, and traveling more slowly still comes the wad. The bullet enters the bladder and disappears inside, a little water spurting out of the hole it makes. Then it reaches the other side, but it no longer cuts through at once, as it did when the bladder was backed up by the water.

Something like a finger seems to push the bladder outward into a long tube, then the tube opens and lets out the bullet, which gradually travels away. The tube does not at once collapse; its form is maintained by the stream of water which follows the projectile.



Cored Holes in Valve Cover



THE VALVE THAT STUCK.

A PUZZLING AIR COMPRESSOR TROUBLE

A writer in a recent issue of the *American Machinist* tells of a little trouble which befell a small air compressor, and of the difficulty experienced in finding and curing it. The compressor was to maintain a pressure of 80 lbs. for driving riveters, but it only managed to keep up to 30 lbs., and that of course was not enough, so machinists were called to find out what was the matter.

They took out all the suction and discharge valves and cleaned and oiled them; then on starting the compressor it kept up the required pressure for about 6 hours when it again dropped to and staid at 30 lbs. This was gone through with two or three times with no permanent cure.

It was finally discovered that there was an intermittent blow-back in the intake which showed that the inlet valves on one end of the cylinder did not close.

When we took these out and examined them, the account continues, we found that cotter pin *D,* which keeps nut *E* from turning, had an exceptionally large head, as shown in the cut. The casting that covers the assembled valve mechanism has three holes at *F F F.* When the cotter pin head happened to be in front of a hole, as indicated at G, it had plenty of operating room. During the working of the compressor, however, the valve turned slightly, and the cotter pin worked away from the cored holes F F F. It then started to rub on the unfinished surface on the inside of the valve cover, and finally stuck on the high point at *I*.

Both valves had stuck the same way, and, of course, were constantly open. This allowed all air sucked in on the suction stroke to go backward and out through the same valves on the compression stroke, instead of going through the discharge valve, and from there into the storage tanks.

The compressor being of a double-acting design it left two valves in good working order to supply the tank, which accounts for the 30 pounds pressure.

The valve cover was bored out larger and deeper on the inside to allow the cotter-pin head perfect freedom, and this was all that was required to remedy this great trouble.

AIR MEN TO HAVE A PATRON SAINT

Paris, Feb. 1.—A little church in the department of Charente-Inférieure has been dedicated to aviators, and its patron saint, Notre Dame du Platin, has been adopted as the patron saint of flying men. Medals are being struck for aviators to wear or attach to their aeroplanes.

One side shows the protectress of aviators, with the motto, "Look upon her and take thy flight," while the other side shows the little church of Platin. Louis Bériot is the possessor of the first of these medals.

Many aviators have mascots. Moore Brabazon always carries a figure of a lucky pig. Leon Delagrange, who was killed when flying in January, 1910, always believed the number 13 brought him luck, having been born March 13, 1873. Tabiteau has similar faith in the number 28.

Edmond Poillot, another victim of aviation, always carried a four leaved clover and never could pass an old horse-shoe without picking it up and carrying it about a few days.

Rolls, yet another victim, used to fasten a branch of mistletoe to his aeroplane before starting. Santos-Dumont looks upon the St. Benoit medal given him by the Countess d'Eu as a talisman and carries it set in a bracelet that never leaves his wrist. Wellman is said always to take a cat with him in his balloon, and Moisant adopted a cat as mascot during his trip from Paris to London.—*N. Y. Sun.*

WHAT OUR BREATH CARRIES

The ultra-microscope has enabled Prof. Courtade of Paris to analyze the human breath far more minutely than it has ever been done before. In a report to the Medical Society of Paris he says that exhaled air contains not only gases, such as nitrogen, carbonic acid, water-vapor, &c., but also a mass of tiny solid particles, some motionless and others mobile.

The latter, he surmises, may include bacteria, both rod shaped and globular. The presence of minute bits of cell tissue (epithelium) in the human breath he regards as positively proved.

The process followed by the investigator in his experiments was very simple. It was only necessary, he says, to examine a glass plate on which exhaled breath had been allowed to evaporate. Under the ultra-microscope he observed collections of dust composed of as rich a variety of substances as that left by evaporated drinking water.

Dr. Courtade hopes ultimately to be able to lay down a new standard of health by a series of comparisons of what he calls the "breath dust" of healthy and unhealthy persons.

A LOW RANGE RECORDING THERMOMETER

A new recording thermometer for the lower ranges of temperature has been recently developed by the Bristol Co., of Waterbury, Conn. The recording thermometers previously constructed by this company, and depending for their operation on the expansion of a liquid, a vapor or a gas, have been useful only for higher temperatures up to 800 degrees F. The principal feature of the new thermometer is a compensating device applied to the spiral pressure tube, through which the thermometer is made to give correct readings at the point where the sensitive bulb is placid, regardless of changes in temperature of the recording instrument itself. The compensating attachment affects the spiral tube only, and no effort is made to compensate for changes of temperature in the capillary tube connecting the sensitive bulb with the pressure coil. The volume of gas in the bulb, however, is very large in comparison with the volume contained in the tube, so that the error due to changes in the tube temperature is negligible. The new thermometer is applicable for recording atmospheric temperatures of water, temperatures of brine in refrigerating systems and other temperatures below 212 degrees F.

TRIBOLUMINESCENCE

When you scratch or rub a substance and it emits light, that is triboluminescence. A strongly triboluminscent compound was described by W. S. Andrews at the Chicago meeting (1910) of the American Electro-Chemical Society. Its composition and mode of preparation is as follows: Zinc carbonate (chemically pure) 70 parts; flour sulphur, 30 parts; manganese sulphate, trace. Mix the zinc carbonate as a fine powder with the sulphur, then dissolve a small piece of manganese sulphate in distilled water and add enough of the solution to the powdered materials to make a thick cream. Thoroughly triturate in a mortar, then pour into a shallow glass or earthenware dish, and dry at a moderate heat. When dry reduce to fine powder, pack hard into a porcelain or fire-clay crucible with a tight cover, and subject to a bright red heat for 20 minutes. The mixture shrinks into a stone-like mass, which emits a train of yellow sparks when scratched.

The sparks will not set fire to inflammable gases and hence is not a substitute for flint and steel, or the cerium-iron lighters now on the market.

NEAR THE LIMIT FOR COMPRESSED AIR WORKERS

Preparations for the installation of electric traction in the Hoosac tunnel are progressing rapidly. This, as will be remembered, is a double track tunnel 4 3-4 miles long, with numerous heavy trains in both directions, so that the smoke is almost intolerable for the engineers and firemen, and the task of placing the overhead wire carriers without the temporary stoppage of traffic would seem to be impossible. It, however, is being done. A single track is made to suffice for business and the other track is given up to a working train. One car has tent-like structures upon its roof which can be extended to fit tightly up against the roof of the tunnel, thus enclosing sections of the surface to be worked on successively, the enclosure being supplied with "fresh" air by a compressor with an intake near the bottom of the tunnel. The pneumatic tools used for putting holes in the roof and other work are supplied with air from the same source. The condition of the air is bad enough at the best. The men wear big hats and goggles and rub their faces with grease paint. Telephone communication with the outside is constantly maintained.

DELAY ACTION FUSES

In certain classes of tunnel, or shaft excavating, delay action fuzes have been used to advantage. These are made so that a very short space of time intervenes between their ignition by the electric current and their detonation. Two kinds are manufactured, one kind called first period delay action fuzes, detonate a little before the other kind, called second period delay action fuzes, when both are connected in the same blasting circuit. When they are used in connection with regular electric fuzes, the latter will detonate at the instant the electric current passes through the circuit; the first period delay action fuzes will follow these, and the second period delay action fuzes will detonate a little later. By their use it is possible to fire one section of a blast, sufficiently ahead of the following section, for the material blasted by the charges in the first section to be blown out of the way when the next section is blasted.

CURIOUS EFFECT OF EXPLOSION

The effects of the recent explosion of the magazine of the Granite mine, at Victor, Colo., were shown in some curious ways. There were 89 large plate-glass windows in the town broken. A correspondent writing from there says, the damage was caused by concussion, not by flying missiles. The force of the explosion seemed to travel in waves, like those of sound, and took out about every other plate-glass window. The Portland Gold Mining Company has an office building with two doors and a large double window between them, facing the Granite magazine. The two doors were both blown from their hinges and one split its full length. The window escaped without a crack.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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PARALLEL CAREERS OF INGERSOLL DRILL AND CAMERON PUMP

It was in a little shop on the corner of Second Avenue and Twenty-second street, New York, that both the Ingersoll drill and the Cameron pump originated, and the manufacture of both began under the same roof. The late Henry C. Sergeant, who is admitted to have done more in the invention and development of the rock drill than any other person, designed the first really successful Ingersoll drill, getting his fundamental ideas of the valve motion from Mr. A. S. Cameron. This was at a time when a reciprocating engine, like a pump or a rock drill, with no crank shaft to carry it over the center, was practically unknown. The first machines of this class were built on steam engine lines, the valve itself being mechanically connected with or operated by the piston. In the first Ingersoll drill, as in the first direct acting pumps, when the piston reached the end of the stroke it reversed the valve by direct mechanical contact with knuckle joints, rods or other devices, which intervened between the piston and the valve.

Here is where great credit is due Mr. A. S. Cameron. He was seeking to perfect a pump which should be used in rough places where exposed parts were liable to wear or injury. He also wanted to design a valve which would open a large port at the end of the stroke the instant that the piston reached a certain point. This was hardly possible with a mechanically moved valve without excessive shock and wear. Cameron's invention, therefore, was to place a small tappet or knuckle in each cylinder head of the pump, which should serve as a trigger to trip and open, through contact with the piston, a small port connecting with one end or the other of the valve chamber. The valve itself was submerged in live steam pressure equal on both ends, and hence when this tripping action took place it reduced the pressure on one end so that then the full pressure on the other end caused it to reverse. In order to do this with the minimum shock at the tappet, and also taking into consideration the importance of having a small port controlled by such action, Mr. Cameron used a plunger piston which in turn overlapped the valve itself, this plunger piston having an area on each end which might be more or less according to the resistance of the valve to the action of sliding on its seat. The valve itself was, and still is, a slide valve, which, as everybody knows, rests tightly upon its ports and does not leak through wear.

Sergeant had a problem more difficult than Cameron, because, in the first place, the speed of a pump is only about 100 feet per minute while that of a rock drill is four times as great. This high speed made it difficult to use any kind of a tappet trigger, and in order to get the quickest action of the valve Sergeant sought to avoid the use of the slide valve and to use the plunger or valve-moving device of Cameron as the valve itself. In doing this he ran against another difficulty: the valve in order to be tight on its seat would press so hard that the speed of the drill became sluggish, and to remedy this he ran a bolt through the center of the valve, which relieved it of a certain portion of this pressure.

Instead of the tappet trigger Sergeant moved his valve by causing the piston of the drill to undercover passages leading alternately to each valve end. Here we have the identical principle, so far as valve movement is concerned, which is embodied in the Cameron pump, namely, an equal pressure on both ends of the valve and the valve moving in consequence of reduction of that pressure on one end and the other alternately, the action itself being determined by the strokes of the piston. No better evidence is needed of the success of this valve action than the fact that the Ingersoll "Eclipse" drill and the Cameron pump are at work today with valves of this type.

The community of interests between Cameron and Ingersoll has extended from this inception to the present day. The castings for the first air compressors of the Ingersoll make were made in the Cameron foundry on East Twenty-second street. For many years, and until the Ingersoll works were moved to Easton, Pennsylvania, castings were made by Cameron.

Adam Scott Cameron was the youngest of four brothers, all of whom took up mechanical pursuits. While a youth, serving his apprenticeship, he was a student at Cooper Institute, giving his nights and spare time to study and research. He graduated with honors and at once applied himself to mechanical matters. He was early engaged in building the Sewell and Cameron crank-and-fly-wheel pump, which during the Civil War was in demand by the United States Navy and the Merchant Marine. At the close of the war the call for these pumps fell off, so that Mr. Cameron turned his attention to the design of a pump of greater adaptability and more general application. The standard Cameron pump was the result, its acorn shaped air chamber, the emblem of the clan Cameron, the oak, being his trade mark and continuing up to the present time. He died at an early age, but before death he stamped his ability and force of character upon the mechanical engineering of his age. W. L. SAUNDERS.

FRIENDLY CO-OPERATION OF RIVAL POWERS

A few years ago we were hearing discussions as to the relative claims of electricity and of compressed air to employment for specific lines of service. There is, however, little talk now of electricity *versus* compressed air, or *vice versa,* because each has pretty completely demonstrated what it can do better than the other, and both now have their lines of employment rather definitely settled. The most noticeable thing, perhaps, is how each has helped the other, or, from the viewpoint of the case which we have immediately before us, we might be tempted to say how much has compressed air done to provide employment for electricity.

In some of the situations which occur it would seem to be difficult to settle the claims of the rivals. For instance, when a water power, hitherto unused, is "harnessed" to drive a generator, and where the current, after transmission perhaps for many miles, is applied to a motor which in turn actuates an air compressor, we might say either that the air compressor has provided employment for the electric current, or that the electric current has done a good turn for the air compressor and made possible its location there.

In case of the electric air drill the matter seems to be much simpler and clearer. Electricity unaided, has had its try at rock drilling, and it cannot be said that it has made any such success in that field as has the air-driven drill, nor is there apparently any likelihood that it will ever be able to, so that for operating rock drills it had almost ceased to be thought of. In the electric-air drill, however, electric current is the only power transmitter, and in a way electricity might be said to be solely responsible for and solely to be credited with the results, but it is the air at the drill which actually does the work, so that after all every electric-air drill in operation represents so much employment which electricity would not have had except as it was provided for it by this ingenious air device.

The amount of the additional employment thus provided for the electric current is not immediately apparent. The electric-air drill incidentally leads the way to the employment of electricity for other purposes; for where it has heretofore been imperative to have the air compressor to drive the rock drills the presence of the compressed air on the spot has led to its employment also for the driving of pumps and hoists and such things, but the advent of the electric-air drill at once makes it possible to dispense with the air compressor and the air pipes entirely and to use the electric drive for everything. There are thus mine and quarry installations with electric drive throughout which would not have been possible without the electric-air drill.

This drill gets additional and exclusive employment for itself and for the current which drives it through the fact that it may be conveyed to, and installed and operated in the most inaccessible places. It can make itself at home wherever men can get to, wherever the wires can be laid, and where it would be impossible to lay air pipes or to convey and operate an air compressor within practical reach of the work.

All the other drills cost more to operate at the higher altitudes, but the electric-drill is unique in that in operation it is entirely independent of its atmospheric surroundings. The air which operates it being entirely enclosed, and not in touch with the external atmosphere, and not exhausting into the atmosphere, it makes no difference how much or how little the pressure of it may be.

The electric-air drill, it is to be remembered, compromises or sacrifices nothing of efficiency or advantage as compared with the air-driven drill. It strikes a blow as sharp and hard as ever was known: it can be moved and set and operated as easily as any, and it costs at the power house less than one-half what other drills cost.

ROCK DRILL STIMULUS

A rock drill is not at first thought the thing to attract the interest of the mechanically inclined. Those least informed about it are apt to pass it by with a casual and indifferent glance as a simple machine doing only the roughest of work. No one ever thought of putting a bit of finish to the outside of it, or even of painting it except with the thought of protecting it from the weather, and even the paint is always coming off second best in its encounter with mud and flying rocks.

Nevertheless, the rock drill is one of the great inventions, and a composite invention at that, to whose development many untiringly ingenious minds have contributed. No machine was ever more completely fitted for the strenuous life or lived it more successfully. Besides its actual work in breaking the rock and releasing the mineral treasures, in cutting the ways of traffic for the commerce of the world, whether borne on the land or on the water, in excavating foundation sites for the heaviest structures ever erected by man, its incidental influence and achievements also evidence its epoch making importance.

It introduced and made familiar the air compressor, which now finds employment in vast activities to which the rock drill is only remotely related. George Westinghouse told recently how the information of the driving of the first rock drills by air in Alpine tunnels, put him upon the right road to the air brake.

The entire line of air driven tools, the pneumatic hammers, riveters, caulkers, rotating drills, direct and motor driven hoists and the rest, are the children and the grandchildren of the original rock drill, and the industries in which these are employed and depended on owe their rapid growth to it.

It was noted recently upon the death of Chas. T. Porter how the exacting requirements of the high speed engine, and his careful supervision of its manufacture, had done much for the promotion of accurate and efficient methods of machine work in the shops of the world. Nothing has been more insistent upon accurate workmanship, precise reduplication and especially upon the adaptation of the different materials to the several parts than the rock drill.

In a way, the requirements of the rock drill as to accuracy in the manufacture are as exacting as those of the linotype machine. All the working parts of each individual drill must fit with precision, so that they will work with absolute freedom and yet permit no leakage of air. All members, even to the entire machine, must permit of being taken apart by any one, anywhere, and then of being assembled again, *all without any kind of packing.*

This is simple enough, perhaps, for the individual drill, but this drill is usually taken apart only because something has gone wrong with it, and when the working conditions of the drill are considered, and the neglect and abuse and accidents to which it is subject are remembered, this is to be expected. In the reassembling of the parts, therefore, some of them will probably have to be replaced by new ones taken from the stock of duplicate parts always at hand. This may be in Michigan or Montana, in Africa or Australia, but the new pieces slip into their places and are at once ready for their work as though they had always been associated with that particular drill. This is one of the wonders of modern manufacture.

If any poor inventor is hoping to introduce some new machine, of a calibre at all commensurable with that of the rock drill, he could not fail to be impressed, if not appalled, by the enormous plant, the variety of ingenious machines, largely automatic, and the crowd of variously skilled workers, employed in the production of the rock drill.

NEW BOOK

A Pocket-Book of Mechanical Engineering, Tables, Data, Formulas, Theory and Examples, by Charles M. Sames. Fourth edition, revised and enlarged. Published by the author, Jersey City, N. J., 218 pages, 4¼x6½ inches. $2.00.

This is a real pocket book of a size convenient to carry. It contains a great amount and variety of reference matter in most compact form, and is up to date.

A CAISSON CATASTROPHE

A very unusual accident occured on Jan. 31, at Newark, N. J., where a pneumatic caisson was being sunk in the Passaic River for a pier for a Pa. R. R. bridge. Work was progressing in the usual way when a bucket, filled with excavated material, which had been hoisted out and clear of the air lock was dropped by the breaking of the chain. The fall broke the lock door, allowing the air in the caisson to escape and the water to pass into the working chamber. Four of the men within by some means managed to get out, but ten were drowned. No details of such an accident as this seem to be called for or could be of any value, although it would seem that some one was certainly responsible for the condition of the chain.

DISASTROUS POWDER EXPLOSION

Almost exactly at noon on Feb. 1, all downtown New York was shaken by an explosion of almost unheard of severity which occurred near the station of the Central R. R. of N. J., a mile or more away across the North River. A large quantity of black powder and dynamite, said to be for a South American shipment, was being unloaded from a car and carried into the hold of a lighter. As to the immediate cause and incidents of the explosion no one knows anything. The lighter and another vessel with their crews were so completely destroyed that none of the bodies of the men were found. A car of cement next to the car of explosive was destroyed, but a third car containing dynamite stood the shock so that its load did not blow up, but sticks of dynamite were scattered about the floor of the pier. About 40 freight cars were wrecked, the windows in the passenger station were blown out and scores of passengers on two ferryboats were injured. A man in a tugboat nearly a mile away was blown out of the pilot house into the water and fatally injured. The principal tangible effect in the city was the breaking of a great number of windows by the suddenly compressed air.

It is confidently asserted by experts that the initial if not almost the entire explosion was that of the black powder. "Contrary to general belief," as Dr. W. G. Hudson, of the E. I. du Pont de Nemours Powder Company, is reported "black powder is far more dangerous than dynamite. We believe the powder became ignited and in exploding detonated some of the dynamite—not much of it. Dynamite freezes at about 45 degrees, Fahrenheit, and it is nearly impossible to explode it when frozen. The temperature on the day of the explosion and for a week before was below 45 degrees."

NOTES

So favorable is the atmosphere of Argentina to wireless telegraphy that the postmaster general proposes to substitute it for the present telegraph system.

A Swedish army officer has constructed an aerial torpedo propelled by a compressed-air motor. It is claimed to have an initial velocity of 984 ft. per second, and a maximum range of over 14,000 ft. Its charge consists of about 5 lb. of explosive.

The latent heat of ice is 142 B. T. U. That is to say, one pound of ice at 32 degrees F. will require 142 B. T. U. to melt it into water at 32 degrees F., or 142 B. T. U. must be extracted from water at at 32 degrees F. to freeze it into ice at 32 degrees F.

It is no longer recognized as an essential in profitable mining that ores be high grade, for some of the greatest dividend-paying mines in the United States are low-grade propositions. But such mines are made successes only through the ability of watchful managements in keeping the operating costs continually down to the lowest possible figure.

A recent performance in metal cutting, with oxygen is reported by the British engineering papers. It is stated that one man employed by the Knowles Oxygen Company, Ltd., cut through 42 girders, 15x5 in. section, in 4 3-4 hours, with a consumption of less than 200 ft. of oxygen and 300 ft. of hydrogen. Reckoning labor at 1 shilling per hour the cost figured out 6 pence per cut.

What seems to be a practicable invention is a device for locking the doors of English railway cars by means of the air pressure of the Westinghouse air brake. By means of a conveniently located switch, the guard instantly locks every carriage door on the train. Similarly, all doors are kept locked until the train has come to a stop, when they are released by the guard.

In Michigan, at Cook Falls on the Au Sable river, a 9,000 kw. hydro-electric plant is under construction which will have at the starting point a tension of 135,000 volts. The transmission system will extend to Flint, a distance of 125 miles, and to Battle Creek, a distance of 190 miles.

The Pope Mfg. Company, Hartford, Conn., now turning out automobiles as well as bicycles, is stated to be doing an unusually heavy business in the latter. In the fiscal year ending July 31, 1910, it shipped 57,000 bicycles. The current fiscal year the shipments will exceed 65,000, and will break any previous year's showing of the company, even in the old days when it was exclusively a bicycle concern, and when that industry was enjoying its boom 16 or 18 years ago.

The electric fan, which adds much to summer comfort, is far from useless in the winter. Shopkeepers have found that the circulation of air which it creates is the simplest and cheapest way to keep their show-windows free from frost. An electric fan used to create a forced draft in a furnace decreases materially the time necessary to heat the house in the morning, and in winter even more than in summer it may prove a useful adjunct to ventilation.

An injection of cement was the novel method lately adopted to make strong and serviceable two crumbling stone railway bridges at Hamburg. The arches—51ft. in span—were cracked in all directions, and small holes were bored partly through the masonry at the sides of the cracks, and thin cement mortar was forced into the apertures at a pressure of five atmospheres. When this had hardened, the stonework was found to be thoroughly consolidated.

From Japan come particulars of the invention of a smoke-preventing furnace in which compressed air is supplied to the fire through tubes forming an upper grate. The fuel is first deposited on this grate and partly consumed; the combustion gases pass downward through the grate, meeting the supply of compressed air. By means of a reciprocating agitator the partially consumed fuel is caused to fall then upon a second grate of the ordinary type, where combustion is completed.

The weather Bureau has made progress toward the installation of apparatus, especially optical, for the study of the quantity of water vapor through a wide vertical extent of the atmosphere (as distinguished from the purely local indications of the hygrometer and the psychrometer). Spectroscopic observations with this end in view are to be undertaken by Prof. W. J. Humphreys.

The following rather unintelligibly worded news item appeared in the Butte (Mont.) Miner, Jan. 1, 32 years ago: "Two Ingersoll drills, for use on the lower level of the Alice mine, were received last week. They will be set at work within a day or two, but, with steam instead of compressed air, the experiences of doubtful issue should be necessarily imperfect ventilation of the lower levels not admit of steam being employed, drills will be laid aside until Bower's air compressors can be brought up from Salt Lake City next spring."

Ever since man has navigated the seas beyond the sight of land he has needed the most accurate measures of time, in order that he might tell his longitude with reasonable correctness. In 1714 the English government offered 20,000 pounds sterling to the man who would devise a chronometer so accurate that longitude could be told within 30 miles, and a descending reward down to half as much for the person who could tell it within 60 miles. In 1765 John Harrison, son of a Yorkshire carpenter claimed and was given the highest award.

A plant for testing the thrust of air propellers has been erected in England by Vicker's Sons & Maxim. The plant consists of a central tower supporting a cantilever one hundred and ten feet long and balanced by an opposite arm fifty-six feet long. A propeller shaft is mounted on the end of the long arm, which is driven by a 100-horse power engine placed in a cabin surrounding the tower. The motion of the arm is due entirely to the action of the propeller. Provision is made for measuring the thrust of the propeller with great accuracy.

A curious accident interrupted the operation of the Hudson & Manhattan power station a short time ago. The fine soot and dust from the back connections had been discharged and allowed to accumulate in the fan room beneath the boilers, and had been drawn by the fans into the air ducts and deposited as a coating of carbon upon their inside surfaces. In some unexplained manner this carbon took fire, and urged by the blast of the fans developed such a heat that the ducts were twisted all out of place, and the entire draft-producing mechanism of the station put out of business.

A new station on the Broadway division of the N. Y. subway at 191st street has been opened. This station is about 170 feet below the surface of the ground, and is farther from the surface than any other station of the Interborough subway. It has cost about $350,000, the work being done as an extra under the original subway contract. Besides the stairway at 191st street, there are four elevators, all in one shaft, and going down as far as the mezzanine floor of the station. Only about a quarter of a mile to the north the ground drops away so that the subway becomes an elevated road.

It is stated that in the Butte district about 700,000 lbs. of copper from mine and tailings water is precipitated monthly. The greater part of this comes from the mine water, about 550,000 lbs. The mine water is heavily charged with the metal in solution, in the form of a sulphate. The woodwork and walls of some of the mines are painted in the liveliest colors by the precipitated chemical. The water issuing from the mines and collected in launders is described as being of a pea-green hue. In these basins are distributed quantities of tin cans and scrap iron, which precipitates the metal.

On the excavation for the St. Mary's Falls Canal the Marsch-Robbins Co., Contractors, have adopted the use of a small air-operated hand hammer drill for drilling "pop holes" in large fragments of rock too large to be handled by the steam shovel. If the "mud cap" method of breaking these fragments was employed, there would be a heavy damage to the windows in the adjoining city. The present method results in a considerable economy in explosives. A block 5x5x4 ft. in size requires one hole 28 ins. in depth in which ¼ lb. of 40 per cent. dynamite is placed with one exploder; "mud capping" would require about 5 lbs. of dynamite in this case.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 3.

980,257. FUME-CONDENSING APPARATUS. William R. Heslewood, Berkeley, Cal.

980,382. MECHANISM FOR UTILIZING THE EXHAUST-GASES OF INTERNAL-COMBUSTION ENGINES. Samuel T. Willis, Worcester, Mass.

4. In combination, a motor vehicle provided with a shaft, a turbine engine connected with said shaft to drive the same and propel said vehicle, a pressure tank or vessel in communication with said turbine, means to control the supply of fluid under pressure from said tank or vessel to said turbine, and an internal combustion engine connected with said pressure tank to discharge therein its exhaust gases, and having its shaft mechanically disconnected from the turbine driven shaft while the latter is being driven by said turbine substantially as described.

980,418. WALL-VALVE FOR PNEUMATIC CLEANING SYSTEMS. John T. Hope, Kansas City, Mo.

980,489. FLYING MACHINE. Henry J. Casanova, Chicago, Ill.

980,624. SAFETY TRAIN-AIR-LINE CUT-OUT COCK. George C. Gale, Alameda, Cal.

980,747. PNEUMATIC PIANO. William G. Betz, Steger, Ill.

980,753. AIRSHIP. William J. D. Bradford, Killeen, Tex.

980,756. DEVICE FOR CHARGING CAPSULES. Domingo Brescia, Quito, Ecuador.

1. A device for charging capsules, comprising a charging vessel adapted to receive gas under pressure, and arranged to be held in a plurality of positions, and baskets for removably holding the capsules within the vessel whereby the valves of the capsules are controlled by the position of the charging vessel.

980,810. AIR-VALVE FOR OIL-TANKS. John M. McDonald, Dubuque, Iowa.

980,813. PROCESS OF LIQUEFYING AIR AND SEPARATING OUT OXYGEN. Rudolph Mewes, Berlin, Germany.

980,828. DEVICE FOR COOLING THE AIR REQUIRED FOR MALTAGE. Emil Ott, Berlin, Germany.

1. An apparatus for cooling and moistening air comprising a chamber having an outlet opening in its bottom, a cooling battery comprising a series of superposed spaced conical rings arranged over said outlet opening the upper end of the battery being closed; means for spraying water upon the interior surfaces of the rings, and means for passing air from said chamber between the rings into the battery and thence downward to the outlet opening.

980,840. AIRSHIP. Matthew Rozboril and Peter Bursky, Binghamton, N. Y.

JANUARY 10.

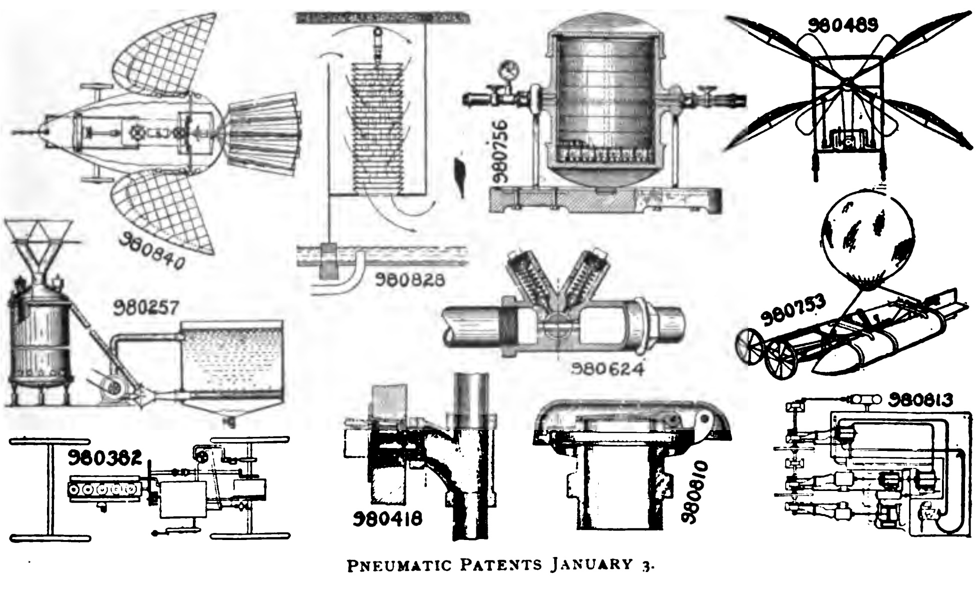
980,916. MEANS FOR AUTOMATICALLY PRODUCING AND UTILIZING AIR-PRESSURE. Henry E. Borger, Dayton, Ohio, and Albert S. Atkins, East St. Louis, Ill.

980,935. AERIAL PROPELLER. Thomas Fahey, Spokane, Wash.

980,944. SUCTION-CLEANER. Tracy Barbour Hatch, Alhambra, and Edwin Walter Goeser, Los Angeles, Cal.

980,977. VACUUM CLEANING APPARATUS. Paul C. Little, Carnegie, Pa.

1. In pneumatic cleaning apparatus, the combination of a reservoir for liquid, a connection for the dust laden air leading into said reservoir, a connection in the further path of the air leading from said reservoir, suitable means for producing suction therethrough, means for condensing the vaporized liquid passing through said connection, a receptacle for collecting the mixed



PNEUMATIC PATENTS JANUARY 3.

vapor and dust sucked therethrough, and a connection leading from said receptacle back to said liquid reservoir.

980,996. DEVICE FOR GENERATING AND ADMINISTERING OXYGEN. DAVID E. PARKER, Niagara Falls, N. Y.

981,036. ROCK-DRILL. ROLAND S. TROTT, Denver Colo.

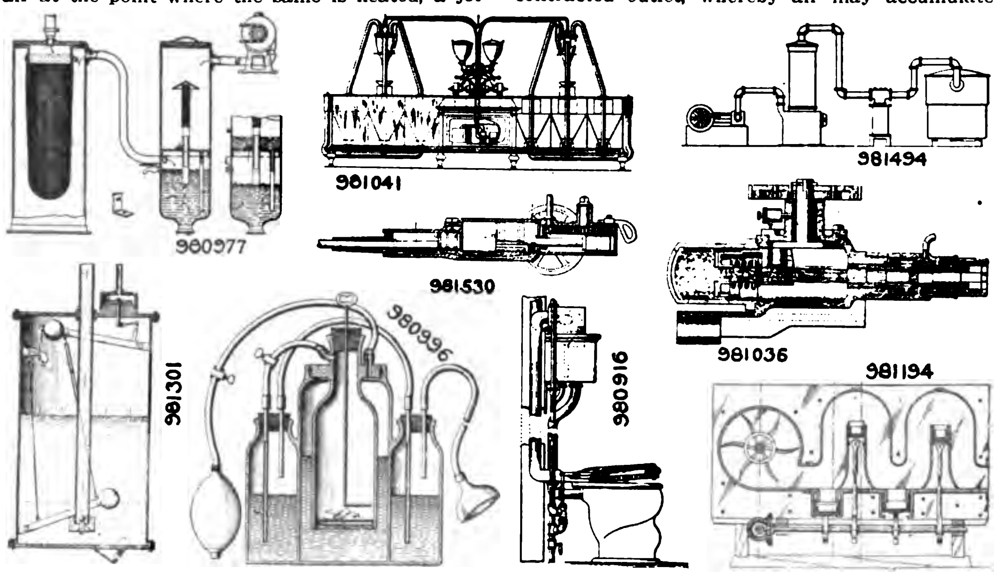
981,041. PNEUMATIC CONVEYER. FRANK F. WEAR, San Francisco, Cal.

981,102. ELECTROLYTIC DEVICE FOR GENERATING PURE OXYGEN AND HYDROGEN. RENE MORTIZ, Wasquehal, France.

981,141. MEANS FOR PRODUCING A VACUUM. PERCY H. THOMAS, East Orange, N. J.

981,170. METHOD OF PREVENTING MINE EXPLOSIONS. JOHN W. COLEMAN, Maybeury, W. Va.

The herein described method of preventing the accumulation of dust particles in the air in a mine, said method consisting in introducing air into a mine at one point, forcing air out of the mine at another point, and hence maintaining a circulation of air; heating the air near the point of intake to the temperature of about 72 degrees F., and injecting into the current of air at the point where the same is heated, a jet



PNEUMATIC PATENTS JANUARY 10.

of steam in the same general direction as the said air current, to supply sufficient moisture to the air to cause the precipitation of the dust particles therein.

981,185. AERIAL APPARATUS. GATES M. FOWLER, San Francisco, Cal.

981,194. CONCENTRATOR. JOHN P. IBSON, Denver, Colo. Filed Oct., 19, 1909. Serial No. 523,418.

981,301. WATER-LIFT. JOHN E. OSMER, Chicago, Ill.

981,363. PNEUMATIC PIANO. WILLIAM G. BETZ, Chicago Heights, Ill.

981,367. AIR-CRAFT. FREDERICK BRACKETT, Washington, D. C.

981,410. AEROPLANE. JOSEPH A. GOODWIN, Berkley, Va.

981,494. VACUUM DRYING APPARATUS. EMIL WILHELM STROHM, Buffalo, N. Y.

981,498. VACUUM APPARATUS. PERCY H. THOMAS, Montclair, N. J.

981,501. VACUUM DRYING APPARATUS. LORIN W. TREICHLER, Williamsville, N. Y.

981,530. FLUID-ACTUATED TOOL. JOHN W. CANTY, Florence, Colo.

JANUARY 17.

981,641. MACHINE FOR HAIR-DRYING AND THE LIKE. HENRY V. HALLIWELL, New York, N. Y.

1. In a device of the class described, an electric motor, a fan, a drum, an electric heating means detachably placed upon the outlet end of said drum, a nozzle detachably placed upon said heating means and of means for suspending said device.

981,755. AIRSHIP. JAMES M. KELLER, Detroit, Mich.

981,716. EJECTOR FOR WELLS. JOHN B. TAIT and THOMAS MALONEY, Maricopa, Cal.

1. An ejector for wells comprising an induction pipe for fluid, an eduction pipe for fluid, a supply pipe for compressed air, a reservoir cylinder of relatively large diameter compared to said air supply pipe, a sleeve at the upper end of said induction pipe, a cylinder surrounding said sleeve and separated therefrom at its lower end to form a contracted outlet and connected at its upper end to the eduction pipe, said reservoir extending a considerable distance above said sleeve on the induction pipe and the said contracted outlet, whereby air may accumulate in the upper end of said reservoir above said outlet to equalize the outflow, as substantially set forth.

981,719. HOT-AIR DRYING PLANT. GEORGE HERBERT THORP, Yarasloff, Russia.

981,733. COOLING DEVICE FOR ENGINES. GEORGE WOLKE, Jacksonville, Ill.

981,748. LIQUEFACTION OF AIR AND ITS SEPARATION INTO ITS CONSTITUENTS. GEORGE CLAUDE, Paris, France.

981,755. ART OF LIQUEFYING GAS AND SEPARATING ITS ELEMENTS. EDSON F. GALLAUDET, Norwich, Conn.

1. The art or process of separating a mixed gas like air which consists in effecting the separation thereof solely by interactions between a downward current of liquefied portions and an upward current of unliquefied portions of the gas.

981,778. AIRSHIP. EDWIN LYMAN MADDEN, Ingersoll, Okla.

981,804. ROTARY PUMP OR COMPRESSOR ROBERT M. SLOAN and ZACHARY M. LINDLEY, Carthage, Mo.

981,899. PNEUMATIC HAMMER. ALBERT H. TAYLOR, Easton, Pa.
982,004. AUTOMATIC AIR-BRAKE COUPLING. THOMAS E. JENNINGS, Scott Haven, Pa.
982,008. SHOCK-ABSORBER. WILLIAM BRUCE KNAPP, Stoneham, Mass.
982,011. VACUUM-RENOVATOR. AUGUSTUS W. NOHE, Chicago, Ill.
982,161. MILKING MACHINERY. ALEXANDER SMAILL, JR., Tomahawk, near Dunedin, New Zealand.
982,190. PNEUMATIC SUSPENSION FOR VEHICLES. WILLIAM H. SHANKLAND, St. Johns, Oreg.
982,225. APPARATUS FOR LIQUEFYING GAS AND SEPARATING ITS ELEMENTS. EDSON F. GALLAUDET, Norwich, Conn.
982,227. APPARATUS FOR PRODUCING OZONE. LUDWIG GLASER, Pankow, Germany.

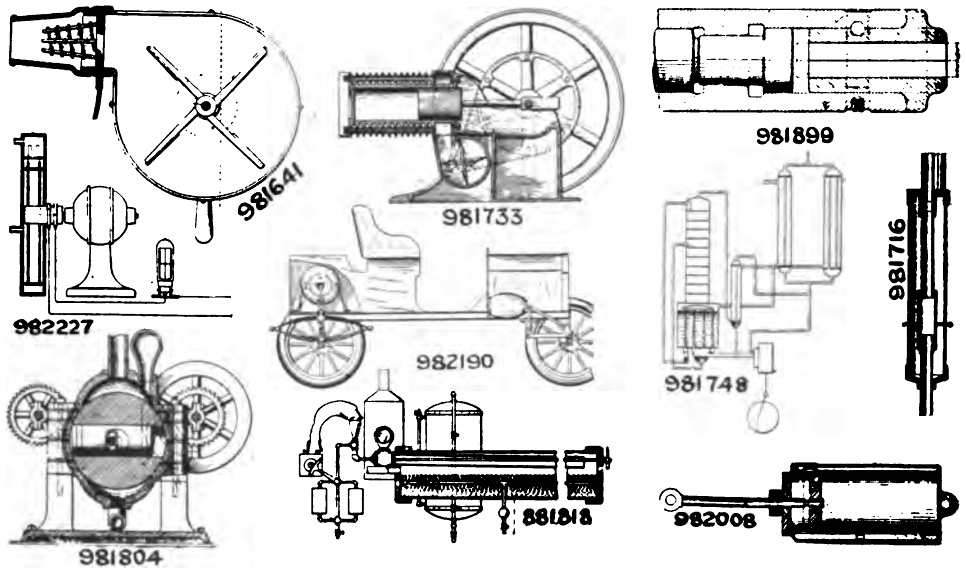
1. A device for producing ozone comprising a conductor of the second class which is cooled by strong air currents, and a resistance with high positive temperature coefficient connected in series with said conductor to prevent said conductor from loosing its conductivity because of the cooling action of said strong air currents.

982,540. JET PROPULSION. PAUL SKOUSE, Athens, Greece.

2. In driving means for vessels, a plurality of explosion chambers, independent accumulators for gas and air with passages leading to each of said chambers, means for compressing gas and air in said accumulators at a relatively high pressure, and means for admitting said gas and air at reduced pressure to said explosion chambers, in combination with a common cam shaft controlling the inlets to said chambers, a common exhaust passage into which said chambers open and forwardly and backwardly directed passages branching from said exhaust to the exterior of said vessel, substantially as and for the purpose described.

982,632. AIR-COMPRESSOR. FRANK M. PRATHER, Los Angeles, Cal.

1. An air compressor, comprising a circular frame keyed to a driving shaft, cylinders disposed in said frame extending radially from said shaft, pistons in said cylinders workably connected to a crank on a driven shaft and adapted to reciprocate in said cylinders, the driven shaft being in alinement with the driving shaft and the crank thereon carrying the pistons being eccentric thereto, and means to feed air into said cylinders on the relative rotation of said shafts.



PNEUMATIC PATENTS JANUARY 17.

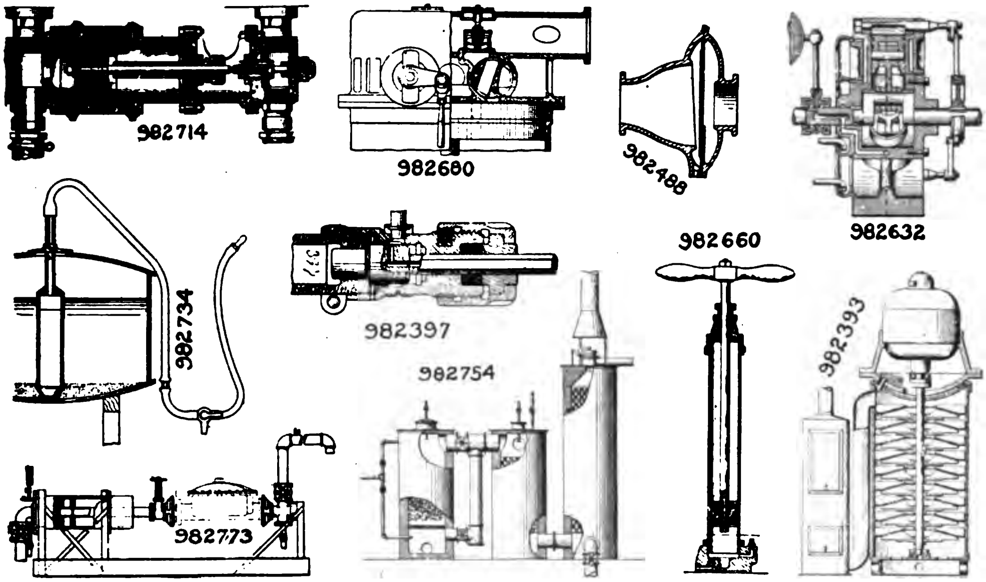
981,818. PROCESS OF REGULATING AND MAINTAINING HUMIDITY. HARRY D. TIEMANN, Washington, D. C. (Dedicated to the public).

1. The herein described method of regulating and controlling the humidity in gas consisting in first raising the dew point to a temperature above that required for the desired vapor tension, then lowering the dew point by condensing the surplus vapor to the temperature corresponding to the proper vapor tension, maintaining this vapor tension by controlling the temperature of the condensing surfaces or bodies and then heating the gas and vapor to the degree finally desired.

JANUARY 24.

982,393. APPARATUS FOR FORCING AIR. IRA H. SPENCER, Hartford, Conn.
982,397. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.
982,488. DEVICE FOR SEPARATING LIQUIDS OR SOLIDS FROM GASES. JOSEPH WILLARD GAMBLE, Philadelphia, Pa.
982,660. AIR-PUMP. JOHN DICKENS, Passaic, N. J.
982,680. AIR-VALVE. LORENZE IVERSEN, West Homestead, Pa.
982,714. TESTING DEVICE FOR AIR-BRAKE SYSTEMS. FRED A. GILFUS, Auburn, N. Y.
982,734. SEDIMENT-REMOVER. ARTURO MARTINELLI, West Hoboken, N. J.
982,753. MULTIPLE-EFFECT GAS-COMPRESSING APPARATUS. GARDNER TUFTS VOORHEES, Boston, Mass.
982,754. PROCESS FOR THE MANUFACTURE OF GAS. GEORGE H. WARING, Omaha, Neb.

1. The process of making gas which consists in passing air through a burning fuel bed to heat it and generate combustible gas in a generator and passing off said gas to and burning it with secondary air in a chamber to heat the latter, and then passing oil down through the hot fuel bed to generate oil gas and oil vapors and partly decompose them into their elements



PNEUMATIC PATENTS JANUARY 24.

of which the carbon remains in greater part in the bed and completing this decomposition of the oil vapors and oil gas and the manufacture of gas rich in hydrogen by passing said vapors through said pre-heated chamber.

982,773. CLAMPING DEVICE. ALBERT B. WOOD, New Orleans, La.

1. A clamping device comprising of movable member provided with a passage, and means whereby fluid-pressure may be applied to the member, the fluid directly co-operating with said member having access to the passage.

JANUARY 31.

982,851. PNEUMATIC SAW. CHARLES J. OSLON, Muskegon, Mich.

982,860. VACUUM JAR-CLOSURE. WILLIS J. PEEBLE, Summitville, Ind.

982,895. ROTARY PUMP. ALBERT E. STOKER, Chicago, Ill.

982,903. ATOMIZER. JOHN S. THURMAN, St. Louis, Mo.

982,906. LUBRICATION APPARATUS. JOHN TRIFTSHAUSER, Hornell, N. Y.

982,923. SUCTION APPARATUS. FERDINAND BARBY, Paris, France.

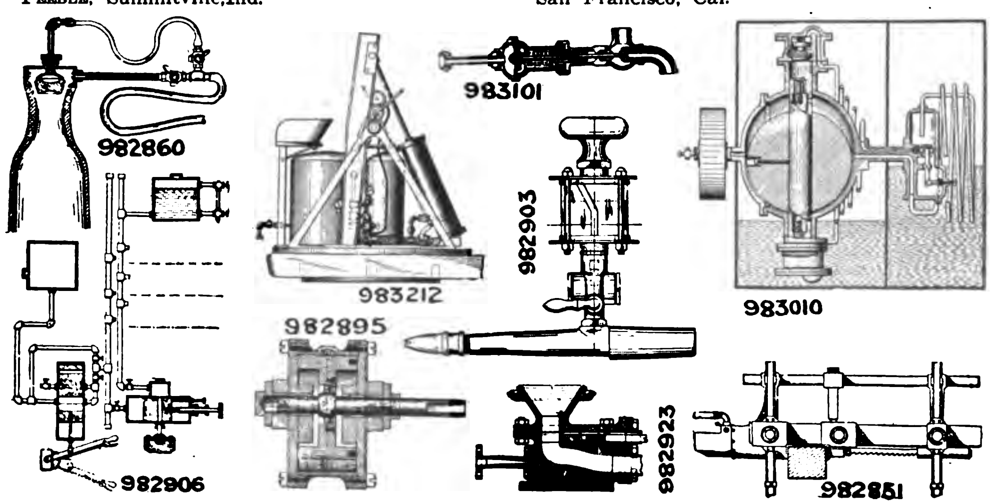
983,010. ROTARY COMPRESSOR. THEODORE R. VINZENT and FRED C. BELL, Alameda, Cal.

983,101. FLUID-PRESSURE GOVERNOR. MATTHEW J. WEBER, Columbus, Ohio.

983,212. MACHINE FOR RAISING AND LOWERING LADDERS. EDWARD F. DAHILL, New Bedford, Mass.

983,233. AERIAL MACHINE. JAMES HUMPHRIS, Johannesburg, Transvaal.

983,243-4. AIRSHIP. CASSIUS E. LAMBURTH, San Francisco, Cal.



PNEUMATIC PATENTS JANUARY 31.

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- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Stearns-Roger Mfg. Co.
- Sullivan Machinery Co.
- Westinghouse Air Brake Co.

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- Baldwin Locomotive Works.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Galigher Machinery Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- Janney, Steinmetz & Co.
- McKiernan-Terry Drill Co.
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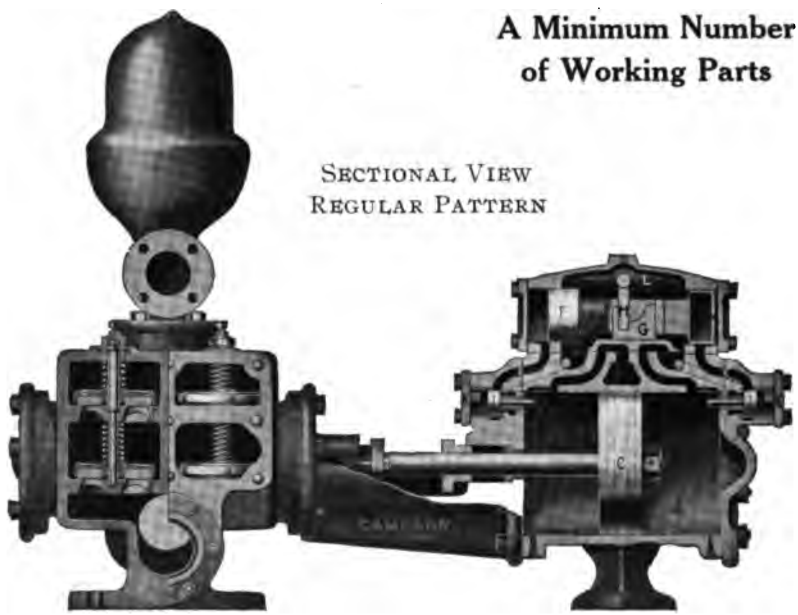

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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SHALLOW AGAINST DEEP HOLES IN HEADINGS

By W. L. Saunders.

The most marked difference between the system of driving headings in rock in America as compared with the European, or what is generally known as the Alpine, system is that in America deep holes are driven while in Europe the holes are shallow. Holes 8, 10 and even 12 feet deep are not uncommon in tunnel headings in the United States, while in the Alps the usual depth of hole is only a little more than one-third of these figures.

It is now generally admitted by engineers of experience in this matter that tunnels are driven in the Alps at double the speed at which they are driven in the United States, hence it becomes a question of moment as to what influence shallow holes have upon the speed of tunnel driving. In considering this subject we at once ask, what size of rock drill is used? It would seem, of course, that in these shallow holes smaller drills must be used, but this is not the case. The rapid tunnel driving in the Alps, where shallow holes are put in, is done with drills about 3½ or 3⅝ inches in diameter, and, as in the case of the Loetschberg south heading, these drills are made in America, and are identical with those used here for the same class of work.

The next question is, what is the nature of the rock? and the answer to this is that it does not make any difference. The rock may be hard or soft, yet there appears to be in America a general tendency to use deep holes, while in Europe there is the opposite tendency.

The distinct difference, however, is in the mounting of the rock drill, which in the United States is a column or a shaft bar, while in Europe it is a small carriage, carrying a shaft bar or column, and in this we have the key to the situation. A column carrying a rock drill on an arm, which is the usual practice, must have the muck cleared away at its base and it must be jacked in place securely. The rock drill when mounted on this column has a limited range of working; only a limited number of holes can be drilled before this column must be moved to another place, hence the tendency is to put in those holes as deep as practicable, so as not to lose time in changing the mounting.

In the Alps a single bar carries all the drills and this bar when once put in place across the heading, by means of the carriage, is securely jacked, and, except where the conditions are exceptionally difficult, it serves until all the holes are drilled. This bar forms a rigid abutment resisting the blow of the drill. It is usually placed above the top of the muck and in some cases it is lowered afterwards for the bottom holes, but in no case does it require anything like the time or attention for adjustments that is usual with the column system. As it is an easy matter to move a rock drill from one hole to another on this horizontal bar it it not considered so important to put in deep holes. On the contrary a large number of shallow holes, closer together and without the rule of three figuring as to alignment, is found to be best in the long run.

In horizontal hole drilling it is often true that the first three or four feet of hole are drilled much more rapidly than at greater depths; that is, as the hole gets deeper the working of the drill is obstructed by the cuttings which are not so easily freed, by the friction of the long steel upon the walls of the hole, by the running of the hole out of line and by the excess of labor put upon the rock drill to reciprocate the heavy, long steel. Another disadvantage is that deep holes are not usually as large in diameter at the bottom as shallow holes, hence there is less concentration of explosive where it is most needed.

Shallow holes well filled with dynamite break up the material better and are more apt to throw from the face, while the deep holes dislodge heavy masses, which sometimes must be again broken up before handling.

An interesting record bearing upon this subject is given by Mr. John P. Ramsey in a recent issue of *Engineering-Contracting*. Mr. Ramsey states that in a portion of the work for the construction of the New York Aqueduct the deep hole method was first used in driving the headings. He says: "We drilled 19 holes 10 feet deep for the dry-side and break-down holes, and six holes 9 feet deep for the cut holes." One of the difficulties revealed by experience was that the deep holes interfered with other details of a regular working schedule; that is, the drilling took almost a two-shift period while the other operations only some 5½ hours, and having no working schedule the men were inclined to lag behind. Furthermore, the drill holes were so deep that the explosion did not pull to the bottom of the hole, resulting in a loss which Mr. Ramsey estimates as some 25 per cent. of the holes. He says at times it was necessary to shoot the cut three or four times before the blast was effective. He also speaks of the difficulties encountered by the steels sticking, usually after the hole was 8 feet deep.

In order to improve the service experiments were made with holes of different depths, and it was finally decided to use holes of 6 feet depth for the side rounds and 5 feet cut; the result of this change in the system was that they now get two rounds during the 24 hours, while before they got only one and a fraction round in the same time. The new system gives them a consistent working schedule, the men doing the same work day after day and thus becoming more efficient. Tables are given which show that the reduction of feet actually drilled per yard of rock removed was 15½ per cent., and a saving of lost holes per yard of rock removed was 46 per cent. Almost ½ a pound of dynamite was saved per yard removed, and the final cost of the work showed a saving of 69 cents a yard, together with an increased yardage of 11 per cent. Mr. Ramsey concludes with the statement that "this is sufficient proof that the shallow hole is more economical than the deep hole in driving headings."

THE BALANCED LIFE*

By J. F. Kemp.

One day in the month of August last, I sat down on the summit of a high ridge in Swedish Lapland, far within the polar circle. It is always an unusual experience for a dweller in our latitudes to look away from a commanding peak over these far northern landscapes. They are in themselves lonely in the extreme, and except in unusual cases, almost without visible life. The scattered communities of Lapps, with their herds of reindeer, or perhaps, in favorable meadowlands, a venturesome family or two of Finns, are all that can be normally expected. The surface is an expanse of lake and bog, with now and then a stretch of higher ground and occasionally a hill. The trees are stunted and gnarled by the storms and cold, and the smaller vegetation hugs the ground in a thick mat. And yet, right before my eyes, and not ten years old, was a town of 7500 inhabitants, with hotels, shops, comfortable homes, and school-houses, as good as anything in our latitudes, and a thousand children in them, with pictures, maps, and even some well-executed works of art upon the walls. I really saw a community in the making—the embryo of a little State. It made a profound impression upon me. Now, a community in the making is not an altogether unaccustomed sight to us in America. We who have been in the West have seen it often, and some of us have shared in the process. But in our latitudes the conditions usually permit the growing of those things which are good for food, or shelter, or warmth. The days are not twenty-four hours long in summer and no hours at all in winter. The frost does not come on the last of August, nor the snow in September, and remain till May or later. The water-pipes are not of necessity laid eight feet underground to pre-

*A chapel address delivered to the students of Columbia University.

vent their freezing, nor are they bedded in non-conductors against the all-pervasive cold of winter. We seldom reach the almost irreducible minimum of which I speak. The ridge on which I sat constituted one of the largest and richest bodies of iron ore yet discovered, and the cause of the railway and of the flourishing town was the plan to mine the ore and ship it to fill the hungry throats of furnaces in Europe and America. And when I thought of my friend of twenty years standing, who was the one who had developed it all and who was now the manager—realizing his almost impossible dreams—I could not help thinking of the position he held as the leader of this community so far from others of its kind. Seven or eight thousand people to be fed, clothed, warmed, educated, employed, and welded into a unit.

On that summit in Lapland my thoughts ran over the ocean to our beloved university, and I could not help seeing in my mind's eye the long procession of engineers who have gone out and who have in some cases, I well know, had the duty and responsibility of organizing similar communities. A mine or a manufactory is always the foster-mother of a community. It furnishes directly or indirectly all the means of subsistence. The manager carries many responsibilities other than the mere business. Away off in Lapland, as I looked over the town of Kiruna, I could not help thinking of the importance of giving it and every similar community an individuality, a character, and a solidarity as the years pass. The life is more than meat and the body than raiment. The daily task must be performed, indeed, the daily wage must be earned, the commercial organization must be perfected, but after that, and beyond all that, a community of feeling must be fostered, an interest of man in man must be established, a life of the spirit must be developed to hold men and families together. While we work in our laboratories, learn to construct our beams and girders, build our railways, smelt our ores, make our profits, and all that, it is not altogether with these material objects that our graduates must deal, but with families and communities and all their varied interests. Pig iron, steel rails or beams, and profits, are not the whole story, but the welfare of men, women, and children is equally involved. This latter responsibility no manager can escape.

DRAINING COMPRESSED AIR

By Frank Richards.

It may be well at the beginning to call attention to the wording of the title of this article. It relates not to the drying but to the draining of the air, the significance of which distinction it is hoped will be evident later.

In the use of compressed air, especially where it has to be transmitted any considerable distance from the compressor to the point, or more frequently the several points, where it is to be employed, there is still in too many cases serious trouble caused by the condensation, and often by the freezing, of the moisture carried by the air. This water trouble has been familiar to all users of compressed air from the beginning, and the cause of the presence of water in the air, and the conditions necessary for its elimination are quite generally understood. As to actually getting rid of the water, however, if not entirely, at least to beyond the stage of annoyance, there is still some of the too familiar difference between theory and practice which so often results from the incompleteness of the former as applied to a specific case.

One of the greatest of the world functions of the atmosphere is the conveying and the distributing of water all over the earth. This is a work in which it is constantly employed, so that when we interrupt it in its work by seizing portions of the air to use for other purposes, it does not drop its water to do our bidding but brings the water along with it, so that all air when we take it into our compressors contains a considerable proportion of moisture.

Normal atmospheric air is usually not completely saturated with moisture, but for any combination of relative volume and of absolute temperature there is always a fixed point up to which it will continue to absorb water if in contact with it, and beyond which it will immediately begin to give up the excess of moisture. Either a change of volume or a change of temperature will immediately change the moisture-carrying capacity of the air. In the operation of compressing the air we violently change both of the great conditions which determine its capacity of humidification, and it might be expected consequently that released water would be at once in evidence. It happens, however, that the two conditions which are so greatly and so suddenly changed by the compression of the air work against, and largely neutralize, each other, so that the water in the air up to this point is not likely to show itself. As the volume of air is reduced, as it is often to one-fourth or even to one-eighth of the normal by a single compression, the water-carrying capacity of the air is also proportionately reduced, or it would be were it not that the air is at the same time heated by the compression, and the rise of temperature increases the thirst of the air more than the reduction of volume would change its capacity.

The moisture in air up to the point of saturation is perfectly transparent and invisible, but immediately that the saturation point is passed some of the moisture is condensed and is distributed through the air in the form of minute globules of actual water, which may not be individually visible, but which are so when the super-saturated air is seen in the mass.

How suddenly water may change from the invisible to the visible, or from the vaporous to the liquid state, I learned as a boy when I used to watch the running of a glass steam engine. This was a wonder (for its time, more than 50 years ago) which used to be exhibited by a traveling troupe of glass-blowers. It was a complete beam engine like a steamboat engine, with steam boiler heated by an alcohol lamp and a jet condenser and air pump, all of perfectly transparent glass and illuminated so that the true inwardness of all was perfectly visible. You could see in the boiler the water in violent agitation and in the condenser the jet of cold water squirting in, with a cycle of fluctuation corresponding to the revolution of the engine, and also the continual removal by the "air" pump of the accumulating water in the condenser; but in the boiler and in the condenser, and all the way between them, there was no visible fluid movement, except for a single instant of each stroke, this invisibility of the steam making the operation of the engine as a whole to seem as absurd, and the connection and sequence of cause and effect as lacking, as when one gets a glimpse into the window of a ballroom when the waltz is in full swing without being able to hear a note of the music.

The exceptional moment noted was just when the exhaust occurred in the cylinder, and then like a flash it was filled with fog, so that as one would say, the steam became visible, although in fact the steam, or that portion of it which became visible, had ceased to be steam and was instead water of condensation which had become so by giving up its heat to momentarily sustain the vaporous condition of the other portion.

The vapor of water when it is mixed with air is invisible, just as it is when it is not mixed with air, and it becomes visible in the same way when condensation of a portion of it occurs.

I have often wished that we could have some compressed air pipes of glass, or at least some peep holes by which we could see inside the pipe. When the compressed air is first discharged from the compressor it is hot, and being hot it is not oversaturated, and therefore we may assume the air to be perfectly transparent. If, however, the compressed air is then cooled down to normal temperature the point of saturation will be passed, some of the vapor will be turned to water, and then there will be some visibility to the entire mass.

This cooling of the air, with the consequent condensation of a portion of the water in it, may occur immediately upon its leaving the compressor if the air is passed through an aftercooler, or it may occur gradually and be completed at a considerable distance from the compressor if the air is only slowly cooled by its flow through the pipes. In either case the water is still in the air, and the change of the water from the vaporous to the liquid state has not got rid of it.

It is assumed by many that if an aftercooler is used, and if the air then goes from the aftercooler to a receiver, it will there give up its suspended water, but this is found not to be true to any great extent. We may assume that the minute globules of water are distributed through the air just as particles of dust might be, and that although they are heavier than the air it must take time, and perhaps much time for them to settle and separate from the air, especially when it is moving rapidly through the pipes.

The globules of liberated water still unprecipitated from the air differ from dust particles in one important particular. Dust does not attach itself to anything as it is carried along, and has nothing but its weight to hold it, even when it settles at the bottom of any pipe or channel through which it may be blown. Water, however, wets and clings to everything it touches. In flowing through pipes the air has a rolling rather than a sliding motion, so that practically all of it somewhere comes in contact with the walls of the pipe, and if there is free moisture in the air the surfaces will be wet by it, and the water will accumulate and trickle down, and flow in a stream along the bottom, and pockets may be placed in the pipe at the low points, and here the water may be drawn off from time to time.

If the temperature of the pipe be only a few degrees below the freezing point the water contained in the air, instead of trickling down the interior will freeze fast just where it touches, and thus it may accumulate in successive layers until the internal diameter of the pipe is much reduced or the flow of air is even choked off entirely. This is by no means unfamiliar experience with some installations in the winter, and constitutes a serious trouble.

The wetting and clinging habit of water makes it quite possible to construct compact separators which are effective in removing released water immediately that the air, by passing through an intercooler or otherwise, is brought to the favorable condition of high pressure and low temperature. In such separators baffle plates are employed, and the water-laden air wets these plates and the water drops or runs down from them and accumulates at the bottom to be drawn off.

Whatever the arrangements employed, it is always to be remembered that provision must be made or opportunity must be provided not only for the condensation of the superfluous moisture in the air after compression but also for draining it off or for taking it out of the air.—*Engineering Record.*

THE NASCENT OXYGEN THEORY IN BLEACHING

One of the reasons to which hydrogen peroxide is believed to owe its strong oxidizing properties is that the oxygen is set free from the peroxide exactly at the spot where it is to be used and is in what chemists call the "nascent" condition, that is, the oxygen atoms have not formed any combination among themselves, so that all their energies are available. It must always be remembered when bleaching or taking stains out of any fabric, that the oxygen atoms are no respecters of persons, so to speak, and will oxidize anything that is open to attack, whether it be the stain you want removed or the coloring matter with which the garment is dyed. Nevertheless, the majority of dyes are less readily open to attack as a rule than the matter which causes the stain, so that if the launderer proceeds judiciously he can generally succeed in removing the one without interfering much with the other. The important thing in applying all bleaches and stain removers is to confine their actions as closely as may be to the spot where the stain rests, and to rinse them out directly their work is accomplished, before they have time to turn their attention to the coloring matter in the garment.

BLOWING WINDOW GLASS

In a few years not a pane of glass will be made by hand; as the glass industry, from being one of the most backward, is becoming one of the most progressive, and the possibilities for the scientific man and the inventive genius are great, as the field is practically new and has great opportunities for development.

A few years ago glass manufacturers sought, and paid big salaries to, "master teazers" (men who superintend melting tank and mixture of materials) who were the alchemists in glass, and who, three or four times a day, threw into the tank a mysterious secret powder that was supposed to purify the glass. Now the chemist has applied pyrometers to keep the temperature even and pays attention to the purity of the materials, so the old master teazer has lost his mysterious importance.

MELTING RAW MATERIALS. LADLING.

Glass is melted and purified for working in a large tank, averaging about 20x60 feet, and built of fireclay blocks a foot thick and with a roof of silica brick. The general construction of the tank is similar to that of a regenerative open-hearth steel furnace, the fuel most commonly used being natural gas, and the direction of the flame being periodically reversed, so as to recover the stack heat in firebrick checker work, and also to prevent burning out the passages.

Raw materials are generally mixed by hand, but a few of the more progressive plants are now employing machinery to mix and deliver the batch to the tank, somewhat as an automatic stoker feeds a boiler, care being taken that it is thoroughly mixed and placed in the tank with as little disturbance as possible, as, if thrown in carelessly, the flying dust of the flux would assail the walls and roof of the tank.

The ladle used in dipping the glass from the tank is a hemisphere of pressed steel, 20 to 25 inches in diameter, a quarter of an inch thick; to which is attached a stout pipe handle about 14 feet long, and a side handle projecting from this at right angles, for dumping. The ladle is supported from a crane in a loose collar, which allows movement in all directions. The ladle is made hemispherical because other shapes were found to produce unequal cooling of the mass, showing what trivial defects become serious matters in glass manufacture.

At a signal from the machine operator, the ladler and his assistant approach the tank with the ladle bottom side up. When the ladle is a few feet from the tank the door is raised and the ladler shoves the ladle totally inside the tank with the rim of the ladle, now upside down, just over the surface of the glass. Then, turning the ladle, with the main handle as the axis, it is filled by cutting (so to speak) a hemisphere of glass out of the tank with the least possible disturbance. If this part of the operation is done carelessly, or with a dipping motion that allows the glass to flow into the ladle, the tendency is to form air bubbles and unequal cooling strains, and, if persisted in, it will mess the glass up to an unworkable state. If air bubbles are formed in the tank, they require hours and days to burn out, and if formed in a ladle of glass, a bubble as big as a pin head will draw the length of a 30-foot "roller" (as the cylinder of glass is called), and be clearly visible. This being a defect, many bubbles will make the roller worthless.

To return to our ladler; as the semi-rotation of the ladle is about completed, the ladler lifts it out of the body of glass, and tries to do so in such a way that the drip that forms on the ladle edge last leaving the surface of the glass is cut off. This can be done so that no drip is left.

Removing the glass from the ladle to the machine is the most important part of the ladling, and is accomplished in one of two generally approved methods. The idea in both is to remove it with as little disturbance as possible and to make the necessary disturbance equal in all directions. The more generally used method is to start to pour on one side of the pot, and then, by moving the ladle over the top of the pot, the glass is placed somewhat as a pie is put on a plate by slipping the pan from under the pie. This method causes greater unevenness of flow than dropping the mass in the center, but eliminates the liability to form air bubbles, and brings the drip to the edge of the pot where it is practically harmless.

GLASS-BLOWING MACHINES.

The principal methods of manufacturing window glass by machinery are the cylinder-pot-drawing machine, drawing cylinders directly from the tank, and drawing the glass in a continuous sheet directly from tank. Of these, the sheet machine, although unperfected, is the most nearly ideal, as it eliminates the ladling and flattening necessary by the first method, thereby producing a pane of glass of unequaled brilliancy. The cylinder machine, drawing direct from the tank is the ideal cylinder machine, as it eliminates the ladling process, but so far has not been perfected so as to compete with the pot machine. The cylinder-pot-drawing machine is the one drawing glass commercially to-day, and is described in general as follows:

As inferred from the name, the pot forms the principal part of the machine. It is a shallow pot about 4 to 6 inches deep and 36 to 40 inches in diameter, having a uniform thickness of 1½ to 2 inches. It is made of specially high-grade fire clay imported from Germany, the clay going through months of preparation before the pot is ready to put in the machine. Some of these operations are grinding, ageing for several months and tramping with bare feet. This latter process seems rather mediæval at first glance, but it is the only one possible to accomplish the purpose, that of removing air bubbles and unground pieces of clay or stone. During all this period it is kept at a certain degree of moisture by being covered with cloth and sprinkled day and night.

Figs. 1 and 2 show sectional views of two successful pot machines. In Fig. 1 the pot *A* is double, and reversible on trunnions, and the principle of the machine is that while one side is filled with glass and cylinder being drawn, the other side is being cleansed of "bad glass," or undrawn residue, by the action of heat from burners *B*. These burners are also used to

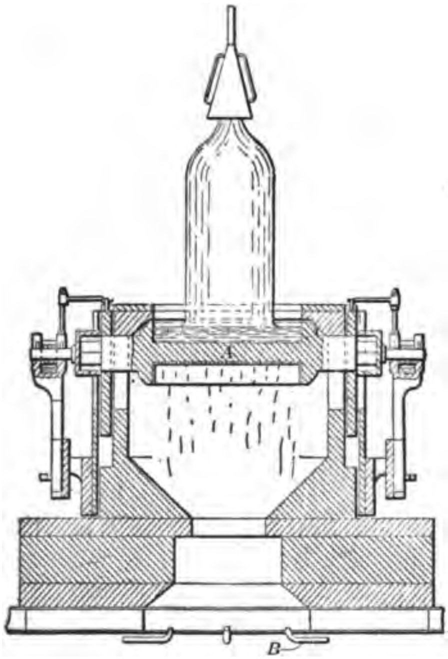


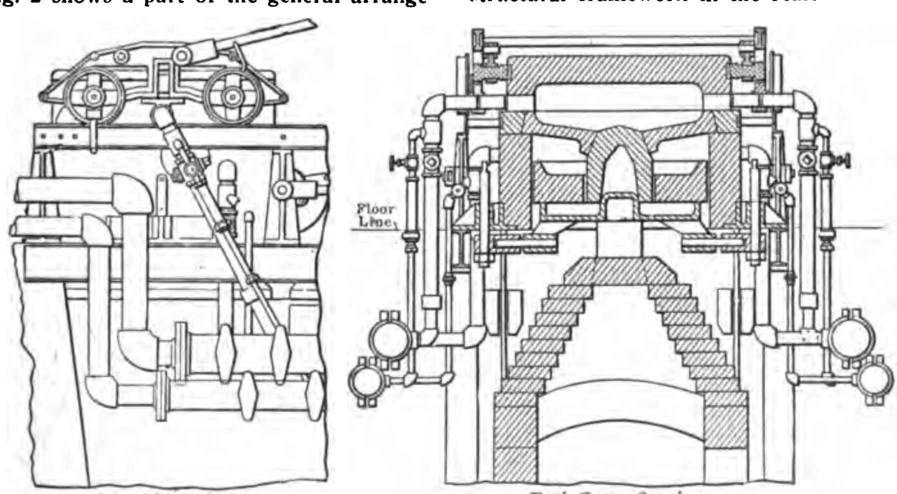
FIG. 1. SECTION OF POT MACHINE.

keep the pot in a heated condition, which tends to keep the molten glass in the upper side of the pot at an even temperature. The drawing and cleansing thus being simultaneous the machine operation is continuous. These pots must be put into the machine already heated to a white heat, and inserted quickly to prevent sudden cooling and conse-

Fig. 2 shows a part of the general arrangement and cross-section of the other machine, in which two separate pots are used to a unit. Each machine consists of three component parts: two duplicate furnaces, each containing a pot; and a furnace hood. As shown in sectional view, the pot has a hole in the center which is closed by a movable fireclay plunger. Beneath the pot, in the furnace proper, air-blast gas burners are inserted. The furnace hood consists of a fire-clay covering having telescopic pipe connections for the burners, and mounted on a carriage that allows of the hood being moved as a whole from one pot to over the other. While a cylinder of glass is being drawn from one pot, the bad glass is being melted from the other. The raising and lowering of the plunger closes and opens the bottom of the pot as required.

THE BLOWPIPE CARRIAGE.

Over these machines is placed the structural-steel framework which supports the "ways" for the blowpipe, or drawing carriage. The ways consist of 2-inch cold-rolled steel shaftings, two to each pot of each machine, spaced three feet between centers. Between the shafts and the arms is also a semi-circular galvanized-iron shield, clearly shown in Figs. 3, 4 and 5; the object being to protect the roller from all air drafts while being drawn and cooled. On the ways are the blowpipe carriages, one of which is shown in Fig. 6. The movement of these carriages is controlled by cables from hydraulic cylinders supported on the structural framework in the rear.



Part Side View. End Cross Section.

FIG 2 SECTION OF TWO-POT MACHINE.

The control of all the carriages and of the air supplied to the blowpipes is concentrated at the operator's stand, which is located about 10 feet in front of, and central with the machines, as shown in Figs. 3 and 4. Fig. 7 shows a diagram of the air and water system for the blowpipe carriage. The water is delivered to the main line at 150-pounds pressure, maintained constant by an accumulator which automatically starts and stops the pump as needed. This water operates the plunger, the stroke of which is half the travel of the blowpipe carriage. The plunger is connected to the carriage by a ½-inch steel cable running over pulleys on top of structural framework.

Air is supplied to the main air line at 6 to 7 ounces per square inch, by a steel pressure blower, and this pressure is maintained constant by an aërometer whose action is automatic on the pressure blower, increasing or decreasing its capacity as needed in the main line. From the main line are taken branches for each blowpipe carriage.

THE BLOWING PROCESS.

At a signal from the operator, the ladler and helper start the ladling process described above; at the same time the blowpipe man takes a blowpipe from the heating furnace where a number of them are being heated to a cherry red on the lower half of the Norway iron head. Placing the blowpipe in a saddle, he cleans the head of all scale and glass with a rough file and makes sure that the air hole is clean. Having done this, he brings the blowpipe to the carriage and attaches it to the air pipe, and while this latter is being done the furnace-hood man removes the hood from the pot in which the ladler is to pour the glass.

The pipe being filled, the operator then lowers the carriage until the heated head of the blowpipe enters the molten glass about an inch, allowing this to stand a few seconds for the glass to adhere. He then very carefully turns on the air until a bubble appears underneath the blowpipe. This latter part of the operation must be very carefully done, lest too much air be turned on, blowing out to one side and making it necessary to dump the whole pot of glass; as once blown out, it is useless to try to form a new bubble. The bubble being formed, the carriage is started slowly upward, with the air shut off for an instant and then gradually turned on again, and the glass begins to bulge out, forming a neck similar to that of a bottle. When the neck is fully formed, the air valve is left as it is at this point and the speed of the drawing is slightly increased, averaging about 40 inches per minute, depending upon the quality of the glass, temperature and thickness desired.

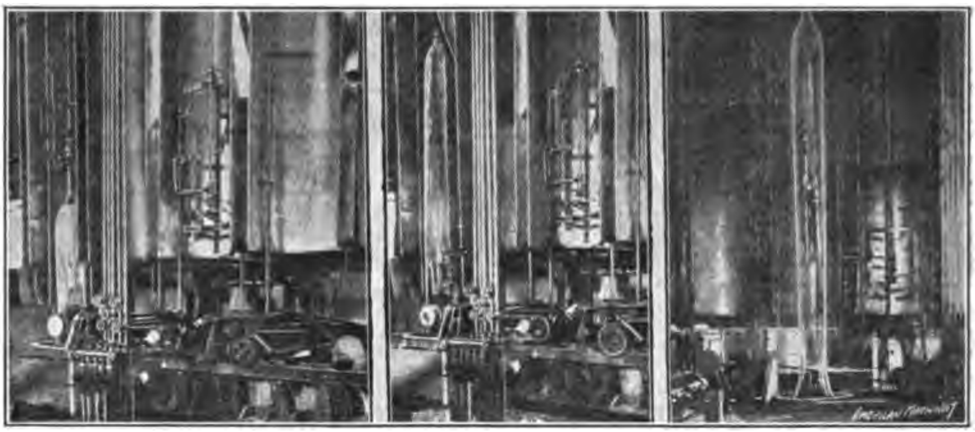


FIG. 3. FIG. 4. FIG. 5.

From the time the neck is formed until the cylinder is drawn, there must be a gradual and scarcely perceptible increase in the air supply and speed of drawing, on account of the varying condition of the air pressure and the temperature of the glass. At the start of the cylinder, the entering air strikes the surface of the molten glass and is expanded, thereby increasing the pressure. As the cylinder is drawn, the mouth of the blowpipe recedes from the surface of the molten glass and the entering air becomes less and less heated, requiring a greater volume of entering air to maintain the pressure. Also, as the glass in the pot is each instant becoming cooler, it is necessary to draw faster in order to keep the thickness of the glass constant.

The flow of air is increased by means of valve *A* on carriage, Fig. 6, which has a long, narrow slot automatically controlled by a pis-

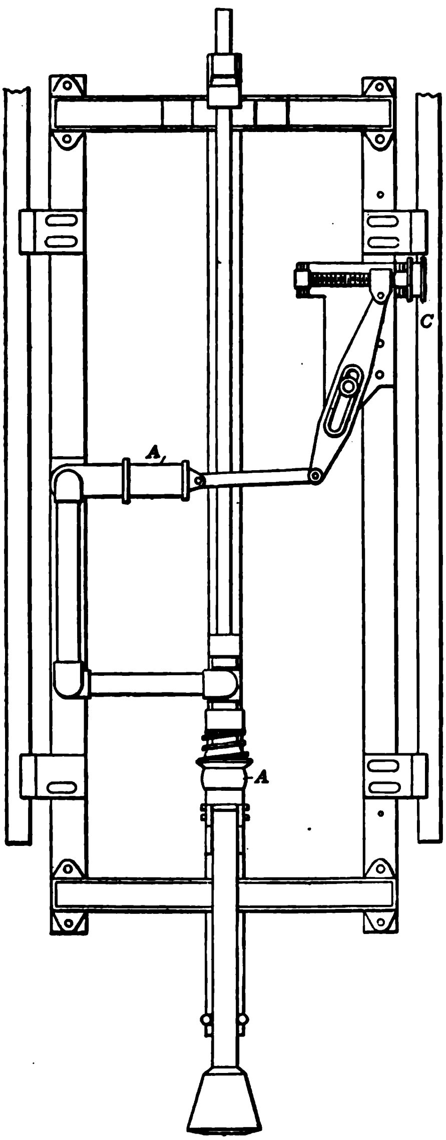


FIG. 6. BLOW-PIPE CARRIAGE.

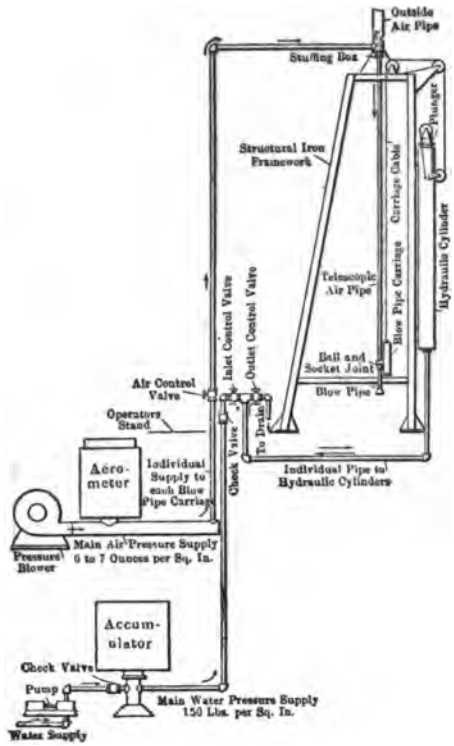


FIG. 7. AIR AND WATER SYSTEM.

ton as the carriage moves upward. Motion is communicated to the piston by the levers and links shown, actuated by a rack. For changing the speed of drawing, the best method has been found to be manual; that is, by the operator opening the value to the hydraulic cylinders as required, as the ever changing atmospheric conditions forbid any set speed of drawing.

Figs. 3, 4 and 5 show various stages of the cylinder while drawing; the latter one showing the cylinder drawn to full length and ready to be severed from the pot. This is done by shutting off the air supply, causing the cylinder to draw in again near the pot, and then pressing a sharp-pointed rod, slightly dampened on the point, against the neck just formed; a crack is then started which, by suddenly increasing the drawing speed, is made to extend clear around the neck, thus severing the cylinder from the pot.

The cylinder is now taken down and laid on horses, to be cut in suitable lengths for flattening. Taking down is accomplished with asbestos-covered tongs placed around lower end of

FIG. 8.

cylinder, and carried by a pulley on a rope. The blow pipe swings in a ball-and-socket joint, and the next operation is to remove the blow pipe from the cylinder. This is done with a moistened, sharp-pointed instrument, as for the lower end.

CAPPING WITH AN ELECTRIC WIRE.

Immediately upon being laid on horses, the two rounded and rough ends are capped off and the cylinder is cut into lengths as desired, depending upon the size of sheets into which the glass is to be cut after flattening. This cutting or capping is done by encircling the cylinder with a small (about 1/32 in.) iron wire, heated to a dull red by an electric current. The current is then turned off and the cutting is performed by a moistened, pointed rod. These short lengths of cylinder are then placed on other horses, to be cracked open lengthwise. This is done by using a long, heated rod, shaped like a knife-edge planimeter, following this with the moistened, sharp-pointed rod.

Being split, the cylinders are taken to the flattening oven where, after being gradually heated almost to the collapsing point, they are spread out and smoothed by a moistened wooden block on a long handle. After this, they pass through the "lehr," or oven, in which they proceed from a highly heated to a cold condition, so as to temper the glass. This is followed by plunging into an acid bath to clean the surfaces.—*American Machinist.*

VENTILATION EXPERIENCES

In the "Plenum System," the air to be used in the building is drawn down a shaft provided for the purpose, taking the purest air obtainable in the neighborhood. It is drawn in through a hole in the outer wall of the building, by the aid of a fan working just inside. It is cleaned, washed, dried, humidified, cooled or warmed, and delivered to main ducts, just inside the building, and from them to branch ducts leading into the rooms to be ventilated. Other ducts lead from the rooms to be ventilated, joining larger ducts, which lead the air to an outlet shaft, as far removed from the inlet as possible. The working of the system appears to be remarkably successful. In the Birmingham General Hospital, for instance, there were no draughts. One was not conscious of any difference in temperature, or any unpleasant draught of air, when passing from a ward to the corridor. There was no unpleasant smell either during the time when dinners were being served or in the time immediately afterwards, when offensive smells are too often prevalent. There was none of that smell of drugs that is so often found all over hospitals. Though the air of Birmingham in the neighborhood of the General Hospital is hardly what one would call ideal, and though Birmingham itself is subject to fogs, and its atmosphere is as full of smoke as most manufacturing towns, the general atmosphere of every room supplied with air in the hospital was decidedly good.

There was one drawback however. I had talks with a number of the physicians and surgeons and nurses in the establishment. Most of them liked the system, but would not have it in their own quarters. One of the medical staff also told me that he found that his convalescents did not get on as fast as in a hospital ventilated in the ordinary manner by natural ventilation. They got on well, he said, up to the point of convalescence, and then they hung fire. At the Manchester School of Technology, and in the Midland Hotel, where I have since stayed on several occasions, there is apparently no complaint whatever. The air in the building is always of a comfortable temperature, and there appears to be none of that lassitude that the doctors and nurses complained of when the system was employed for their own quarters. Enquiry also into the ventilation of operating theatres disclosed the fact that surgeons who have to stand often for a long time, when engaged in a number of operations, and the nurses who are in attendance, get very tired, owing to the warm temperature that is necessary to be observed, and to the accumulation of moisture in the atmosphere.

While at Birmingham, I was also, by the courtesy of the hospital superintendent, allowed to inspect the record which is kept of the temperatures in each ward, and I found that it was uniformly at 63°F. The superintendent explained to me that this temperature was a compromise, that the medical staff had different views as to the temperature that should be carried, and eventually the one named was decided upon. It appeared to me at the time, that this question of the temperature was the cause of the staleness which the nurses and doctors complained of, and of the slowness in convalescence. We know, that for health, we require to sleep in cool rooms, with our windows open, as far as possible, except in very cold weather. And the reason I think is, because the lower the temperature, the larger the weight of oxygen in any given volume of air, and consequently the greater the vivifying effect of the atmosphere. I think that if convalescent wards, and the residential quarters of doctors and nurses were ventilated with air at a lower temperature, very good results would follow. At the Manchester School of Technology, they have control of the temperature in each class room. The engineer in charge told me that the requirements of each class room varied very considerably. One lecturer liked temperature a little bit up, another was better with it a little bit down. One lecturer's throat might be a little relaxed, and so on.

OZONE.

It appeared to me that the matter might even be carried farther, and that either oxygen or ozone might be employed in certain cases, to add to the invigorating effect of the atmosphere, and I suggested it in one of the medical papers. News has since come to me from America, that a system of adding ozone to the air of some of the public buildings has been adopted, and with great success. There are a number of appartus on the market, designed for the manufacture of ozone. All are on very much the same lines. There is an electrical condenser, and a high tension alternating current is delivered to it. Air is drawn through the condenser, its plates being arranged so that this can be done, and a certain portion of the oxygen of the air passing through is converted into ozone. The National Air Filter Co. of Chicago have worked out a number of apparatus, some small enough to be used in ladies' boudoirs, and ranging up to apparatus sufficiently large for the auditorium of their largest theatre, and for their public library. Great complaints had been made about the atmosphere of their public library. It was largely the resort of "out of works," who are also frequently the unwashed, and consequently unpleasant odours were very much in evidence. Germs evidently were also floating in the atmosphere, and the chief librarian had contracted a chronic affection of the throat in consequence. Ozonised air is now delivered into the main duct of the Plenum System, with which the library is ventilated, and the result has been exceedingly satisfactory. The librarian has recovered from his affection of the throat, no odours are present, and the books which had shown signs of deterioration have now ceased to do so. I suggest that something of the kind would be of service in the hot weather, for warehouses, offices, etc., in Calcutta, Bombay, and the large cities of India and the East. Nothing keeps a man up to his work so well as a supply of oxygen, and ozone in moderate quantities is even better. A few years back, I was attending an exhibition in London. Looking through exhibitions, as most of your readers know, is exceedingly fatiguing work. At the close of the day I came to an exhibit of an ozone making apparatus, and I got the attendant to discharge his current of ozonised air over my person for some minutes. The result was very satisfactory. I was very much less tired that evening than I ever remember to have been after a similar day's work.—*Correspondence Indian and Eastern Engineer.*

In early November, 16-year-old Miss Jones lifted 52,800 tons of rock with 400 pounds of explosive. Miss Jones then fried an egg with the same kind of powder scattered on the ground to demonstrate its safety.—*Cleveland Press.*

VERTICAL GAS RETORTS IN ENGLAND

The Bradford city council has just recommended that $155,630 be expended on an installation of vertical retorts at the Thornton Road city gas works. In Germany, it is said, vertical retorts have been very widely adopted during the past two or three years, but Bradford is one of the first towns in England to adopt the system, the merits of which are receiving much consideration throughout the country. Among the advantages claimed for the system, first in importance is the very substantial decrease in the cost of production brought about by the increased yield of gas from a specific quantity of coal; an improved quality of coke is produced; the yield of by-products is increased; naphthalene troubles are largely reduced, if not entirely eliminated; and a vast improvement is effected from a hygienic standpoint. Another advantage also is that a plant with sufficient gas-producing capacity can be put down on half the space occupied by the horizontal retorts, giving a greater area for storing the coke. The labor costs are said to be about one-eighth of those in the use of horizontal retorts.

GLYCERINE

Many years ago, in an obscure mining village in Sweden, an apothecary was making lead plaster in the ordinary way by heating olive oil with litharge and water, when he chanced to notice that the liquid which was mingled with the pasty lead compound had a strangely sweet taste. On further investigation, he found that the sweet taste was caused by the presence of an oily liquid which was dissolved in the water. No such substance was described in the books of the day.

Scheele, the apothecary, knew that he had discovered a new substance. He soon found that this sweet liquid was not the product of olive oil alone, but that other oils and fats would yield it under the same treatment. So he named it the "sweet principle of fats," or "oil-sugar."

More than a century has passed since Scheele's discovery, yet it is but little over sixty years since "oil-sugar" was found to be of practical value, except for a very limited use in medicine. Chemists have given it the more formal name of glycerine, derived from a Greek word meaning sweet.

Every one to-day is familiar with the clear, thick liquid so commonly used for toilet purposes. Its soothing and softening effect on dry or inflamed skin is the quality for which it is best known in most households; but few people have any idea of the variety of purposes to which it is applied.

Among its most striking and valuable properties are its great solvent power, its chemical stability, and its sweetness. Moreover, it is digestible, will not evaporate, and owing to this and its hygroscopic qualities, will prevent the drying and hardening of materials with which it is mixed.

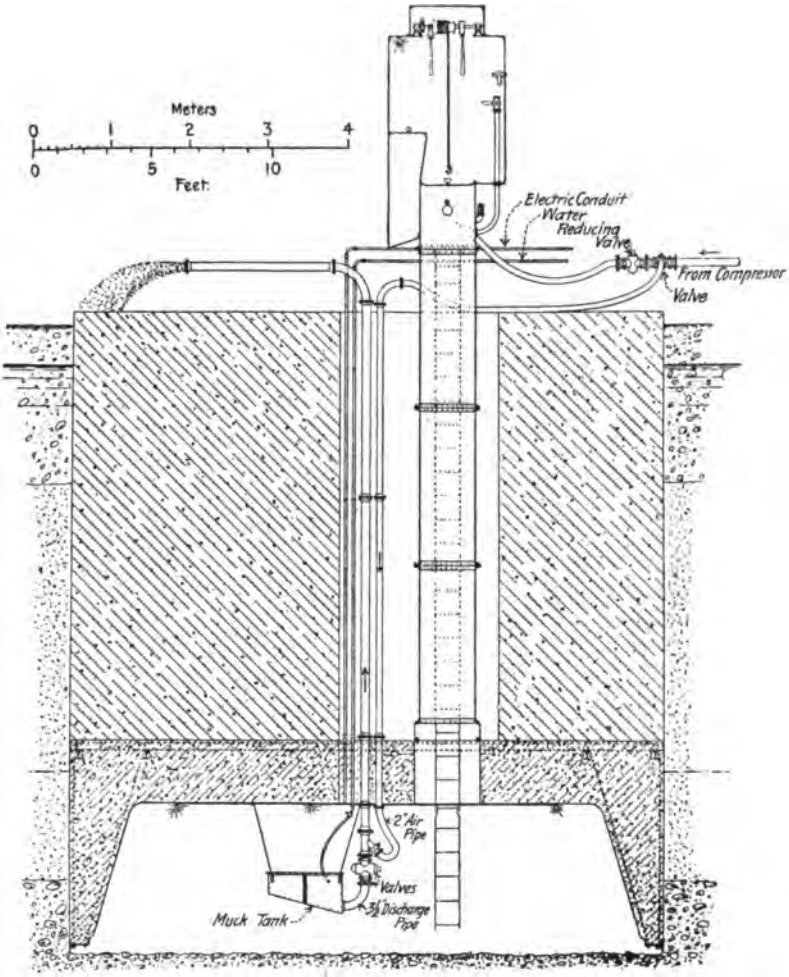
These peculiar qualities make it most valuable in the preparation of medicine, unguents, and various food products, as preserves and mustards; likewise in beer, wines, and other bottled goods, where it is said to act as a preservative. The fact that strong solutions of glycerine and water will not freeze in the lowest winter temperatures has caused its use in our "wet" gas meters.

Some of the more important industries in which it is used are vulcanizing India rubber, silvering and gilding glass, dressing leather for gloves, preserving anatomical and botanical specimens, and the manufacture of what is, perhaps, the most powerful explosive known to science, without whose aid some of the grandest triumphs of modern engineering would have been impossible—nitroglycerine.

In a pure state glycerine is one-fourth heavier than water. After long exposure to a freezing temperature, glycerine will deposit rhombic crystals resembling those of sugar candy. Its boiling point is 490 deg. F. Pure glycerine will burn readily if first heated to about three hundred degrees. It gives a pale blue flame similar to that of alcohol, and to the chemist it is an alcohol.

PNEUMATIC MUCK EJECTOR WITH TWO-STAGE AIR SUPPLY

The cut here reproduced from *Schweizerische Bauzeitung* is a diagrammatic representation of a specialized form of pneumatic muck ejector used in caisson foundation work at Aaran, Switzerland, as described by G. Lüscher its designer. The usual air supply is maintained in the working chamber of the caisson sufficient to resist the water inflow corresponding to the depth, but as pneumatic tools are used in the caisson, an air supply is maintained



PNEUMATIC MUCK EJECTOR.

sufficient to operate them while exhausting into the air of the caisson. The entire air supply is in fact furnished at the higher pressure, while the caisson pressure is controlled by passing that portion of the air through a pressure-reducer.

The ejector comprises a hopper-bottom muck tank, a valved discharge pipe leading from the bottom of the tank to the open air, a valved auxiliary, high pressure air pipe leading into the discharge pipe at an acute angle, and a water pipe for furnishing water to keep the contents of the tank in fluid condition. The tank is made in sections, so as to permit taking it through the air-lock. The discharge pipe as used was 3½ in. diameter, the high pressure air pipe 2 in. The latter pipe joins the discharge pipe at a forward angle of about 45°.

In operation, the tank is filled with muck, and if this is clayey in nature sufficient water is added to enable it to be blown out, while sand is handled without water addition. The discharge valve being kept closed, the auxiliary air value is opened, producing a strong ejector action in the discharge pipe. Then the discharge valve is opened, and the muck is blown out very rapidly. The tank is kept constantly supplied by shovelers; whenever the tank becomes nearly empty the discharge valve must be opened at once, to prevent serious loss of air from the caisson.

The working principle of the apparatus is that the caisson pressure is used only to force the material far enough for the ejector action of the auxiliary or high pressure air to take hold of it; the latter then does the main part of the lifting.

AN UNUSUAL EXAMPLE OF PNEUMATIC CAISSON WORK

The deep foundations for the new Municipal Building, in New York, are notable for the magnitude of the work and its rapid execution under great difficulties, and for the manner in which perplexing contract difficulties were equitably adjusted. The substructure is designed to carry a 165,000-ton superstructure, rising to a height of 580 ft. above the street, on 106 separate piers. Some of these piers are supported on solid rock and some on sand and quicksand, the latter being without any appreciable variation in the slight settlement they have shown. These foundations have been sunk far below the ground-water level to depths closely approaching the limits for pneumatic pressure work. Thousands of yards of sand and quicksand have been excavated far below the surface without injury to adjacent tall and heavy buildings. Elevated and subway railroad structures, and large gas, water, sewer and electric mains below the street surface were maintained in service with no serious interruption to the heavy traffic of vehicles, pedestrains, and street cars on an important city street which crosses the full width of the building. This work of sinking the piers has been accomplished in about a year at a cost of about $1,500,000 and without serious accident or the loss of life.

The caissons vary greatly in size, form and depth and are of several distinct types, showing the most recent improvements in construction of this sort, together with new features developed to meet the special conditions existing at the site. The working chambers are of steel where the greatest economy of space is necessary, and of reinforced concrete where there is abundance of room, while in intermediate cases wooden caissons, heretofore standard for all but the smallet piers, are used. Permanent wood and steel are almost eliminated from the finished structures and the strength and weight of the concrete were utilized largely in the construction operations.

Rapid and efficient work in a very congested area enclosed by streets with heavy traffic of all sorts has been accomplished by the installation of a battery of steam boilers of over 1,800 hp. capacity, seven large air compressors, 26 hoisting engines, 11 steam pumps, 16 air locks, six concrete mixers, 56 steel buckets and other equipment in proportion, all located within the limits of a 164 by 374-ft. triangular lot. Storage was largely eliminated by the delivery of material only as needed, plant and materials were handled without delay and shifted repeatedly by a system of 26 traveling and movable derrick booms, and extra space was provided by elevated working platforms under which foundation operations could be carried down. Economy and rapidity of construction were promoted by the construction of the deep piers in rapidly shifted forms, entirely above ground, and by building them up to heights reaching a maximum of 60 ft. before sinking.

The piers, with maximum loads up to 5,000 tons, were at first designed to have all foundations carried down to rock, but when it was found that the danger and expense of reaching the deepest rock were too great, additional investigation and practical tests were made on the bearing capacity of the soil and part of the piers were redesigned and proportioned to rest without serious settlement on the sand far above the rock. Fortunately the heaviest and tallest part of the building has rock foundations and it is believed that the loads on the other piers are so well within the tested bearing capacity that no injurious settlement will be occasioned by their final loads.

After the contract had been made for 116 caissons to be sunk to solid rock and the work was well under way, it was decided to eliminate 10 of the piers and modify the design of 30 others, which were to be sunk to a less depth than at first proposed, thus greatly changing the condition and cost of the work. The advantages and disadvantages accruing to both the owner and contractor from these changes were carefully studied; allowances were made for the elimination of very dangerous and costly work, for the loss of reasonable profits, for the delay in operations and change in plans and material, and for fixed and overhead charges. An equitable basis of unit prices was deduced from the results of this investigation, and the original contract was accordingly modified to suit the new conditions in a manner that was satisfactory to both parties and is believed to afford a valuable basis for the readjustment of future contracts. These results are due to the harmonious efficiency of engineers and contractors, experienced in caisson work and in general construction, unhamperd by interference from the laymen connected with the city administration. —*Engineering Record.*

FOR INCREASING THE EFFICIENCY OF MINING LABOR IN TRANSVAAL

A paper before the Transvaal Institute by Mr. Kenneth Austin, M. E., treats of the above topic. Without going deeply into facts regarding the efficiency of drilling and explosive operations, it is generally admitted that for some time to some a very large portion of the available hand labor will be used in this field for drilling the rock; first, because of the lower cost of the labor; second, because of the smaller diameter of the holes drilled by hand; third, because of the disturbance of the roof being less when small holes are used than where large machine holes are exploded.

Under these conditions Mr. Austin suggests the use of a handy self rotating, well balanced hand drill weighing about 18 lbs., for starting the holes to be drilled, to a depth of 4 to 6 ins. This method is designed to secure:

(1) The correct alinement of the hole for guidance of the laborer.

(2) A less number of hand drills necessary for starting the holes.

(3) A saving of time in starting holes.

(4) The use of the laborer's time in drilling rather than the toilsome process of starting a hole on an angular face.

(5) The placing of a hole in its proper place.

It is estimated that 60 holes a day would be started by the machine.

The machine uses a total of 30 cu. ft. of free air per minute. The hose used is only ½-in. internal diameter, and would be wound on a hose-reel with suitable connection to the air main. When not used for air, the hose may be used for conveying water to wet the broken rock before or during shoveling operations.

It is well ascertained that best results are obtained in breaking ground when the amount of burden roughly given to a hole is two-thirds of the length of the hole drilled and according to the width of the stope, and consequently it is more economical to drill a hole from 48 ins. to 52 ins. rather than one of only 36 ins. length. Experiments carefully conducted in certain stopes on the East Rand have been made, and it was found that a 36-in. hole, under the best conditions only provided a total of a half to one ton of broken rock, whereas the longer holes, 42 ins., 48 ins. and over, provided from 1½ to 2 tons and over of rock, dependent, of course, upon the varying conditions in each stope, as before mentioned. This being the case, any scheme for increasing the length of the hole will directly increase the efficiency of labor, as represented in tons broken per laborer, and also increase the efficiency of that laborer, by assisting him to attain the desired definite results without great expense.

Naturally, some system is required which can be readily adopted without disturbing the mine organization too much, or cause difficulty by adoption. It will be a different method to the present one, and one whereby the mines in charge will drill one day's set of holes in one face of stope, and will be followed by hammer boys the next day, while he prepares another face for subsequent operations. The whole system would be practically one where machinery assisted and developed the efficiency of labor and system of working. It may be said that if machines are used at all, why not use them altogether? This, however, involves the use of more air than required under this method; the setting up of bars to hold drills, and the drilling of larger holes, with the greater consumption of explosive than where the hole is finished for a ⅞-in. diameter gelatine cartridge through the entire length of the hole.

Cost of Air.—The 18-lb. weight automatic rotating machine uses only 30 cu. ft. of free air per minute. Assuming the cost of power supplied to be 1 ct. per kilowatt hour, and that 12½ KW. will compress 100 cu. ft. of air to the desired pressure, namely, 80 lbs. per sq. in. (gage pressure), the cost per air amounts to 1-in. drilled per min. x 6 in. deep x 30 cu. ft. per min. equals 6x30 equals 180 cu. ft. of air, or say 200 cu. ft. of free air per hole. Taking the above factor of 12½ kilowatts per 100 cu. ft. of air compressed the power used would be 2x12½ or 25, say 30 kilowatts.

The advantages obtained by the adoption of the method above described, can be seen if a comparison be made with a first-class mine on the Central Rand where hand drillers are paid 1c. per in. if 42 ins. are drilled, plus a bonus of 6 cts., which amounts to 49 cts. per 42-in. hole. Now if this hole can be increased in depth (thus allowing a greater burden to be placed on it) to say 48 ins. or 52 ins. the extra cost of air, etc., would amount to only 1ct. per hole.

Cost of Plant.—The cost of each automatic rotating drill is $110, and allowing three machines for each miner, the capital cost would be, with hoses and other plant described, say $500 for each set. The machines would wear at least two years and cost $7.50 per month (when working) for repairs. Only one machine would actually be in use, but three have been included in the estimate, so that at any time one could be on the surface for repair, if needed, and one held in reserve by the miner. The daily cost based on the above figures would then be:

Cost of the whole plant, $500.—600 working days in two years equals $0.83 per day for redemption; an excessive figure, because only one machine would be in use.

Repairs per month, $7.50.—26 shifts per month equals 29 cts. per day for repairs. Extra gelatine used, 2 oz. for deeper hole, equals $0.02.

This amounts to a little under 5 cts., total extra cost, to obtain an increase of broken ground amounting to ½ ton or more per hole.

The writer has called attention to the fact that it is not low working costs alone which are to be desired, for it may happen that low working costs do not mean increased profits. It can easily be demonstrated that it is economic folly to strive after low working costs, if the profit is not increased, and he submits that the proposals in this paper will secure all objects, namely, lower working costs, greater efficiency, and, last but not least, larger profits.

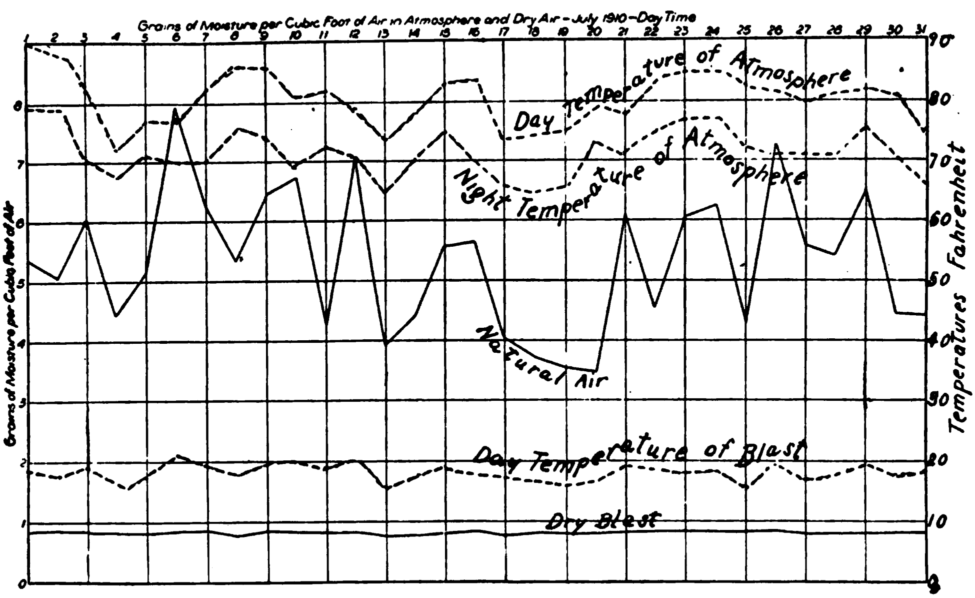
OXYGEN FROM THE ATMOSPHERE

Separating oxygen from the air, says James Swinburne, is not the same as making liquid air. To separate oxygen from nitrogen involves doing mechanical work, which is converted into heat. A rectifying plant may be considered as an apparatus, which takes in heat substantially at the boiling-point of the liquid with highest boiling-point, and gives it out at a lower temperature near the boiling-point of the most volatile liquid. An air separator thus takes in heat at 90° C. abs., gives out heat at about 82° C. abs., and at the temperature of the works, say, 273° C. abs. The Linde process may be regarded as a rectifying plant of this sort, and a thermodynamic engine, in which a gas is compressed so as to liquify at 90° C. abs. under pressure, and to evaporate at 82°, thus supplying the heat at the boiling-point of the oxygen, and absorbing it at the boiling-point of the air. Such a process is generally considered irreversible, but is in fact nearly reversible and therefore economical. Assuming an efficiency of 40 per cent., the cost of oxygen comes out approximately one shilling (25 cents) per ton on a large scale. This ought to lead to its use in blast-furnaces and other cases where an extra high temperature may be important.

WONDERFUL NATURAL FIBRE

Take a certain kind of glass, soften it by heat, draw it out into fine, flexible thread, weave it with care into a fabric incorruptible as to decay and the action of most acids, but not as to heat, and you have approached the limit of man's effort to produce a mineral fibre. Nature makes a shrinkage crack in a mud-like stone, fills it with water, dissolves a little of the mud in the water and crystallizes the whole crack full of threads which are much finer, more flexible, and stronger than the glass fiber, and in addition thereto capable of withstanding a temperature of 2000 to 3000° F. Remembering that the water combined in these fibers runs as high as 14 per cent. of the whole weight, one is forced to the conclusion that some of nature's processes are "past finding out."

The Greeks named this fiber "asbestos" (unquenchable, unconsumable); the Romans made cremation robes of it, and Charlemagne astounded his gaping courtiers by casting his well-soiled table cloth into the fire and withdrawing it, clean and white for another feast. Nor has it been many years since an otherwise respectable and industrious lumberman was accused of witchcraft and run out of a camp in the Canadian woods because he persisted in washing his socks in the stove, instead of by more conventional methods.



RECORD OF COOLING AND DRYING.

SUCCESSFUL AIR COOLING AND DRYING

For results most nearly approaching perfection we naturally look to the records of laboratory experiments, and the diagram which we here reproduce from *The Iron Age,* with our addition of the temperature lines, has its first interest for us in that while its showing is so remarkable it represents what is accomplished in operations which are upon the largest scale known to our industries. Our readers are mostly familiar in a general way with the Gayley Dry Air Blast, which has accomplished such economies in blast furnace practice by the device of refrigerating and drying the air.

The data here presented are furnished by Mr. Gayley from a Western plant for the month of July, 1910. The summer months represent the period of greatest humidity and highest temperature, and for that reason they furnish the best opportunity for demonstrating the efficiency and value of the process. While the atmosphere, as shown by the figures, varies widely in both temperature and moisture, the variations in the dry air are within narrow limits, and approach as close to uniformity as seems possible to obtain in a mechanical device that is treating 40,000 cu. ft. of air per minute.

The amount of work done by a dry air plant in mid-summer in removing moisture is ordinarily not fully comprehended by simply expressing the moisture content in grains per cubic foot of air. Taking, for example, a very humid day, July 6, when the moisture as shown in Table 1, averaged 7.90 grains for the day and night, there would have entered the furnace under natural air conditions 7797 gal. of water in the 24 hours. This would be the equivalent of 185.6 barrels. The dry air on the same day contained only 0.86 grain, and the quantity of water entering the furnace was accordingly reduced to 849 gal., thereby eliminating 6948 gal., and saving the fuel necessary to dissipate it. Taking again the day with the lowest humidity, July 19, when the moisture for day and night averaged 3.45 grains, the furnace would have received 3410 gal. of water, but the dry air carried in only 809 gal., representing an abstraction of 2601 gal. Thus, even on days of relatively low humidity, the quantity of water extracted is very large.

The amount of water extracted through the dry air process expressed in gallons as seen in Table No. 2 is very impressive, and will be particularly appreciated by practical blast furnace managers who are familiar with the cooling effect produced in the furnace hearth from

1910. July.	Grains of moisture per cubic feet air. Atmosphere. Day	Night.	Dry blast. Day.	Night.	Temperature (Degrees F.) Atmosphere. Day.	Night.	Dry blast. Day.	Night.
1	5.37	5.46	0.85	0.84	91	79	18.5	19
2	5.09	6.10	0.86	0.86	89	79	18	19.5
3	6.06	4.96	0.85	0.83	82	71	19	18.5
4	4.43	4.56	0.84	0.81	72	68	16	16
5	5.14	5.98	0.82	0.85	77	71	17.8	19
6	7.96	7.84	0.86	0.86	77	70	21	21
7	6.24	6.56	0.86	0.85	82	70	19.5	20
8	5.31	6.59	0.79	0.83	86	76	18	20
9	6.47	6.97	0.86	0.82	86	74	20	19
10	6.76	5.37	0.84	0.82	81	69	20	18
11	4.25	4.89	0.82	0.77	82	73	19	18
12	7.03	5.54	0.84	0.79	79	71	20.5	19
13	3.91	4.20	0.78	0.80	74	65	16	15.3
14	4.40	5.15	0.79	0.80	78	70	18	17.6
15	5.57	6.24	0.81	0.83	83	75	19	19
16	5.63	5.51	0.85	0.81	84	70	18	18
17	4.03	4.31	0.79	0.85	74	66	17	17.7
18	3.78	3.54	0.81	0.83	75	65	17	14.7
19	3.54	3.37	0.80	0.84	75	66	16	15
20	3.48	4.35	0.81	0.85	79	73	17	18
21	6.07	6.33	0.82	0.82	78	71	19	17.5
22	4.52	4.96	0.83	0.82	84	75	18.5	18
23	6.04	5.87	0.83	0.82	85	77	18	17
24	6.21	6.61	0.84	0.85	85	77	18.5	19
25	5.28	5.16	0.83	0.83	83	72	16	17
26	7.28	5.79	0.85	0.83	82	71	19.2	18
27	5.58	6.10	0.80	0.84	80	71	17	18
28	5.31	5.74	0.82	0.82	81	71	18.2	18.7
29	6.47	7.06	0.82	0.84	82	75	19.2	20
30	4.43	4.74	0.83	0.79	81	70	18	18.5
31	4.40	4.29	0.81	0.78	75	66	18.5	17.3

TABLE 1.

July, 1910	With natural air. Gallons.	With dry blast. Gallons.	July, 1910.	With natural air. Gallons.	With dry blast. Gallons.
1	5,349	834	17	4,116	809
2	5,517	849	18	3,588	800
3	5,438	829	19	3,410	809
4	4,432	814	20	3,915	819
5	5,488	844	21	6,119	800
6	7,797	849	22	4,678	814
7	5,428	844	23	5,876	814
8	5,873	799	24	6,327	834
9	6,633	820	25	5,152	819
10	5,981	819	26	6,450	829
11	4,511	785	27	5,764	809
12	6,203	804	28	5,453	800
13	4,002	779	29	6,184	810
14	4,713	785	30	4,525	799
15	5,828	809	31	4,288	782
16	5,522	819			
Total, July				164,560	25,254
Equivalent in barrels of 42 gal. each				3,918	601

TABLE 2.

small leak from a tuyere or bosh plate. The diagram shows graphically the grains of moisture in the atmosphere and the resulting dry air. The uniformity of the dry air speaks for itself, as to its value in a process so delicate in adjustment and so variable as a blast furnace.

When the results of dry air were first made public in 1904 it was thought by some that the economical results obtained were not due so much to low moisture in the dry blast, as they were to creating conditions of uniformity in the moisture—that is, if the moisture was maintained uniformly at 2 to 2.50 grains or 3 grains, the results would be practically as good as if it was reduced to 1.5 grains. This, however, does not appear to be borne out in actual practice, as the best results are obtained when the moisture is reduced below 1 grain per cubic foot of air, and is markedly greater at 0.75 grain than at 1.50 grains. The reasons for this do not seem at present to be clearly understood, although it has been demonstrated in practice.

The conclusion reached from the experience of the past six years is that dry air blast conservatively considered will effect a saving of 10 per cent. in fuel, with an increase in output of 12 per cent., and the product can be increased beyond this at the expense of fuel saving, and vice versa. The tendency in some cases is to increase the output at the expense of fuel saving. At one works the saving in coke was 7.5 per cent. on dry air, but concurrently the output was increased by 23 per cent. Thus the dry air blast not only reduces the cost of pig iron, but it also creates uniformity in the furnace operations, and any cheapening of the pig iron cost is reflected to a greater extent in the finished steel product.

It is not necessary to offer any explanation of the diagram, which speaks for itself, except to call attention to the fact that the moisture scale is at the left hand and the temperature scale at the right hand.

LIFE ON VENUS

It is stated that Professor Pickering of Harvard University asserts that Venus, our nearest planet, is likely inhabited by huge monsters and gigantic lizards, such as roamed here in the primitive forests and lakes 300,000 years ago. It is not an easy matter to believe such statements came from a Harvard professor. These views belong to the past, which, of course, all astronomers know.

Venus is similar to the earth in size, density and gravity, but here the similarity stops. Venus, according to Professor Lowell, from observations at both the Flagstaff observatory and others, always presents the same side to the sun, and her day and year are the same length, she turning on her axis in the same time she revolves around the sun, which is 225 days. There is really no day and night there as on earth. It is always day on one and the same surface of Venus, and of course night on the opposite side. As Venus is only 67,200,000 miles from the sun, while the earth is 92,900,000 miles, she receives much more light and heat from our luminary than the earth gets. If our earth always presented the same face to the sun it would be but a short time until all that surface would be wrapped in devouring flames and the other half of this globe in darkness and winter greater than the north pole ever knew. Now intensify this light and heat and let it continuously beat upon the same face of Venus for millions of years and the mind can but vaguely conceive the molten, and later baked, condition. The atmosphere driven from the burning half would rush to the dark, cold side to condense and then congeal into eternal ice. Between the hot and the cold line an equator would be formed, where the most terrific warfare of elements would be waged forever in such storms as have never swept our world. Life on Venus is unthinkable from our idea of what life must have to exist on the earth.

TRANSFERRING TAR BY COMPRESSED AIR

The half tone here reproduced from *Engineering-Contracting* practically explains itself. In many parts of the country the roads are being constructed of tar-macadam. The stone being first spread to the required depth, tar is then poured on to fill the interstices and to bind the material, which means that a large quantity of tar is used, and the selection of facilities for handling it becomes important. The tar is conveyed by railroad in tanks similar to those used for carrying oil, and from these it is drawn into horse-drawn trucks for the final operation. The material usually has been forced out of the tank car into the distributing by means of steam pressure applied to the top of the car. Steam pressure has not been found to be altogether satisfactory, on account of the water which condenses and remains in the car. When pressure can be furnished by compressed air, however, from, say, a portable compressor, the method is entirely satisfactory. In the case here shown the iron discharge or transfer pipe was 3½ in., the air pressure was 15 lbs., and 700 gallons were loaded in 5 minutes.

CARE OF PNEUMATIC TOOLS

The *Railway Age Gazette,* in a valuable series of articles on the Care and Selection of Machine Tools and Shop Equipment, prints the following from W. H. Snyder, Assistant General Foreman at the Stroudsburg shops of the N. Y., S. & W. R. R.

The use of pneumatic tools should receive the most careful attention of all workmen, and especially of the foreman directly in charge An air hammer should never be put in service without first being well oiled with a good grade of suitable oil; if it continues in service it should be oiled every two hours without fail. Pneumatic tools are like a human being; without the proper nourishment and care they will very soon be a total wreck and useless for service. Never connect an air hose to an air hammer or motor without first blowing the hose out well. There is nothing that will ruin a pneumatic tool quicker than the dirt or grit that is liable to collect in an air hose. At our shop all pneumatic tools have to be delivered to the tool room every evening before the men go home; the hammers are put in a tank containing equal parts of signal oil and kerosene. This keeps them well oiled and prevents them from gumming up. In giving the tools out in the morning the hammers are drained out and given a good oiling with pneumatic tool oil. The motors are also well oiled before they are handed out.

The advice to clear the hose before using is especially important; of the complaints received by the makers, investigation shows a large proportion to be due to the stoppage of some one of the air ports by bits of rubber from the hose, which due caution would obviate.

Mr. Dyer, of the N., C. & St. L. shops at Nashville, Tenn., says:

Pneumatic tools are real labor savers. The foreman should instruct his men in the proper use and care of these tools; the main thing is to see that the air drills are properly lubricated. More air drills are ruined from the lack of oil than from any other cause. The air hammer should be more generally used in the erecting shop. Remember, the operator will more than double the output with it over the old way of using hammer and chisel. Instruct your apprentices how to use the air hammer.

An "Old Railroader," in this series of articles, says as follows concerning care of Air Motors and Hose:

The manner in which air motors and hammers are handled is as bad, if not worse. Instead of being placed on a rack or some other receptacle when not in use they are thrown on the ground and the motors are rarely shut off. As yards are made up of all kinds of filling it is easy to estimate how long a motor will last. Anything that is in the way or repair parts that are needed for cars are likely to be thrown on the motor or the hose. The damaging of hose by the careless handling of material often causes unnecessary expense and delay. To illustrate: A certain gang had considerable trouble with a particular motor for a couple of days and also with air hammers. They could not be made to work right and after the second trip to the shop it was decided to send a man to the yard to locate the trouble, as the tools worked properly at shop when tested. He found that the trouble was due to the hose and not to the motor; the inner lining was loose and the action of air in flowing to the motor closed it, with the result that no air could reach the motor.

The above cases serve to show that the fault can often be traced to the foremen and leading men, inasmuch as they fail to instruct the men and follow it up to see that the instructions are carried out. In case the men placed in charge do not know enough to instruct those in their charge blame must be placed on those higher up.

SINGING SANDS

The attention of the public has recently been directed to those curious freaks of nature, "singing sands." When a small quantity of this sand is clapped between the hands it is said to give forth a sound so shrill as actually to resemble a hoot. Put into a bag and violently shaken, the sand emits a noise strangely like the bark of a dog. The most notable of these sands are those of the Hawaiian island of Kauai. Similar sands also occur in the Colorado desert, where also are to be found those curious moving sands that continually travel hither and thither over the vast plain of clay. Their movements are induced by the winds, and when a strong breeze is blowing the particles of which they are composed give out an audible humming or singing. Under the microscope, these sands show an almost perfectly spherical form, so that they roll on each other at the slightest impulse, a circumstance that also accounts for the rapidity with which the sands travel over the desert. One theory advanced with respect to the "singing" of these sands is that it is due to an exceedingly thin film of gas that covers the grains. Gathered and removed from the desert, the sands lose their vocal properties.—*The Engineer, London.*

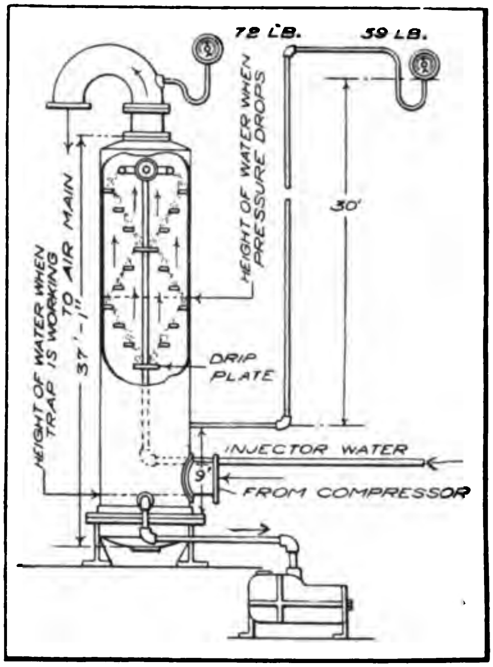
AFTERCOOLER EXPERIENCE

The cut herewith, reproduced from *Practical Engineer,* is a sketch furnished by a correspondent of that publication, who asks a question in connection with it. In this case a vertical air receiver, in itself of not abnormal type, has been converted into an efficient aftercooler without any material reduction of the receiver capacity. The receiver or cooler has within it two sets of drip pans arranged as shown, and water is injected at the top against the receiver pressure to successively overflow the several pans and thus to cool the air passing through, the water being automatically discharged at the bottom.

The temperature of the air in this case is reduced from 200 Fahr. to 70. The cost of providing and operating a pump or other means for injecting the water against the pressure would seem to be the principal objection to this arrangement, as with the familiar types of tabular aftercoolers the water is not under pressure and usually circulates by gravity alone. The actual contact of the air with the water is not objectionable, as the air would emerge in a saturated condition in any case. Provided that all the water released from the air by the cooling of it while at its highest pressure is actually removed from the air, instead of being carried along with it, there would be no trouble from water in the air farther along the line when its pressure became lower.

It seems in this case the trapping device for removing the water from the cooler sometimes failed to work and the water would accumulate in such quantity that its level would rise above the small pipe at the side leading up to the right hand pressure gage, and when that occurred the reading of that gage would be, as shown, considerably below the full air pressure as shown by the left hand gage.

This really is quite easily explained. Supposing the water to be left in the cooler above the gage pipe at a time when the compressor was stopped and the compressed air had been discharged, then upon starting the compressor and filling the cooler again with air at full pressure, water would be driven up the gage pipe, compressing the air in the pipe into the horizontal portion and the siphon, and if the water rose to the height of 30 feet it would have a back pressure of 13 pounds, or the difference between the reading of the two gages.



BOTH GAGES CORRECT.

MICE AND CANARIES AS MINE GAS TESTERS

The use of white mice on board submarine boats to give notice of escaping and dangerous gases—which they do by exhibiting uneasiness or by dying—has suggested the adoption of a like expedient in coal mines. When an explosion occurs in a coal mine the great danger to rescuers lies in the possibility or likelihood that there may be gas in the workings down below. There may be much gas or little gas; or there may be no gas worth mentioning. The rescuers, in any given case, are unable to tell; and men sent into the depths with helmets and oxygen apparatus have, of course, no means of ascertaining. The latest idea is for the helmet men to carry with them little cages containing two or three white mice. If the latter show no signs of distress the oxygen pioneers telephone back to that effect and then the members of the life-saving corps who are without protective apparatus are enabled to rush in fearlessly. "Come along! It's all right!" cries the helmet man through his portable telephone—and his mates follow. By this means much precious time, when minutes may mean lives, is saved. This plan has already been tried with success by a mining company in Pennsylvania. One of its incidental advantages lies in the fact that the men do not wear helmets, and are thereby relieved of a burden of about forty pounds. Undoubtedly they can work much more effectively.

Caged canaries played a prominent part in the attempts made to reach the men suffocated by the explosion which occurred in a coal mine a few miles from Manchester, Eng., recently. Picked men from all pits in Lancashire were rushed to the Pretoria pit, and gang after gang attempted to penetrate the passages and galleries. At the head of each gang or relief team were six men equipped with breathing helmets whose duty was to repair the broken ventilation doors so as to restore the thorough ventilation of the pit, and to report the first indications of gas. Their lamps, of course, gave them an idea as to the condition of the air, but in addition they carried canaries in cages, as these birds show signs of distress at the first presence of gas. The Pretoria-pit disaster was the worst in England in many years, some 360 miners, among whom were many boys, being killed.

COST OF MODERN MINE EQUIPMENT

The following occurs in a commencement address at State College, Pa., by John H. Jones, President of the Pittsburgh-Buffalo Company, Pittsburgh, Pa.

In 1879, I remember, all that was necessary to open a coal mine was to make an investment of approximately $10,000 except in isolated cases where shaft mines were installed. I also remember that in the mine where I was working they produced about 160 tons of coal per day, and they did this by commencing work at 4.00 o'clock in the morning and working until 6.00 at night—fourteen hours a day!

To-day the conditions are entirely changed. A few years ago, when the largest mines in the world were equipped at a point on the Monongahela river and it was stated that these mines would produce 5,000 tons daily, many who claimed to know all about mining insisted that the company equipping these mines was making a great mistake. Instead of spending $10,000 they spent more than one million dollars before they dumped a ton of coal. To-day these same operators and miners point to that mine with pride and say—"There is the largest mine in the world." These mines have produced one thousand tons of coal in an hour—certainly this is a great change—one thousand tons per hour, 166 tons in ten minutes; more coal in ten minutes than the average mine produced in fourteen hours thirty years ago! This is wonderful progress, and it has been made possible only by thought, knowledge, and the application of the principles that we have here set forth.

To open and operate modern mines to-day requires the best engineering talent, experienced superintendents, and mine foremen whom the State will certify as efficient and capable of taking care of the mines. In some of the large mines as many superintendents, mine foremen, fire bosses and other foremen are employed to-day as were employed in every department of the mine thirty years ago.

Thirty years ago, as I said, it cost $10,000 to equip and open an average mine, and to-day it costs a million dollars or more to equip and develop a modern mine; therefore, if you are the right man, do you think that a man who has millions invested will hesitate to employ you at a higher salary than is received by the Governor of the Commonwealth? I answer "No." He would get a bargain at that price.

I know of several miners who, ten years ago, began studying to secure mine foremen's certificates . These men have made good, and are to-day receiving salaries ranging from $3,000 to $20,000 per year; many others are in business for themselves.

HIGH PRESSURE GAS FOR SHOP USE

High Pressure gas for manufacturing and general power purposes, also for street lighting, is now being delivered in Birmingham, England. The normal gas pressure there has been about 1/8 lb. per sq. in., measured as usual in inches of water; the "high" pressure is about 8 lb., gage. The first trial of it has been made at an aluminum casting works, where it melted about 100lbs. of aluminum in one hour, which should not seem remarkable.

The furnaces are of the simplest construction, there being an enclosure of fire-clay about 3½ in. thick. No special burner is required, though a careful adjustment of the air aperture in the furnace is necessary. It was calculated that the melting of 112 lbs. of aluminum cost 32 cents, which was lower than the cost of coke while there was an entire absence of oxidation.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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[In our March issue, page 5978, second column, the first line of type below the cut belongs at the top of the column.]

FREEZING-UP OF COMPRESSED AIR PIPE LINES

In northern countries great inconvenience is caused by the freezing of compressed-air pipe lines. The difficulty has been eliminated to some extent at permanent, well regulated properties by burying the pipe. Even in these installations trouble is often experienced in the smaller lines to blacksmith shop or exploratory shafts, which may be at some distance. A method whereby this difficulty could be eliminated for all time would be acceptable and has been the cause of much study, as nothing disorganizes a force of men so much as the gradual or sudden loss of air supply.

In the latitudes where weather from zero to 40 deg. below is occasionally experienced, the pipes freeze from the circumference, gradually diminishing the pipe area until the passage is entirely stopped. As a preventive of this, the introduction of salt or sal-ammoniac has been found very effective up to the moment of entire blocking of the pipe. At a number of properties a barrel of salt is kept in the engine room and at regular periods, usually at the beginning and middle of each shift, several pounds are introduced into the pipe line just beyond the air receiver. The pressure is then increased by the air compressor and the salt blown through the pipe, flushing out the ice. The quantity of salt necessary is, of course, dependent upon the size of the plant. There is a record of one line transmitting approximately 1000 cu. ft. of free air per min. for 1700 ft. where two barrels of salt were used in the course of the five winter months, and completely did away with all freezing troubles.

In pipe lines where sags exist, no trouble is encountered by freezing in the dips, as the salt collects as brine, preventing freezing. For quick relief from a partly frozen line, the pipe is sometimes used as a part of an electrical circuit temporarily until the pipe is warmed sufficiently to blow the ice out.—*Stacy H. Hill in Eng. and Min. Journal.*

Perhaps it is nowhere more true than in

compressed air practice that prevention is better than cure. Get the water out of the air before it commences its travel in the pipes, and there will be no freezing and choking of the pipes afterwards. There should be an aftercooler and then a separator, if the two functions are not combined as they should be, as near the compressor as possible, when the air is at its highest pressure. If the air is then brought to the lowest possible temperature it will give up its surplus of water, or, what is not quite the same thing, will be in condition to do so. The lowest temperature possible with aftercoolers of the usual types must of course be a little above the freezing point, but by the use of brine this might be carried lower. When the air so dried is conveyed through pipes much colder there will still be some deposition of moisture and consequent accumulations of ice coatings in the pipes, but the trouble will be minimized. Beyond the aftercooler in extreme cold weather the further drying of the air is a question of expense. There might be alternate pipe lines of sufficient length to permit of the thawing and draining of one while the other was in use, but this few would resort to.

A suggestion quite pertinent in this connection comes to us from the *Natural Gas Journal,* where a correspondent writes of a similar trouble and his method of treating it in the transmission of natural gas. He writes:

"As to the use of cooling tanks at the wells to reduce the temperature of the gas before it goes into the lines, now that cold weather is with us again, it might not be inopportune to say that I have found it effective to accomplish this purpose by using an extra large sized pipe from 100 to 1,000 ft. long next the well, so that a considerable amount of hoar frost can accumulate inside of the pipe, before its internal orifice becomes so much reduced as to cause a noticeable difficulty. At the end of this large pipe, I put a water catch or tank. Then, whenever a melting day comes, this hoar frost melts and is carried forward by the flow of gas into the water catch, from which it can be let off in the usual manner. The advantage of this over using tanks alone, is that there is a larger cooling surface; the gas is more thoroughly chilled and less likely to cause trouble on the other side of the water catch or tank."

TURBOCOMPRESSOR EFFICIENCIES

Editor Compressed Air Magazine.

The article on the Turbocompressor appearing on page 5940 of the February issue of COMPRESSED AIR contains some statements which I cannot allow to pass without a few remarks.

The first statement is that "it is claimed that even at pressures as high as 150 pounds per square inch, the new type of turbocompressor is at the very least equal in thermal and mechanical efficiency to the very best kind of reciprocating air compressor." The objection to this statement is found in a direct contradiction on page 5942 where the article says that "the high efficiency already obtained (78 per cent.) as referred to adiabatic compression, places these turbo blowers very favorably in comparison with the best reciprocating blowing engines." This must, of course, include mechanical efficiency. As first class manufacturers of modern reciprocating air compressors are guaranteeing from 85 to 88 per cent. for this item, in large machines comparable in size to the turbo units, the statements above given seem exaggerated. With the turbo machine it will appear also that the efficiency of compression decreases with increase of pressure; whereas, with consistent design this efficiency increases with the ratio of compression in the reciprocating machine.

Going back to page 5940, the following remark is given: "They run practically without noise at all loads". I, myself, have never been present when one of these machines was operating, but from first-hand reports I understand that they make considerable noise not unlike a sharp whistling shriek. This may not be any worse than the pounding of poppet valves of the reciprocating machine, but at any rate the turbo machine scarcely can be called noiseless.

The next statement is that they require a minimum of power to drive. The objection to this has already been given. The statement immediately following the above; namely, that they are easily governed through a wide range of variation of speed, without materially affecting the economy, may be a good point as opposed to the reciprocating machine, although the curve in Fig. 5 seems to show a falling-off in efficiency. How this compares with variable speed control of the reciprocating steam machine, or with the clearance controller of the Ingersoll make, or the automatic air cutoff of Nordberg for constant speed, would surely be of interest.

On page 5941 the article includes a paragraph on the greater efficiency of cooling the air in the turbo machine. This of course is true and the maker of the reciprocating machine scarcely hopes to effect economy through jacket cooling. Judging from this you can see that the much greater efficiency of the reciprocating air cylinder points to the fact that there must be some other very serious losses in the turbo machine.

Of course, if the turbo machine is driven by a steam turbine the economy of the steam end may be much greater than the steam end of the reciprocating machine. Some figures which I lately received from a large installation of large turbo compressors, however, do not seem to point to anything unusual in this line. This advantage with the steam machine would fail entirely with an electric driven unit and you know that the call for this latter style of machine is increasing every day with the additional facilities for long distance electric transmission.

S. B. Redfield,
Associate Editor American Machinist.

[The article on Turbocompressors was reproduced from an authoritative English source, which we regret that we are not now able to identify with certainty. With regard to the principal contention of our correspondent, that as to the efficiency of the Turbocompressor, which is the only one which we have space to consider, it is proper to remind Mr. Redfield that there are efficiencies—and efficiencies. In Richard's "Compressed Air," published fifteen years ago, there were (pages 94-97) enumerated four consecutive discounts, if we may call them so, to be deducted from the theoretical computation to obtain the ultimate efficiency. A fifth discount on account of leakage of piston and valves was not thought of. The conclusion reached was: "It is safe to say that the ultimate efficiency never goes as high as 80 per cent., while it often goes below 60 per cent. If any compressor builder feels aggrieved over this statement, a fine opportunity is opened for a demonstration of a higher efficiency." And up to date no compressor builder has been heard from, at least by the writer. In Peele's "Compressed Air Plant," second edition, published last year, there are reports of various tests of steam driven compressors, the efficiency percentages of some of which are given as follows: Page 171, 78.1; page 180, 60.8; page 184, 67; same page, 59. The last item was volumetric efficiency alone. On page 186 there is a friction loss of 39 per cent. between the steam and the air cylinders, or a power efficiency of 61 per cent., and so it goes when efficiencies are talked about.—Ed. C. A. M.]

COMPRESSED AIR TRANSMISSION FORMULAS

Editor Compressed Air Magazine.

Referring to the formula and tables for friction of air in pipes presented on page 5950 of your Feb. issue, [The Rix-Johnson formula, used in article by Frank Richards. Ed. C. A. M.] I have compared the results given by this formula with those obtained by the formula in Harris's "Compressed Air," and I find they check each other to a surprising degree, within the limits over which the formulas are intended to apply. However, neither will give reasonable results for very high velocities and low pressures. But we should note that the authors exclude such cases by the conditions or assumptions under which the formulas are developed. In comparing the labor of computation, the Harris formula has much the advantage, since it is adapted to straight logarithmic computations. Moreover, the Harris table or diagrams, either of them, covers the whole field of practice in a most concise and simple form, rendering the labor of computation almost nil.

Observer.

[It is gratifying to be assured how completely these two formulas corroborate and endorse each other. Beyond that it may be said that the two formulas will suit two distinct classes who have occasion to use them. It is perhaps to be regretted that there are two classes, but we may expect them to always exist. The Rix-Johnson formula calls for simple arithmetic and nothing outside of it. The Harris formula must have a table of logarithms at hand and some familiarity with, and reliability in, the use of them. Ed. C. A. M.]

"THE SUBWAY EAR"

Editor Engineering News.

In a recent issue of the *Saturday Evening Post,* which does not knowingly use the incorrect or the misleading for holding the interest of its readers, there appeared a little article with the above title, in which it was stated that those who habitually ride in the subway are having their hearing impaired by the air pressure to which they are subject. "To provide the requisite ventilation", it was said, "air is continually forced into the underground tunnel. Consequently the air in the subway is at a pressure considerably greater than outside. When a person descends into the tube his eardrums are bulged inward; when he leaves the tunnel the sudden removal of pressure causes them to bulge outward. This when often repeated, is liable to set up an irritation, which in turn may bring about catarrh, etc., etc."

Now it may be true that riding in the subway does have a deleterious effect upon the hearing, but not on account of the increase of air pressure, for there is no such increase. The other day I put my little pocket aneroid in my pocket and entered the Subway at 125th street and Lenox avenue, riding continuously to Bowling Green, say about eight miles. Going down from the sidewalk to the station platform there was an increase of pressure represented by .04 inch of mercury, or, say, .02 lb. per square inch. In all the trip there was no increase of pressure above this. In fact the pressure began to fall, but the fall at the greatest was only .10 inch of mercury, or, say, .05 lb. The somewhat lower pressure, within this slight range, continued through most of the trip, the final reading on the Bowling Green platform being identical with that at 125th street.

It may be contrary to the popular impression, but there is no artificial forcing of air into the subway. The fans which were tried for the purpose did not produce satisfactory results and, as narrated by Dr. Soper in his excellent Boston paper upon subway conditions, their use was discontinued, relief having been ultimately found by making large openings between the tunnel and the outer air, and through these, as Dr. Soper says, the tunnel "breathes" both inwardly and outwardly, and the tunnel pressure is the same as that outside except for the slight difference due to the difference of altitude.

In riding up or down in the elevator, between the sidewalk and my room on the 14th story where these lines are written, the barometer shows a change of pressure just double that observed in the eight mile subway trip.

FRANK RICHARDS.

NEW BOOKS

Applied Thermodynomics for Engineers, by William D. Ennis, M. E., Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn. New York: D. Van Nostrand Company. 446 pages, 6¼x9¼ inches, 316 illustrations. Price, $4.50 net.

Although, as the author says, the title of the book is a broad one, the spread of the book itself is commensurate. The theories of thermodynomics are clearly presented, and the practical portion covers the entire field of power development and application, beginning with compressed air, then treating successively of hot air engines, gas power, the steam engine, steam turbines, the steam power plant, distillation, mechanical refrigeration. The first and the last of these topics, in which we are most interested, are treated so completely as, in a way, to guarantee all the rest. Each chapter is supplemented by an extensive and excellent set of problems to be worked out.

Motion Study, a method for increasing the efficiency of the workman, by Frank B. Gilbreth. Introduction by Robert Thurston Kent. New York, D. Van Nostrand Company. 140 pages, 5¼x7¾ inches, 44 illustrations. Price, $2.00 net.

This book at a casual glance might be called a study of the laying of a brick, but it really does make an astonishing presentation of the possibilities of labor saving by systematic study of the movements involved in specific operations and by the arranging of them in their proper sequence.

A. S. M E. PITTSBURGH MEETING

The spring meeting of the American Society of Mechanical Engineers will be held in Pittsburgh, Pa., May 30 to June 2, inclusive. The society now has in the Pittsburgh district a membership of about 160, and it has not met there since 1884.

An executive committee consisting of E. M.

Herr, chairman, George Mesta, J. M. Tate, Jr., Chester B. Albree, D. F. Crawford, Morris Knowles and Elmer K. Hiles, secretary, will have charge. It is expected that from 300 to 400 members and ladies will be in attendance. There will be professional sessions when papers will be read and discussed. There will also be inspection trips through the leading local industrial establishments, besides automobile trips through the parks, a visit to Carnegie Institute, Memorial Hall, etc.

AN INCIDENTAL TAYLOR AIR COMPRESSOR

E. H. Sellards, in a recent issue of *Science*, describes a "spouting well," which is practically a Taylor air compressor although unintentionally produced. The Taylor compressor has been frequently described in our pages, the last occasion being the large construction at Cobalt, Ontario, June, 1910. The following is Mr. Sellard's account:

In parts of Central Florida bored wells are somewhat extensively used for drainage purposes. The wells are drilled through the superficial material and as a rule enter the Vicksburg limestone of Oligocene age, although other porous limestones may serve the same purpose. Many of the wells terminate in cavities in the limestone, while others reach layers of shell or other porous material. Surface water entering the wells is carried into the limestone formation. In some localities in the central part of the State these wells have been found efficient in carrying off surface water and in draining small marsh areas.

One of these drainage wells near Orlando, in Orange County recently developed the unusual phenomenon of spouting. The well was drilled, in 1907, near the edge of a small lake. It is 12 inches in diameter, has a total depth of 260 feet, is cased 60 feet, and terminates in a cavity in the limestone. The level of permanent underground water at this locality is 33 feet from the surface. The well is intended, by carrying off the surplus water, to prevent the lake from rising above a given level, since to do so would flood the farming land.

When first seen by the writer the water of the lake stood a few inches above the level of the top of the pipe, and the well was receiving water at much less than its full capacity. At intervals of a few minutes the well would reverse itself and spout, throwing a column of water into the air. The spouting comes on gradually. First, the well ceases to receive water and begins bubbling; The column of water follows, rising with considerable force to a height of 20 feet or more above the surface, the spout occurring with tolerable regularity at intervals of four minutes. The manager of the farm states, however, that the interval between spouts varies from 2 to 15 minutes.

Although drilled 3 years ago and receiving water more or less continuously during that time, the phenomenon of spouting developed for the first time in September, 1910. The well continued spouting without interruption for a little more than a week and until shut off by the owner.

At this stage of the lake the well is receiving water at less than its full carrying capacity and as the water enters the vertical pipe it forms a suction, carrying a large amount of air into the well, which doubtless collects in a chamber or cavity along the side or at the bottom of the well. As the well continues receiving water the air accumulates under pressure in this chamber until ultimately the pressure under which the air is confined is sufficient to overcome the weight of the overlying water plus the inertia of movement and hence rushes out with considerable force, carrying the column of water with it. The fact that the well when first drilled did not spout and afterwards began spouting indicates that the essential conditions were subsequently developed either by caving or by other changes in the underground conditions.

TO SAVE BOTH SIDES OF A SHEET OF PAPER

Those who are in the habit of collecting, filing and indexing, engineering and other data are often troubled by the fact that the matter to be preserved runs over to the other side of the same sheet, or different and unrelative articles both of value are upon opposite sides of the same paper. For the relief of such the following description of the process of splitting paper has been prepared:

Procure two pieces of cotton cloth slightly larger than the sheet of paper which it is desired to split. Cover the paper with a thin coating of flour paste; dampen one of the pieces of cloth and place it over the pasted side of the paper; smooth out carefully, taking particular pains to see that there are no air bubbles under the cloth. Now paste the other side of the paper and cover with the second piece of cloth in exactly the same way as with the first piece. Allow the cloth and paper to become thoroughly dry, and then pull the two pieces of cloth apart gently. The paper will separate in the center, leaving a face attached to each piece of cloth. To remove the paper, soak the cloth in water and then gently detach. With a little practice on waste paper, one can soon become quite proficient in splitting sheets. The method described works admirably on fairly heavy paper, and it is suggested that those desiring to try it, work on a heavy grade first. With thin paper, considerable more time and skill is required.

NOTES

Cast iron or malleable iron that has been sand-blasted instead of pickled for cleaning the surface, gives, according to the *Brass World*, much better results in electroplating, as there is less liability to "spot out." Many platers have, therefore, abandoned the pickling of castings.

One ton of refrigeration is the amount of heat absorbed by the melting of 2,000 pounds of ice at 32 degrees F. into 2,000 pounds of water at 32 degrees F., or the amount of heat that must be extracted from 2,000 pounds of water at 32 degrees F. to reduce it to 2,000 pounds of ice at 32 degrees F., or $2{,}000 \times 142 = 284{,}000$ B. T. U.

Compressed-air sewage ejectors were put in a few years ago in Guildford, England, to raise sewage from low-lying areas and permit it to discharge into the basins at the sewage-treatment works. There are eight of these ejectors in use with capacities ranging from 50 to 1200 gal. per min. The compressed air for operating them is furnished by a power station situated adjacent to the town refuse-destructor. The waste heat from this destructor generates sufficient steam to drive the air-compressors which raise the sewage.

What is said to be the largest rubber suction hose ever made was made for a Philadelphia dredging firm, to be used in a deep water operation. The outside diameter of this hose is 33 inches, while inside it measures 29. The 1,290-pound spiral spring which comprises the foundation of the hose was rolled cold from a rod 1 inch in diameter. The rubber and fabric entering into its construction weighed 3,215 pounds. The rubber and duck were applied in alternate layers with coatings of gum, after which the entire piece was placed in a container and vulcanized with live steam.

It is reported that an aerological observatory will be erected on the Iselberg (altitude 916 meters) by special direction of the Duke of Saxe-Coburg-Gotha. The task of installing this station has been intrusted to the Lindenberg Observatory. It is also expected that an aerological station will shortly be opened on the Feldberg, in the Taunus Mountains, Prussia. These will be important additions to the German network of stations for upper air research. Germany is already far better provided for in this respect than any other country.

Syenite, cyanide and kyanite are pronounced nearly alike, but are names for very different things. Syenite is the not uncommon granite-like rock composed of orthoclase, feldspar and hornblende; in other words, a quartzless granite, named from Syene in Africa. Cyanide is well known in cyanide of potassium. Kyanite schist is a somewhat rare schistose rock, largely composed of the beautiful, pale blue mineral kyanite, which crystallizes in long, broad, flattened prisms of the triclinic system. The rock is more common in the eastern states. Cyanide and kyanite are both derived from the Greek kuaneos, meaning blue.

An interesting and apparently rational explanation of the thunder accompanying lightning is given in *Nature* by Herr H. L. Braun. According to this explanation the electricity discharged between two clouds or between a cloud and some object on the earth decomposes the small particles of water in the atmosphere into its constituents. The hydrogen and oxygen thus produced are mixed mechanically and form an explosixe mixture which is immediately ignited by the heat of the flash, and when exploding produces the characteristic rattling report of thunder.

Old man Dodder doubled the size of his dry kiln at the planing mill and found that the 5-horsepower fan was too small and would not deliver enough hot air. His nephew Bill was back from college and tackled the job. He figured all over the side of the shed and told his uncle that to deliver twice the amount of air he would need a 125-horsepower engine to run the fan, as the rules showed one must cube the horsepower required to run the fan with the old kiln. The old man scratched his head and sent for Jim, the engineer, to help him out. Jim grinned and said that all they would need was another 5-horsepower fan, as the two would deliver double the amount of air.—*Power.*

The melting of metals in vacuum is the ideal method, because oxidation is prevented and gases present in the metal are expelled from it. While it has long been known that the method of melting metals in a vacuum gave superior results in the final product, the method has been limited to very small quantities of metal, due to the difficulty of carrying it out in practice. Metals which ordinarily are considered as brittle substances, and incapable of being rolled or drawn, can be produced, by melting them in vacuum, in a malleable or ductile condition. Examples of such metals are tungsten and tantalum, which in this way can be made in the form of wire, and are used to a great extent in the newly bought incandescent electric metallic filament lamps.

The *Engineering Review* mentions a case of a large gas engine plant which was some time ago exported from Great Britain to a British colony and erected at the location several thousand feet above sea level. The engines did not give the power expected from them and several reasons were advanced to account for this deficiency. It was finally concluded that the loss of power was due to the altitude of the power station. Upon investigation of the theoretical and practical considerations involved it was found that there is a loss of about one per cent. of the indicated horsepower for each 1000 feet increase in elevation. The effect of an increase in elevation on an engine with a low ratio of compression is slightly less than on an engine with a high degree of compression.

In the discussion of a paper on mining locomotives before the South African Institute of Engineers Mr. Kenneth Austin, author of the paper, says that the costs of operating large European mine haulage systems, which costs include allowance of 10 per cent. for depreciation, are as follows: (1) electrical overhead wires operating locomotive, 1 ct. per ton mile; (2) compressed air locomotive, 2.4 cts. per ton mile; (3) benzol locomotive, 3.2 cts. per ton mile; (4) electrical accumulator locomotives, 3.6 cts. per ton mile. The figures show the electrical overhead wire system to be the cheapest but that it has its disadvantages is apparent, for at Kimberly, the overhead wire system was tried and abandoned in favor of mechanical rope haulage. The electric locomotives gave satisfaction but the total working costs were lower for the mechanical rope haulage on account of the fact that white labor was necessary with the locomotives. The cost of installation of the electric system at Kimberly was about five times as great as for the rope haulage, which was also a determining factor.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 7.

983,284. STARTING DEVICE FOR EXPLOSIVE-ENGINES. FREDERIC N. HOWARD, Harris, R. I.

2. A starting device for explosion engines comprising a distributing chamber arranged to contain pressure sufficient to start the engine, valves controlling the passage of the pressure from said chamber to the engine cylinders, means whereby said valves may be unseated by the pressure in said chamber, a magnet for controlling the operation of each valve, and selective means for operating said magnets.

983,293. STREET - DUST - REMOVING MACHINE. ARNOLD KUNDIG-HONEGGER, Zurich, Switzerland.

983,363. PNEUMATIC MINING - MACHINE. MARTIN HARDSOCG, Ottumwa, Iowa.

983,374. PNEUMATIC MUSICAL INSTRUMENT. EUGENE DE KLEIST, North Tonawanda, N. Y.

983,426. ELEVATOR-OPERATING MECHANISM. EDWIN CARLSON, Minneapolis, Minn.

3. The combination with an elevator car and means for raising and lowering the same, of a counter-poising device for said car, comprising a cylinder and a piston, one of which is subject to movement of said car, and an air storage reservoir connected to said cylinder and affording a variable pressure on said piston.

983,574. VACUUM - SWEEPER. FRANK B. SHAFER, Northville, Mich.

983,605. COMPRESSOR. HENRY W. N. COLE, Brooklyn, N. Y.

983,610. BLEED-COCK FOR AIR-BRAKES. JOHN M. DOOLEY, Bloomington, Ill.

983,643. TRAIN-LINE-VENTING VALVE. FRANKLIN A. PIERCE, Wheeling, W. Va.

983,729. FLUID-ACTUATED AIR - PUMP. SAMUEL C. LAIDLEY, Chicago, Ill.

983,793. PNEUMATIC - DESPATCH - TUBE SYSTEM. FRANKLIN H. WOLEVER, Chicago, Ill.

983,806. OXYGEN - GENERATOR. RICHARD CLINTON BRADLEY, Shreveport, La.

983,808. METHOD OF SINKING CONCRETE COLUMNS, PIERS, AND THE LIKE. CHRISTIAN B. CHRISTIANSEN, New York, N. Y.

983,813. AIR-COMPRESSING BLOWER. PETER J. FANNING, Providence, R. I.

983,834. DEHYRATION OF CAUSTIC ALKALI. PAUL ERWIN OBERREIT, Ludwigshafen-on-the-Rhine, and FRIEDRICH MORITZ JAHRMARKT, Mannheim, Germany.

1. The process of obtaining caustic alkali from solutions thereof which consists in concentrating the caustic alkali solution until it has reach the point at which it would act upon the material of the containing vessel, and then further concentrating *in vacuo* at a temperature sufficiently low to prevent action of the material of the vacuum drier but sufficiently high to drive off substantially all of the water.

983,837. LEAK-ALARM FOR PNEUMATIC TIRES. EMIL J. F. QUIRIN, Tioga Center, N. Y.

983,865. SUCTION-PUMP. NAT H. FREEMAN, Boulder, Colo.

983,933. AUTOMATIC PRESSURE-GOVERNOR. WALTER J. RICHARDS, Milwaukee, Wis.

983,962. CAN-TESTER. CHARLES WERNER, San Francisco, Cal.

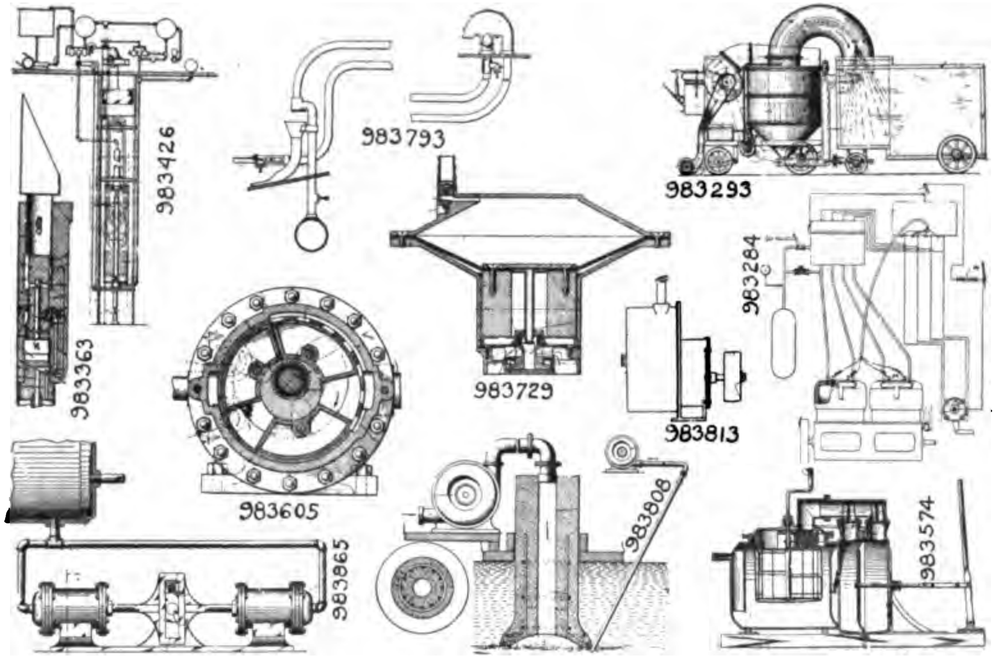
1. In a can tester, the combination with a clamp yoke having an arm furnished with a movable can clamp, and a hollow arm provided with a sealing head, a movable puncture device mounted on said hollow arm within said sealing head, and a pressure gage and source of compressed air connected with said hollow arm, substantially as specified.

983,971. PNEUMATIC CLEANING IMPLEMENT. ROY C. BAKER, Boston, Mass.

983,986. DRILL DUST-ARRESTER AND AIR-PURIFIER. WILLIAM E. DWYER, Leadville, Colo.

983,988. PNEUMATIC CLEANER. CHARLES B. FOSTER and WILMOT W. GLIDDEN, Oak Park, Ill.

984,030. GAS-LIQUEFYING APPARATUS FOR DEMONSTRATION PURPOSES. WILHELM PAUL SCHNEIDER, Hamburg, Germany.



PNEUMATIC PATENTS FEBRUARY 7.

4. A suction pump comprising a cylinder, a piston mounted to reciprocate therein, a conduit in communication with the cylinder, a reversible check valve located in the outer head of the cylinder, the inner head of the cylinder also having reversible check valves, whereby the said pump is adapted to cause either a suction or compression, the piston also having reversible check valves, and suitable means for operating the piston, for the purpose set forth.

FEBRUARY 14.

983,876. GOVERNOR FOR VALVES. FRANK L. CROSS, Detroit, Mich.

983,879. PNEUMATIC GOVERNOR. THOMAS DANQUARD, New York, N. Y.

983,882. DUST-ARRESTING AND AIR-PURIFYING DEVICE. WILLIAM E. DWYER, Leadville, Colo.

983,907. APPARATUS FOR GENERATING OZONE. CHRISTOPH KNIPS and EDUARD EY, Charlottenburg, Germany.

984,047. APPARATUS FOR DETERMINING DUST AND MOISTURE IN GASES. LESLIE A. TOUZALIN, Chicago, Ill.

984,072. AIR-GUN. WILLIAM J. BURROWS, Plymouth, Mich.

984,098. VACUUM CARPET-SWEEPER. CARL G. LUNDIN, New York, N. Y.

984,104. DIVING-SUIT ATTACHMENT. ENOS B. PETRIE, New York, N. Y.

1. The combination with a diving suit, of a relatively large hose connected at its upper end with a pop valve, and a smaller air supply pipe extending through the hose and into the suit.

984,112. PNEUMATIC TOOL. HENRY SCHUMACHER, Denver, Colo.

984,133. FLOATING DOCK. HANS GIESE, Berlin, Germany.

2. A floating or off-shore dock, comprising a bottom pontoon having a chamber into which water passes while lowering the dock and in which air is compressed by the entering water, a chamber to which water is admitted for sinking the dock, means for throttling the escape of

air therefrom to equalize the internal pressure with that of the outside, and means for forcing compressed air into said last-mentioned chamber to expel the water therefrom, to raise the dock while water is being at the same time expelled from the first-mentioned chamber by the air compressed therein.

984,144. AERATING-CHURN. THADDEUS S. LEESE, Avalon, Pa.

984,153. PNEUMATIC - PRESSURE GAGE. OLE OLSEN, Fruitvale, Cal.

984,171. ROCK-DRILL. DANIEL SHAW WAUGH, Denver, Colo.

984,187. APPARATUS FOR DISPENSING CLEANING FLUIDS. JOSEPH N. B. BOND, New York, N. Y.

984,220. AIR-CUSHION. JESSE G. HILTON, Prescott, Ark.

984,221. PRODUCTION OF GASES OF HIGH OXIDIZING EFFICIENCY. CHARLES HORNBOSTEL, New York, N. Y.

FEBRUARY 21.

984,549. PNEUMATIC STACKER. JAMES E. FOSTER, Clarksburg, Ontario, Canada.

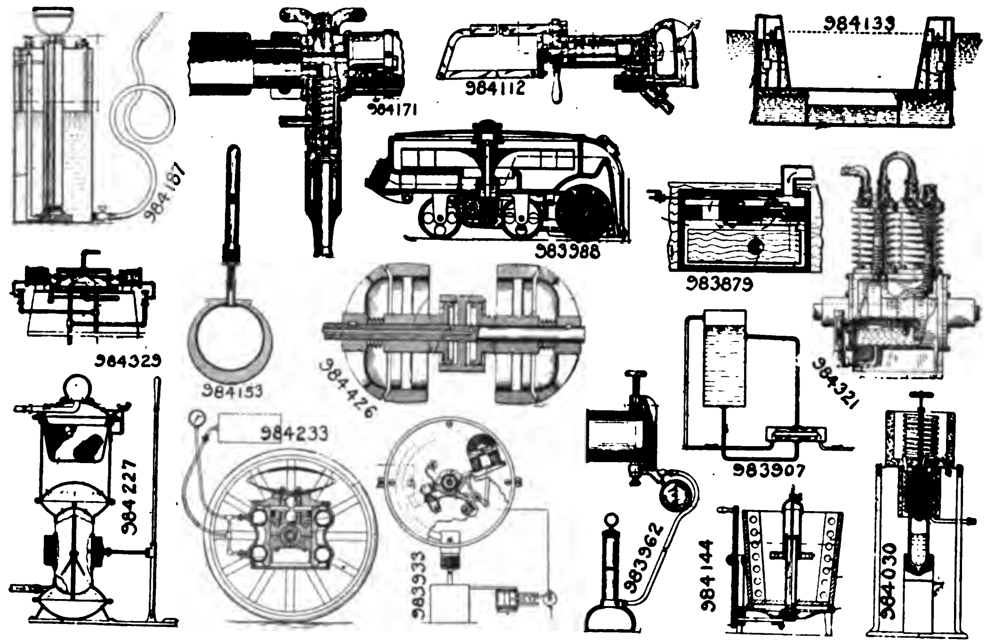
984,553. TEMPERATURE-CHANGING DEVICE FOR CARS. CASSIUS M. GAY, Los Angeles, Cal.

984,579. THERMOSTATIC MOTOR. FRITZ MARTI, Bas Obispo, Panama.

1. A device of the character described comprising a rotatably mounted container, a tube extended from said container, one end of said tube having communication with the interior of the container and adapted to contain mercury, whereby said device will be rotated by variations of density of air in the container.

984,585. SOLAR-HEAT MOTOR. EDWIN H. MCHENRY, New Haven, Conn.

2. The combination of a vaporizer, of a solar heat collector connected to said vaporizer, means for causing air to circulate through the collec-



PNEUMATIC PATENTS FEBRUARY 14.

984,227. SUCTION-PUMP FOR VACUUM-CLEANERS. JACOB C. LUDEN, Reading, Pa.

984,233. PNEUMATIC SUSPENSION FOR VEHICLES. GORDON A. MURPHY, Oakland, Cal.

984,321. COMPOUND AIR - COMPRESSOR. WILLIAM R. THOMPSON and ELMER E. CASE, South Norwalk, Conn.

984,329. PUMPING APPARATUS. FREDERICK C. WEBER, New York, N. Y.

1. Pumping apparatus comprising a chamber adapted to receive and discharge a liquid, means for alternately withdrawing air from the chamber and for supplying air thereto under pressure, a valve controlling the withdrawal and admission of air, and valve throwing means—actuated in one direction by air pressure from the said chamber and in the other direction by suction resulting from the withdrawal of air from the chamber—for throwing the valve in reverse directions.

984,426. PNEUMATICALLY - OPERATED CLUTCH. ARTHUR V. HANNIFIN, Chicago, Ill.

984,512. COMPRESSED-AIR DEVICE. ALFRED MCKNIGHT, Wilmington, Ohio.

tor and vaporizer, and means for supplying the air as it is heated with water vapor.

984,599. APPARATUS FOR STORING AND DISTRIBUTING WIND-POWER. STEPHANE PICHAULT, Valenciennes, France.

984,606. PORTABLE PNEUMATIC SHUTTLE-THREADING IMPLEMENT. ANGELO RICCI, Natick, R. I.

984,628. VACUUM-CLEANER. FRANKLIN C. WHEELER, Cleveland, Ohio.

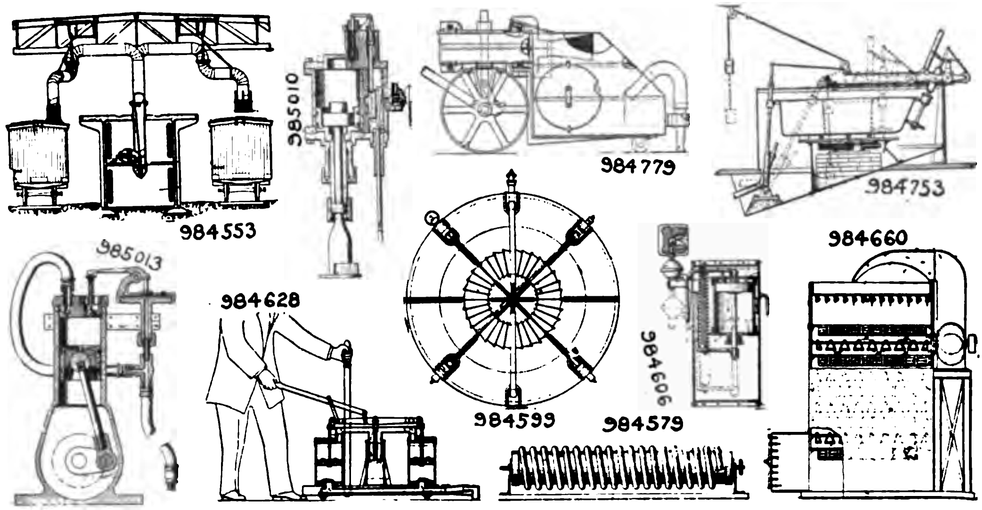
984,660. LIQUID - COOLING APPARATUS. FREDERICK W. HAAS, Pittsburg, Pa.

2. In a cooling apparatus, means for causing water to fall in a state of fine subdivision, means for passing through the same a current of rarefied air, and means for returning to the water supply any water carried with the air.

984,753. SAND-BLAST APPARATUS. CHARLES W. EBELING, Elm Grove, W. Va.

984,755. WINDMILL-GOVERNOR. WILLIAM A. FIFIELD, Minot, N. D.

984,779. PORTABLE AIR-SUCTION CLEANING APPARATUS. FREDERICK H. SANDER, Malden, Mass.



PNEUMATIC PATENTS FEBRUARY 21.

984,875. APPARATUS FOR LIQUEFYING GASES. ALBERT C. WOOD, Philadelphia, Pa.

984,925. PROCESS OF OXIDIZING NITROGEN OF AIR BY MEANS OF ELECTRIC DISCHARGES. KARL KAISER, Wilmersdorf, near Berlin, Germany.

985,010. FLUID - PRESSURE - OPERATED BOTTLE-CAPPING MACHINE. ROSS V. CRAGGS, Baltimore, Md.

985,013. AIR-PUMP. JOHN DESMOND, Chicago, Ill.

FEBRUARY 28.

985,131. WINDMILL. WILLIAM P. BENNETT, Woodstock, Ohio.

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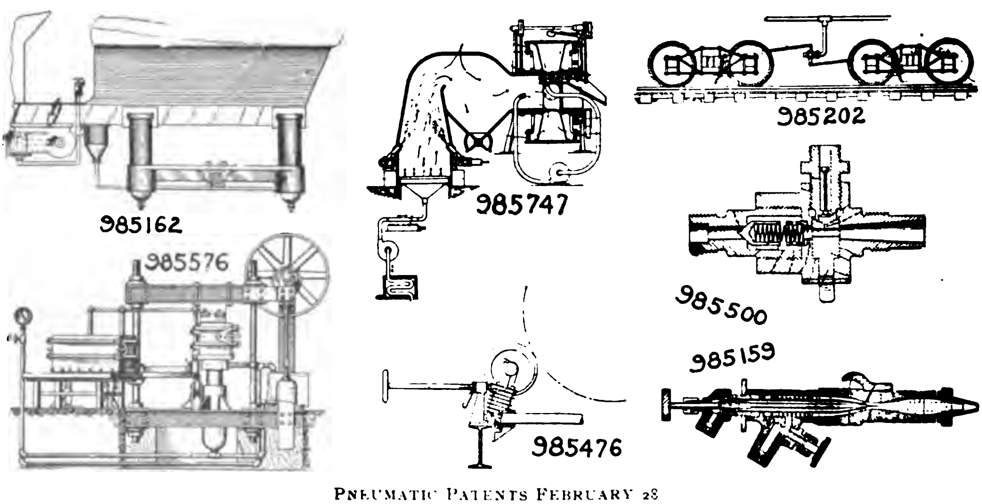

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Vol. XVI | MAY, 1911 | No. 5

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Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

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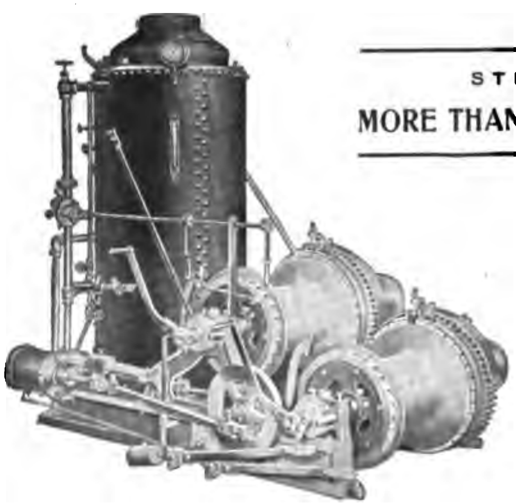
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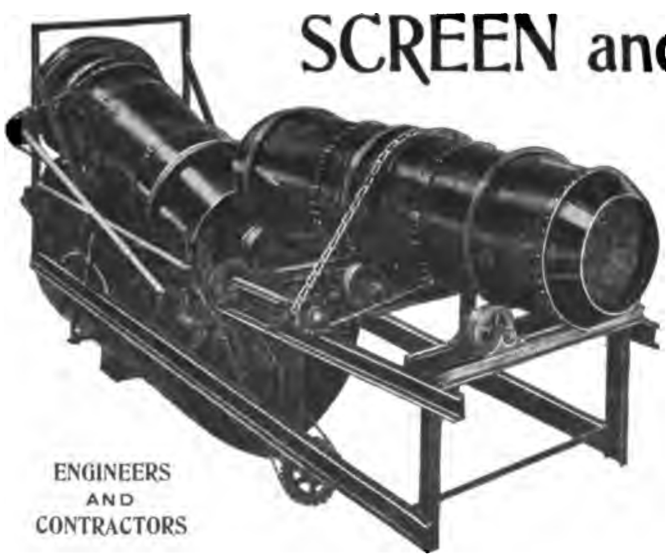

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KING SOLOMON'S QUARRIES.

KING SOLOMON'S QUARRIES

The interesting photo here reproduced from *Stone*, for which publication it was originally made, should be of wide general interest, and we may assume its appeal to our own readers in that compressed air is here so conspicuous by its absence, showing one of the marked contrasts between the ancient and the modern ways of working.

Thomas R. Wallace, U. S. consul at Jerusalem, recently reported concerning the vast abandoned and long forgotten quarries beneath the northern portion of the Holy City. They were discovered a few decades ago by accident. A Dr. Barclay, an American tourist, was out hunting, and as he passed along the north wall of the city his dog disappeared beneath the wall. Following him Dr. Barclay discovered the entrance, then almost entirely closed with rubbish, of these grottoes or quarries. This discovery led to their exploration, and it was found that vast quantities of white stone had been taken out for building purposes, enough, it has been estimated, to build the present Jerusalem within the wall two or three times over.

The exceeding whiteness of the stone, its nearness to the temple area, its suitability for building purposes, being soft when first quarried, but hardening on exposure, the great chamber deep in stone chippings, where vast quantities of the quarried stone had been cut into shape, suggesting the allusion to the temple having been put together without the sound of hammer or saw—all these and other considerations conspired to establish the idea that has since taken hold on the public mind, that here indeed was that of which Josephus and the Old Testament spoke in connection with the building of the temple.

The quarries are entirely substerranean and reach to a great depth, comprising many separate chambers. The photo was, of course, taken by flashlight, and from it we get a good idea of how everything was left by the workmen after they had removed the last row of building blocks. The manner of hewing out the deep grooves on each side of the block, and at its top and bottom, and the way the wedges were introduced at the back for breaking the block from its bed rock, can all be plainly traced, as well as the niches for the workman's lamps, so placed that the light would shine into the cut.

COMPRESSED AIR EXPLOSIONS

By W. L. Saunders.

Men in charge of compressed air plants should watch and study carefully each case where ignition or explosion occurs in compressed air pipes and passages. It is a dangerous thing to maintain a large volume of compressed air in a condition where there is a liability of ignition of corbonaceous matter.

A case has recently been brought to my attention where a typical plant of air compressors, consisting of two straight line machines with compound air cylinders, was working in an engine room pumping air at a pressure of about 90 pounds into a receiver from which the air was led a distance of about 150 feet to the mouth of a shaft. An explosion took place at the mouth of the shaft, the pipe and tee (6") were ruptured, about 6 feet of the pipe breaking open and the tee being shattered. The pipe down in the shaft, which was held together by flanged couplings, was broken to the extent of one section of pipe only, this section, together with the flanges, being thrown out and the flanges broken.

One peculiarity about this construction, which may have had something to do with the explosion, is that the air pipe line leading from the receiver to the mouth of the shaft was not on a level, but was depressed at the receiver, which means that there was a pocket in this line near the receiver, which might have accumulated moisture, oil, carbon or other material. The first lesson to be learned from this explosion is that under no circumstances should such a pocket exist in an air pipe line. In this case there appears to be no reason for such construction, though at times, and particularly in mines, it may be impracticable to prevent a condition like this, but in such cases the pocket should be accessible and should be provided with means for draining, preferably in the shape of a small air receiver or enlarged section of pipe.

This plant was provided with a Pittsburg recording pressure gage. This recording gage record shows a pressure running uniformly at about 90 pounds per square inch during the day, until about half past 3 o'clock in the afternoon, when the line forms a right angle, going abruptly in a straight line up beyond the limits of the gage. Evidently when this explosion took place the needle was driven upward until it stuck.

An investigation in this case led immediately to the question as to what oil was used. A sample being furnished and analyzed, showed a flash test of 360 degrees, Fahrenheit; which cannot be called a low flash test, though it might have been higher. Oil showing a flash test of 360 degrees is fairly good oil for this purpose.

It is impossible to determine definitely in a case like this where the explosion or ignition began, we simply know that the air pipe in certain places broke, and as these places were connected through an uninterrupted compressed air passage with the interior of the compressor cylinder, through the receiver, it is reasonable to say that the high pressure which this explosion or ignition produced extended all along the line, and that the rupture took place at the weakest points. A pipe joint, especially where it connects with a cast iron fitting, is naturally weaker than an air receiver or the discharge passages of an air compressor cylinder.

It is unreasonable to suppose that ignition actually took place at the point of fracture.

It is more reasonable to infer that the beginning was in the air cylinder itself or at a discharge valve, and it is plain that compressed air when charged with vapor of oil will ignite or explode along the entire line, provided a spark initiates it. What takes place in the cylinder of an automobile is probably what took place in the case of this explosion. An automobile engine gets its power through the ignition of a chamber of air compressed and charged with an explosive vapor—gasoline. The proportion of gasoline to air is very small; the gasoline, however, being so thoroughly distributed throughout the air that it heats or ignites the air at all points, causing rapid expansion.

The word explosion is a relative term. Steam may be said to explode when it pushes the piston of an engine, through an effort to occupy more space, because the original particles of water are converted into steam by heat. An air receiver filled with compressed air and heated will have an explosive tendency for the same reason. In other words, an explosion may be said to be the result of the tendency of a confined substance to occupy more space, and if that action takes place slowly it is called an expansion. If it takes place rapidly or suddenly it is called an explosion.

In the automobile cylinder, for instance, we cannot call it an explosion because it acts harmoniously and practically, producing mechanical power. If the ports and passages of an automobile engine were made too light the result would be an explosion, or, if we inserted gun powder or dynamite in the cylinder instead of gasoline, we would produce an excessive pressure which would rupture the engine; this would be an explosion.

Another point to be considered in studying a compressed air explosion is that the quantity of carbon that is present in the air has a good deal to do with the seriousness of the explosion. It is not uncommon to have what is known as flaming take place in compressed air ports, pipes and passages. A candle will burn in a closed air receiver containing compressed air more violently than in the free air. If while burning this candle flame comes in contact with inflammable gases mixed with the air there will be what is known as flaming. What takes place in the automobile cylinder might really be called flaming, but the point to consider in compressed air plants is that, as with the automobile cylinder, this may do no damage provided the parts and passages are strong enough. If, however, this flaming is something more than what takes place in the automobile cylinder, because there is present in the air a sufficient amount of carbon to produce a violent explosion, then the condition becomes serious.

Take gun powder, for instance. We have a solid, which contains the elements necessary to combustion intimately commingled and ignition produces explosion. This combustion takes place so rapidly that we have a real explosion, and not a mere flaming or expansion as in the automobile cylinder. To continue the illustration let us suppose that we have a little dynamite in the place of the gunpowder. Here we have a still greater suddenness of combustion and a more violent explosion.

A piece of gun powder the size of a pea will produce one result, a quantity of gun powder the size of a cocoanut will produce another. Gun powder the size of a pea might be placed in the air pipe of a compressed air installation and ignite without doing any more damage than flaming, but a quantity of gun powder equal to the volume of a cocoanut would be certain destruction. The point to be considered here is that this carbon oil, or other material which collects in compressed air receivers, pipes and passages, if only there in small quqantities, might ignite without doing damage, but if it is neglected, allowed to accumulate, and a condition arises by which ignition takes place, we have a serious explosion.

The first point therefore, is to so build that there will be no chance through pockets to accumulate oil, carbon and other inflammable matter. Receivers, valves and passages should be looked into once a week and cleaned out. Do not clean them out in the easiest way; that is, by the use of kerosene, for this is adding fuel to the flames, but clean them out mechanically with a scraper.

No one can tell where or how an explosion of this kind originates. It is probable, however, that it comes from the air cylinder, either through a defective discharge valve, which might stick and allow the receiver air to come back again hot into the cylinder and thus pile up too great a temperature, or it arises from a foreign substance being drawn in with the free air and through friction of the piston or valve resulting in a spark. This point is frequently neglected. We look at free air around an engine room and it looks all right, but it usually is not all right, and it should be cleaned by straining before it is allowed to go into an air compressor. There have been cases where the machinery has been completely destroyed in a few months through foreign substances, or even acids from furnace smoke, being drawn into the air cylinder, compressed and concentrated. Steam is clean, because it is distilled water, the foreign substances remaining in the boiler, and we frequently lose sight of the fact that because we have so little trouble in the steam cylinder we should not neglect the air end. Apart from the liability to destroy the piston, cylinder and valves, we are pumping down into a mine chamber dusty or foul air. The best air is that which comes from a well, and if a well is not available an artificial one can be built outside the engine room by putting some boards together, making a frame, and with the use of cheese-cloth, bagging or other cheap substance, baffle plates may be constructed and kept wet for catching at least the dust and dirt that is always in the air about an engine room. This also serves to lower the temperature, and it is certain that the cooler the air is when it goes into the cylinder of a compressor the more economical is the process of compression.

INERTIA OF AIR COMPRESSOR INTAKE

Fig. 1 shows an air-compressor indicator diagram with this rise in intake pressure above the atmosphere line at the end of the suction strokes, *A A;* such diagrams often being found and by some mistakenly regarded as evidence of discharge-valve leakage.

It is quite generally admitted that, under favorable conditions of unobstructed piping, high piston speed and relatively large number of reciprocations, a water pump actually will deliver more water than its piston displacement would indicate. This is simply because the water, attaining a high intake velocity, does not stop instantly when the piston reaches the end of its travel, but the inertia of the moving water tends to continue the flow during the instant of rest previous to reversal of piston stroke.

This sounds like "perpetual motion," but an instant's reflection will free the mind of such an impression. The speed and inertia given to the rapidly moving water must, of course, have come from the piston, and this latter must have received them from the power of the driving mechanism, so that every extra foot-gallon of work done will be accounted for at the motor end of the machine.

Such conditions in a water pump could obtain only with relatively low heads because, water being incompressible, the energy of flow quickly would be absorbed in overcoming the pumping head as the water rushed directly through the pump cylinder into the discharge. This restriction would not hold, however, with moving air for, although the air is very much lighter and has much less inertia for a given volume, even at its higher speed, this inrushing air would not encounter the pressure of the discharge at all; but simply would crowd into the cylinder against a pressure approximately atmospheric, causing a slight increase of this pressure above the atmospheric line, as shown in Fig. 1.

If the inertia effect does take place, as the rise in the air-intake line would seem to show, to marked degree sometimes, what effect does it have, and can any practical steps be taken to improve the action of a compressor thereby?

BASIS OF CALCULATION.

As a basis for calculating such an effect of inertia we may turn to the method of calculating the inertia forces of the reciprocating parts of a steam engine. We may do this on the assumption that the motion of the air in the intake pipe is in a series of pulsations corresponding to the reciprocating motion of the air piston. Close to the compressor cylinder, this probably is very nearly true and the effect must be similar in a gradually decreasing degree at greater distances. Even at the further end of a compressor intake pipe of considerable length, these pulsations are distinctly noticeable upon placing the hand in the current of air rushing into the pipe. Far enough away from the piston, the pulsation waves are, no doubt distinctly modified from the approximately simple-harmonic motion of the piston, but the distance would have to be very great before the elasticity of the incoming air would be such as to absorb all pulsations and result in an even flow of air into the pipe.

Those who have studied the crank effort diagram of the steam engine, or other machine involving a crank and connecting rod, are aware that the starting and stopping forces at the ends of the strokes are, with an infinite connecting rod (or a "Scotch yoke"), equal to the centrifugal force that would be produced if all the reciprocating parts were revolving about the shaft at the radius of the crank circle. If the force at the end of the back stroke or beginning of the forward stroke, this force tending to produce tension in the rods, be considered positive; the stopping force at the other end of the stroke, tending to produce compression in the rods, must be considered negative.

At some time, then, during the stroke of the piston, the inertia forces must become zero, the parts having been completely accelerated and traveling along in equilibrium. With an infinite connecting rod (Scotch yoke), this point of zero inertia force occurs at mid-stroke, and a diagram of the forces of inertia of the parts would be as in Fig. 2. In this case, the forces at each dead center would be alike, and the point of zero force would be, as said, at mid-stroke.

In this reasoning the difference between *inertia* and *inertia force* must be distinctly appreciated. At mid-stroke the *inertia*, or stored energy would be maximum, due to the high velocity; but the *force* exerted would be zero, because there would be no acceleration or retardation. Toward the stroke ends, however, the slowing of the motion would transform the *inertia* into an active *force* pressing on the crank pin and assisting the motion, this force becoming a maximum just at the instant of stopping. At this instant, of course, the *inertia* would be zero. Whatever force assists the crank pin toward the end of each stroke, correspondingly tends to retard the crank pin during the start of the next stroke, so no net work is done by these forces.

EFFECT OF CONNECTING-ROD ANGULARITY.

For the real conditions of a finite connecting rod, we may refer to some calculations by Professor Jacobus in the Transactions of the American Society of Mechanical Engineers, Volume 11, pages 492 and 1134. In these

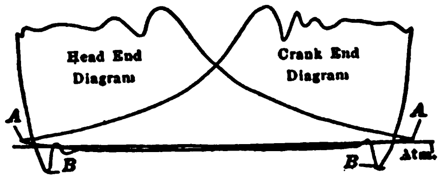


FIG. 1

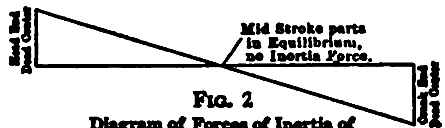


FIG. 2

Diagram of Forces of Inertia of Reciprocating Parts with Infinite Connecting Rod or Scotch Yoke.

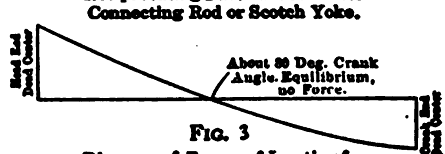


FIG. 3

Diagram of Forces of Inertia of Reciprocating Parts with Connecting Rod Length of 5 times the Crank Arm.

American Machinist

AIR INTAKE DIAGRAMS

papers will be found a table of factors worked out, by which the theoretical, infinite-rod forces may be multiplied to obtain the actual, finite-rod forces. A plot of such a calculation will produce a curve like Fig. 3, where the forces at the two ends of the stroke are unlike and where the zero point is somewhere around 80 degrees of crank angle, measured from the head center. These changes are due simply to the effect of the connecting-rod angularity in putting the piston forward of where it would be at any one time if the rod were infinite and had no angularity.

For an infinite rod, the force of inertia, in pounds, at any position of crank angle is expressed as follows:

$$F = \frac{W \pi^2 N^2 R}{900 g} \cos. \theta,$$

where

W = Weight of reciprocating parts, in pounds;

N = Number of revolutions of crank per minute;

R = Crank radius, in feet;

g = Acceleration of gravity, 32.2;

θ = Crank angle, measured from head dead center.

When $\theta = 0$, $\cos. \theta = 1$ and F becomes the same as the centrifugal force, as already explained, for the dead-center position.

From Professor Jacobus' figures, for a machine having a connecting rod of length equal to five times the crank arm, the usual design for air compressors, the force at beginning or end of either stroke, should be

$$F = \frac{W \pi^2 N^2 R}{900\, g} (cos. \theta + 0.2).$$

APPLICATION TO MOVING COLUMN OF AIR.

To apply this formula to a moving column of air in a pipe, W will be the weight of air in motion, N will be the number of double reciprocations corresponding to the revolutions of the compressor crank, but the value of R will not be the crank radius. This will be understood from the fact that, due to the intake pipe being much smaller in area than the air cylinder, the air in this pipe must travel faster and further at each stroke than the piston does. Suppose the intake pipe area is approximately 12 per cent., or 1/8 of the piston area. Then, at any given time, the air must be traveling 8 times as fast as the piston and, in order to fill the cylinder, the requisite air will have to travel 8 times as far in the pipe as the piston does in the cylinder. In other words, the air pulsations are 8 times as long as the piston stroke, and consequently, in this case the value of R in the formula for the air must be 8 times the length of the compressor crank arm.

As might be expected, the formula shows that the inertia force is proportional to the square of the number of revolutions. This means that the greater the number of stops and starts in a given time, the greater the forces. Consequently a relatively short stroke with a given piston speed is conducive to heavy forces.

AN EXAMPLE.

To take a specific example: Suppose we have a 36-inch stroke air compressor, running at a speed of 100 revolutions per minute, a practical figure for modern, high-speed practice, especially for direct-connected electric drive with motor on compressor shaft. Let the cylinder be 34 inches diameter and let its average net area be 900 square inches. The intake pipe area, being 1/8 of this, let its inside diameter be 12 inches, with actual area of 113 square inches. The ratio of cylinder and pipe areas then will be 8 to 1, and so the air speed and length of air pulsation will be 8 times as great as those of the piston.

Let us say that the intake pipe is 25 feet long, from entrance at outside of building to cylinder; let the temperature of the air be 60 degrees Fahrenheit. At the instant of piston stoppage, the air in the inner end of the pipe will be compressed by the inertia to some pressure above the atmosphere, while that at the outer end will be atmospheric, and only that in the middle section will be, say, half a pound below atmosphere. It then will be reasonable to assume that the average pressure of all the air is atmospheric at the instant of stoppage and greatest force and pressure. The weight of the air contained in the pipe then must be 0.0764 pounds per cubic foot, and as the volume of the pipe of 12 inches inside diameter and 25 feet length is 19.6 cubic feet, the total weight of air flowing in the pipe at this instant will be 1.50 pounds.

Taking first, the force at the head center, we have, by applying the formula already given for a five-crank length connecting rod;

$$F = \frac{1.50\, \pi^2\, 100^2 \times 1.5 \times 8 \times 1.2}{900\, g}.$$

In this expression, the factor 1.5 is, of course, the crank circle radius in feet, and the factor 8 is the ratio of cylinder area to intake pipe area and, consequently, the ratio of air pulsation length to piston stroke; so that the product of these two factors represents the imaginary length of crank arm that would produce the air pulsations occurring in the intake pipe. The factor 1.2 is the sum of the cosine of 0 degrees (unity), the crank angle at head dead center, and the factor 0.2, calculated by Professor Jacobus for the connecting-rod length chosen.

The solution of the expression given above is:

$$F = 73.5 \text{ pounds}.$$

INERTIA FORCES DUE TO RECIPROCATION.

This is the total pressure exerted in stopping the column of air at the end of the suction stroke at the head dead center, but it must be remembered that, if the air passage is continuously of the same area, 113 square inches, this pressure will be distributed over this whole area and so the pressure per square inch exerted will be $\frac{73.5}{113} = 0.650$, or over 5/8 of a pound.

CUMULATIVE EFFECT.

Just at this point we should consider a further inertia effect; the "piling up" and compressing of the air in the cylinder and the inner portion of the intake pipe. The result of such an action would be to allow the remainder of the air in the pipe to continue flowing and crowding in, so that the actual length of air pulsation is greater than we have assumed. The effect of increasing this pulsation length is to increase the value of R in the formula, and thus further increase the force which we are endeavoring to calculate. The logic is that, the number of pulsations per minute remaining the same, the stopping force must be greater if the distance traveled, and consequently the linear speed, is greater; also the additional air entering the pipe adds its inertia to the effect.

As this would tend further to increase the pressure, let us assume that the final pressure would be, say 0.7 pound above atmosphere, or 15.4 pounds absolute. Now, the volume of the compressing cylinder is 18.7 cubic feet and, as an estimate, we may include the last 6 feet of intake pipe in this "piling up" effect. This gives a total volume of 23.4 cubic feet into which the incoming air is crowded from an initial pressure of 14.7 to 15.4 pounds. Then this 23.4 cubic feet of air will occupy a space of $23.4 \times \frac{14.7}{15.4} = 22.3$ cubic feet, thus leaving $23.4 - 22.3 = 1.1$ cubic feet of the last part of the pipe for more air to crowd into. With a 12-inch intake pipe this means a length of 1.4 feet, and this length is to be added to the value of R, or imaginary radius of pulsation wave. As the old value of R was $8 \times 1\frac{1}{2} = 12$, we now have 13.4 feet for the more probable value of R.

As the value of F is directly proportional to R, the more probable value of F now will be

$$0.650 \times \frac{13.4}{12} = 0.726 \textit{ pounds},$$

giving a final intake air pressure of over 15.4 pounds per square inch absolute, which agrees with our assumption when we began to consider this "piling up" effect. It is, therefore, reasonable to assume that there would be, under the circumstances of this case, an initial air pressure just at commencement of compression, of 0.726, or nearly ¾ of a pound above atmosphere. This would increase the volumetric efficiency by quite 5 per cent., a result well worth striving for.

FORCES UNEQUAL AT HEAD AND CRANK.

At the crank end of the stroke, the force would be somewhat less, as the value of $\cos. \theta$ would be -1, and $-1 \times 0.2 = -0.8$. This would then make the pressure at the crank end about 0.484, or a little less than ½ pound per square inch above atmosphere, increasing the volumetric efficiency at this end by over 3 per cent. The average efficiency increase for the two ends then would range about 4 per cent.

This condition of unequal effects at the two ends is borne out in practice, for an examination of the indicator diagrams containing these inertia effects invariably shows more initial pressure at one end than at the other.

To be strictly logical, the increased quantity of air admitted to the outer end of the pipe by the crowding and compressing of that at the inner end, should be taken into account. This increase was shown to be 1.1 cubic feet, bringing the weight up to 1.58 pounds. This would further increase the head end inertia force to $\frac{1.58}{1.5} \times 0.726 = 0.765$ pound per square inch, or over ¾ of a pound pressure; and the crank-end force to 0.51, or over ½ pound per square inch. This would tend to show that we are at least on the conservative side, leaving room for pipe friction and other losses.

PRACTICAL CONSIDERATIONS.

From the foregoing, it would appear that a longer intake pipe would contain more air in motion, and so would give an increased inertia force and higher volumetric efficiency. Double the length of pipe would give double the weight of air; but, as before intimated, the pulsations probably are modified considerably at the end of so long a pipe. Another matter too, is the loss of pressure by friction through this long pipe, but this is really negligible if the air speed is kept down around 4,800 feet per minute. As an example, tables worked out in Kent, from B. F. Sturtevant Company's formulas, show that the loss of pressure through 25 feet of 12-inch pipe, with a speed of 4,800 feet per minute, is about ½ ounce.

It may well be asked "why should the pipe produce this inertia effect any more than if the air flowed directly from the atmosphere into the cylinder, thus avoiding even the small friction of flow. The answer is that the air in the pipe has a smooth flow and has an opportunity to attain the velocity calculated; whereas, if the pipe were absent, the atmospheric air would flow from all sides at low speed and furthermore, all energy of motion would be lost in eddying at entrance. The pipe keeps the air flowing straight, swiftly and without eddying to any great extent.

Some persons will realize that this force or pressure required to stop the incoming air at the end of the stroke must be balanced by an equal and opposite inertia force required to *start* the pulsation at the beginning of the stroke. No better evidence of this can be desired than the ever present "hooks" *B B*, Fig. 1, on all air-compressor indicator diagrams. Two excuses usually are given for these; inertia of indicator parts dropping from the pressure of discharge to that of intake, and the pressure required to open poppet valves. The first excuse seems inadequate with a modern, light indicator and as to valve resistance, the writer has seen these "hooks" with Corliss inlet valves open wide before the stroke started.

It will be well to add that an actual case of this kind; but which, owing to several elbows and a strainer in the intake pipe, it was impossible to figure upon intelligently; recently has been brought to the writer's attention, where the initial pressure of the intake line is about 1½ pounds above atmosphere at one end and 1 pound at the other.

COMPRESSED AIR FOR SHAFT SINKING IN QUICKSAND

By P. B. McDonald.

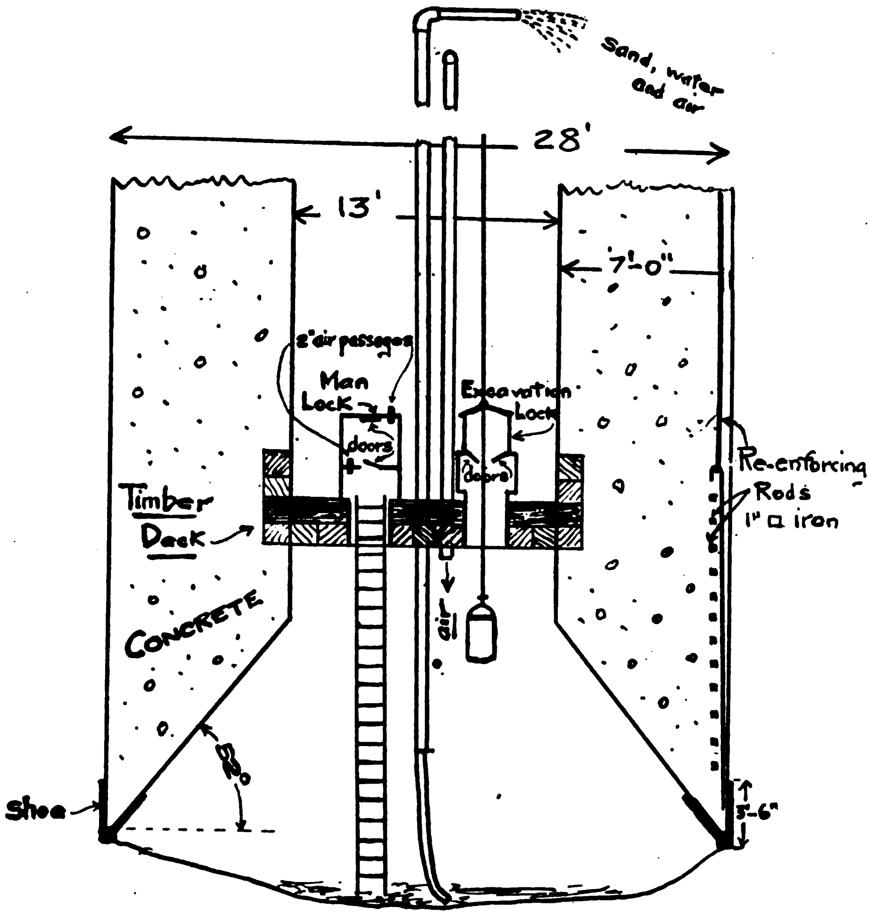
In the past few years a number of reinforced concrete shafts through quicksand and soft soil have been sunk for iron mining companies of the Lake Superior district by the Foundation Co. of New York. The Cleveland-Cliffs Iron Co., which, by the way, has introduced several desirable reforms into the mining business. was among the first to recognize the possibilities of the compressed air method for shaft sinking and to apply the proved devices of bridge pier, tunnel and building foundation work to mining. Their Smith and Kidder shafts on the Swanzy range, sunk in 1907 and 1908 by the Foundation Co., were in a way innovations to the mining men of the district, and established a precedent that has since spread to the Marquette, Menominee, Mesaba, Vermillion and Cuyuna ranges.

In principle the method is as follows: A vertical, hollow cylinder of concrete is constructed on the surface with a steel shoe on the pointed, cutting edge. The earth is excavated from the inside and the caisson sinks of its own weight. It is kept plumb by digging out under the high side. More concrete is added at the surface in 5-ft. sections and the sinking goes on until ledge is struck, when the steel shoe is sealed to the solid rock so as to make a tight joint. In going through quicksand air locks are put on the top, and compdessed air is forced into the caisson to hold back the sand and water, which would otherwise fill the shaft.

First taking up the process in ordinary soft ground where compressed air is not necessary, it is recalled that the method is by no means a new one, but has been used considerably in Germany, where the caissons were constructed of stone or brick. But neither of these materials can be compared to concrete, which combines weight with strength to form an almost ideal material.

In shape the caisson may be rectangular, eliptical or circular. The type which is used in the iron country is circular on the outside and may be circular or rectangular inside; the sketch shows the latter case. In the caisson, circular both inside and out, the thickness varies from the bottom up. In other words, with the pressure. Thus one shaft was made 3 ft. thick at the bottom and 1 ft. 6 in. at the top.

A clam shell, or a regulation contractor's derrick, is used in the excavation when there is enough water to make the ground safe, and water up to this limit is desirable. However, much of the excavation has to be done by men shovelling into a bucket, especially where boulders interfere with the equal sinking of the caisson. It is sometimes necessary to apply additional weight to sink the structure. and wet sand and pig iron have been used for this purpose. Blasting is sometimes resorted to, even when the compressed air is on, and not uncommonly the ledge dips at such an angle that it is necessary to blast it down to a level



SHAFT SINKING IN QUICKSAND.

surface in order to properly seal the caisson. Or, if the rock is oxidized and crumbly at the surface, it has to be broken down to a solid foundation.

The steel shoe is made in four sections of 90 degrees each, which are riveted together on the ground. The sides of the shoe are ½ in. steel plate, and they are held together by cross pieces of ½ in. web plates placed about 4 ft. apart all around the circle. The shoe is left open at the top and concrete is filled into it.

The concrete is built up in 5 ft. sections. The outside forms are curved steel plates in sections of 90 degrees; the inside form is a wooden frame that is carried up as the caisson sinks, or the inside forms may be steel also.

When compressed air is used the problem becomes more complicated and more costly. A heavy deck of timber or steel is fitted into a recess in the wall and is calked tight. Two apertures are left in the deck, over each of which a steel cylinder about 4 ft. in diameter is placed. One cylinder is a man lock and the other is an excavation lock, through which the dirt is hoisted out. The deck may also admit an air pipe for blowing air into the shaft, and a blow pipe through which a mixture of sand, water and air is blown out by the pressure inside, thus assisting the excavating work.

The doors of the excavation lock are controlled from the outside. After the bucket has been pulled through them they are closed and the bucket is hoisted, carrying the cover of the lock with it on a buffer. When the buffer is lowered again the top is bolted back into place, the doors are opened and the operation begins again. A stuffing box on the cover at the rope hole keeps the air from escaping.

The man lock, in addition to the two doors, has two 2 in. air passages controlled by valves to gradually change the pressure in the steel cylinder. The lower door and the 2 in. air passage are closed when men are admitted to the cylinder; then the upper door and the upper 2 in. air passage are closed and the lower air passage is slowly opened so that the pressure gradually rises to that in the caisson, when the men are allowed to climb down below. The process is reversed when the men are coming out.

This locking through of the men is time-taking and cannot be hurried. If sufficient time is not taken to accustom the ear drum to the pressure while going in the head rings with an almost unbearable pain. In coming out, if the men do not remain long enough in the lock they are seized with the "bends," a paralysis of the body and limbs that sends them shrieking to the "hospital" lock. This is a large steel cylinder, some 20 ft. long by 7 ft. in diameter, in which a high air pressure is maintained; when the men are inside this a small valve is opened and the pressure is allowed to fall very slowly until it becomes normal.

Five hundred dollars per foot is not an exorbitant cost for sinking through quicksand for the large sized shafts put down in the Lake Superior region.—*Mining Science.*

BOTTLE MAKING MACHINES

Mr. Leonard A. Kupferberg recently read before the Junior Institution of Engineers an interesting paper upon the Manufacture of Glass Bottles. Although machines for this purpose have been the subject of many inventions, it is only quite recently that they have been so perfected as to enable them to compete with manual labor.

The principle of all the machines so far invented is to cast a stick or bar in a mold, one end of which forms the mouthpiece of the bottle. A punch or pin is inserted through the mouthpiece part of the mold, thus partly hollowing the bar. The mold is then removed; a second one, with the full shape of the bottle, takes its place, and the tube is inflated into the desired shape. The glass, in most of the machines mentioned, is filled into the tube-mold by manual labor, that is to say with a scoop.

Cast iron is usually the material from which the molds are made. The bottles supply enough heat to the molds to prevent their being cooled too quickly. The pressure required in bottle machines varies, according to the glass used, from 10 to 30 lbs., per sq. in.

By far the most ingenious is the Owens' machine, having six sets of molds fixed to a frame revolving on a vertical axis. A small ante-chamber, the base of which is formed by a revolving fire-proof clay tub, is attached to the furnace. The latter supplies the revolving tub with glass, the object of its motion being to constantly supply new glass to the machine.

Separate burners are arranged round the chamber for the purpose of maintaining the temperature of the glass in the tub. On one side of the chamber the tub projects several inches, and into this the end of each one of the tube molds is dipped, and is there filled by suction. During the revolution of the frame the various stages of formation (the replacement of the molds, the inflation, etc.) are gone through, and shortly before a mold re-arrives at the tub, it opens and deposits its bottle, bottom upwards, into a funnel, through which the bottle slides to a small stove for the so-called "fire-finish." In the stove, it is exposed to a high temperature, which brings the glass near the melting-point, thereby removing any tension in the neck or mouthpiece caused by the insertion of the cold pin in the beginning of its formation. Six sets of molds are fixed to the revolving frame, each revolution of the latter therefore producing six bottles. On leaving the "fire-finish" stove the bottles are placed in the annealing stove.

The Owens' machine turns out 14,000 to 16,000 bottles per 24 hours. Twelve of these machines are now in satisfactory use in Europe.

Inflating hand-made bottles by mechanically compressed air has frequently been tried, but always with indifferent success. The even distribution of the glass in the walls of the bottle largely depends on the pressure used, and this can be adjusted evenly by the lungs, but not so by the means of mechanically compressed air.

TURBO AUXILIARIES TO PISTON COMPRESSORS

As works and industrial establishments grow in size, it is often a very difficult matter to know what it is best to do in order to keep the plant up to the capacity that will adequately fulfil the demands which are made upon it. In the early days of an establishment the power may have been ample, but with the passage of time it is gradually borne in upon the minds of the owners that something will have to be done if their output is not to be very seriously handicapped. There are more ways than one of doing this, and probably two of the ways are to erect entirely new plants, and do away with the old plant when the new is ready for work, or to add new plant to the old, so that, when run together, the latter may receive the help it requires. The cost of either of these methods is often much more than would have been the case had the additional power been installed at first, and the decision as to which offers the more favorable prospect for the future is one that frequently requires no little experience, because many other things than actual first cost may have to be considered.

A case of the kind recently arose at an English colliery, where, in order to meet the increased demand for air, either the existing piston-compressor plant—a cross-compound engine with cylinders 28 in. and 50 in. diameter, by 60 in. stroke, driving duplex air cylinders of 33 in. diameter, running up to from 30 to 35 revolutions per minute as a maximum—could be augmented by a similar set, or, with a view of increased efficiency on the air cylinders, by the installation of a compound two-stage compressor, or finally by the adoption of a turbo-compressor set receiving its driving energy from the exhaust (at about atmospheric pressure) of the low pressure steam cylinder. Here the plan contemplated was that the turbo-compressor should pass its discharge through an inter-cooler into the existing air cylinders. It was found that the cost of the second complete piston compressor would very much exceed the first cost of the turbo-compressor installation, and it would also require much more floor space; moreover, a gain of efficiency could be obtained only with the new piston compressor plant, whereas the turbo-compressor would improve the working efficiency over the whole combined capacity. For these reasons, therefore, it was decided to install the turbo-compressor. The results have fully justified this decision, a gain of about 17 per cent. over what would have been secured from a second piston compressor having been obtained.

The turbo-compressor is of the Rateau type, and was subjected to tests which proved that the guarantees were fully realized, easily delivering from 6,000 to 7,000 cubic feet of free air per minute at 12.8 lb. gage. The steam consumption claimed for the turbine also was established. The flexibility of the plant was particularly noteworthy, as outputs up to 12,000 cu. ft. per min., and pressures up to 16 lb. were easily realized.

When running the existing piston compressor at the normal speed of 30 revolutions per minute, taking in air at atmospheric pressure and temperature, the maximum volume discharged at 60 lb. was 3,000 cu. ft. of free air per minute, while with the addition of the turbo-compressor set, with the piston compressor at the same speed as before, an increase in the free air capacity of over 100 per cent. was obtained, and the total efficiency both of the air and of the steam was greatly improved.

The low pressure steam cylinder of the existing duplex piston compressor now discharges into a large steam receiver—an old boiler shell with automatic relief valve arranged to prevent undue accumulation of pressure. From this the steam passes through the exhaust steam turbine to the condenser arranged underneath the turbine exhaust branch. The turbine is absolutely under the control of the reciprocating compressor, as a demand for more work from the plant requires more steam from the duplex compressor, and provides the turbine with the necessary steam for the required air capacity or pressure.

The Rateau turbine is of the multicellular type, the cylinder of which is divided into a number of compartments, in each of which are fixed the distributing vanes. It is of the "Action" type, the fall of pressure taking place in the distributors only, the expansion being utilized to create kinetic energy. As the pressure is the same on both sides of the moving wheels, balancing pistons are not required as in "reaction" turbines, where the fall of pressure takes place partly in the moving wheels. A Rateau type of centrifugal multi-stage blower is also used. Diaphrams are placed between the wheels and take the air at the outlet of each wheel and lead it through channels of special shape into the eye of the next wheel after having transformed the velocity head into pressure head.

From the very satisfactory results given by this installation it is believed that there will be a wide field for the application of turbo-compressors both for increasing the output of existing plants and materially augmenting the economy. It is also expected that they will prove very suitable for separate new plants, owing to the wide range of capacity and pressure that they possess, in addition to their high efficiency.

BACTERIA

Many seem to regard germs as minute animals, others seem to consider them insects, and therefore often confuse the scope of bacteriology with that of entomology. Bacteria are really microscopical plants—they are the smallest of all living things. Indeed they are so minute that it is almost beyond our conception to think of life existing in such minute objects. The unit used in measuring bacteria is known as the micron, which is equal to 1:25,000 of an inch. The average diameter of bacteria is about one micron. It would require therefore 25,000 bacteria of the average dimensions placed side by side to measure an inch, or it would require about 2,000 of these to cover the point of a pin, or about 200,000 to completely cover it. In shape bacteria are of three general types—spherical, vod shape, and spiral form, and are accordingly divided into three general classes, known as coccaceae, spirrillacae, and bacillacae. Bacteria can be found almost everywhere in nature. As a general rule their function may be termed analytical, that is they are continually breaking down the higher forms into simpler forms of life. In the soil they liberate plant food from its unavailable state of highly complex matter and render it assimilable to the plants. They multiply by division, which under favorable conditions may take place every quarter of an hour. The parent cell, dividing once every hour which is not an exceptional case—would under favorable conditions produce a progeny of 17,000,000 bacteria in 24 hours. From this it will be noted that in the bright lexicon of bacteria there is no such word as race suicide. Happily for man in his fight against harmful bacteria conditions are not often such in nature as to allow for this theoretical progeny.

DECOMPRESSION FOR COMPRESSED AIR WORKERS

A valuable paper on Caisson Sickness was read recently before the Royal Society of Arts by Mr. Leonard Erskine Hill, F. R. S., and the paper has been carefully abstracted by the *Engineer*, London. Our readers will be aware, it says, that it has been recognized for a long time now that the troubles experienced by men working under pressure are due to the fact that nitrogen is dissolved in the tissues of the body. When decompression occurs suddenly, or more or less quickly, this nitrogen cannot escape sufficiently quickly, and bubbles of it make their appearance in the blood and interfere with the circulation. We need only quote one form of disease produced as an example. The paralysis known as diver's palsy is due to a local death and degeneration of the spinal cord brought on by bubbles of nitrogen blocking the circulation there. The question has been well studied both in this country and abroad, and it was early recognized that the harm did not lie in actually being submitted to pressures higher than that of the atmosphere, but in this pressure being too suddenly relieved. Accordingly it has been customary in diving and other operations necessitating the use of high pressures to arrange for a graduated rate of decompression varying with the pressure employed. In a book on the subject published in Germany in 1900, Messrs. Von Schrötter, Heller and Mager laid down the principle that a uniform decompression rate of two minutes for each .1 of an atmosphere; or, in other words, twenty minutes for each 15 lb. pressure was safe. They based the calculations by which they arrived at this conclusion on the law of saturation and desaturation of the body, which had been enunciated by Zuntz. Up till comparatively recently the whole idea has been to decompress slowly but continuously, and in cases of high pressure the period of decompression has necessarily been lengthy. In a lecture which Mr. Hill gave at the Olympia Exhibition in October, 1907, he expressed himself as believing in steady and uniform decompression. In his recent paper he shows that he has reason to believe that what is known as stage or step decompression is to all intents and purposes as good and as little injurious, and, moreover, that it saves time.

It was, we believe, Dr. John Haldane who first advocated step decompression.* He proposed that supposing a diver were working under a pressure of six atmospheres, in decompression he should be quickly brought up to a point where the pressure was only from 1½ to 2 atmospheres; that he should remain there from thirty to sixty minutes and then be brought quickly to the surface. The idea was not immediately universally adopted; indeed, there are doubtless many who still adhere to the principle of gradual but continuous decompression.

By no means the least valuable portion of Mr. Hill's present paper is that which is devoted to the numerous experiments which he, in collaboration with others, have carried out regarding the effects on the human body of various methods of decompression. It would be impossible with the space at our command to go in detail into these experiments. They were, however, evidently carried out with great care, and by means of an old steel boiler with a cubic capacity of 42.2 cubic feet. In this either Mr. Hill or his co-worker, Mr. M. Greenwood, were exposed many times to pressures exceeding + 60 lb., four times to + 75 lb., and on one occasion Mr. Greenwood underwent a pressure of +92 lb.—this, we may mention, being equivalent to immersion in water to a depth of over 210 ft. They investigated the effect of various methods of decompression by analyses of urine passed under different pressures and circumstances, arguing that when the kidney is actively secreting, the saturation of the urine with nitrogen gas must approximate to that of the arterial blood. They also experimented with various animals, including goats and pigs.

The conclusions which they reached were, first, that it is safe for a man to be rapidly decompressed after exposure to about + 18 lb.; this, it may be added, is the general experience in caisson working. Then the investigations led to the opinion that a stage at + 8 lb. lasting fifteen minutes is enough after a shift at + 30 lb., and a stage of thirty minutes at + 15 lb. after a shift at + 40 lb. to + 45 lb., provided a medical lock for recompression is at hand. Recompression in case of adverse symptoms after too rapid decompression was found to be of much value; but evidently Mr. Hill thinks that expert medical advice should be available in any works where high pressures are employed.

The final opinion at which Mr. Hill appears to have arrived is that whereas decompression times are often too short, those tabulated by the Admiralty Committee are unnecessarily long, particularly if the men are persuaded to exercise their bodies during decompression. This committee, by means of experiments on goats, found a great superiority of the stage over the uniform method of twenty minutes per atmosphere, and drew up a set of tables which give times of decompression with a great appearance of exactitude. The tables were, however, based on theoretical assumptions as to circulation time, volume of blood, and desaturation of the blood in its passage through the lungs. Mr. Hill points out that as bodily activity has a most potent effect on the circulation, increasing the rate perhaps six or ten times, and converting "slow" parts into "quick" parts it seems clear that these tables have only a limited accuracy. Moreover, he asserts that the statement that the blood is desaturated in its passage through the lung requires proof. Hence, having personally found the benefit of bodily exercise during decompression he advocates it most strongly, averring that not only may decompression time be reduced by its means, but that the chances of harmful consequences are reduced. If, for example, men coming out of a caisson could be made to climb up to the top of the shaft and down again during the time they are waiting for the end of the stage it would greatly increase their safety. Experiments made with the breathing of oxygen immediately prior to decompression have indicated that such a proceeding would also tend in the direction of protecting the workmen from ill effects, especially if bodily exercise be indulged in during the compression. With the two combined Mr. Hill thinks the time of decompression might be shortened. Further investigations, however, are necessary before it can be determined by how much the time may be safely shortened.

The work of Mr. Hill and his *confrères* has undoubtedly carried our knowledge of the subject further than it was, and it is now pretty clearly known under what conditions men may work with safety under high pressures. The great thing is to see that they conform to the

*COMPRESSED AIR MAGAZINE, Vol. XIII, Page 5106.

necessary regulations, which they are by no means always ready to do. This is understandable. They are naturally anxious to be free after a spell of work. Much of the sickness experienced in the past has been due to wilful disregard of regulations. Anything, therefore, that can be discovered which will reduce the time necessary for decompression without increasing the risk must be beneficial, for the less time the men have to spend while the pressure is being removed the less likely are they to infringe the rules.

GAS CURE FOR WHOOPING COUGH

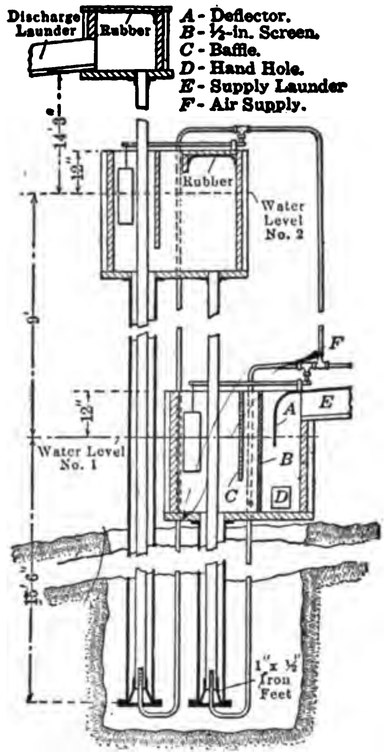
A Los Angeles, Cal., newspaper item states that from twenty to two hundred persons afflicted with whooping cough and similar throat troubles crowd into the purifier house of the local gas company every day and that two thousand cures have thus far been recorded. There was an epidemic of coughing in that city last month, and right valiantly the gas company came to the rescue and threw open its doors to the afflicted. The writer of the item attributes the cures to "naphthaline fumes," and thus explains their origin: "The naphthaline is a by-product of the oxides of iron used to divert the sulphur from the gas." A sign might be hung over the door bearing the name "bronchial and pulmonary dispensary." Those who "cough up" at the cashier's window in such agony might be sent to the "dispensary" to recuperate. Thus the querulous, the asthmatic and whooper shall gather together for the gas man to bestow upon them his blessing.—*Progressive Age.*

FROZEN DYNAMITE

Frozen dynamite is the subject of grave suspicion among most engineers, yet experts hold that it is far less sensitive than unfrozen dynamite. In order to prove this, Dr. Walter G. Hudson and Mr. E. J. Riederer, the latter superintendent of the Du Pont works at Lake Hopatcong, conducted some experiments on Feb. 24 that are decidedly interesting. They were made with a particularly sensitive grade of 60 per cent. gelatine dynamite and also with some straight dynamite. A number of these sticks were used as targets for bullets from a Krag-Jörgensen Government rifle, loaded for a velocity of 2150 ft. and fired at a distance of 50 ft. from the dynamite. The bullets discharged in this way failed in every case to explode the sticks of frozen, straight and gelatine dynamite. Other frozen sticks were then thawed and used as targets in precisely the same way. In every case the bullets detonated them, thus showing the decreased sensitiveness due to freezing. The same thing was shown in another way by using thawed sticks which were broken in two. If a cap with 30 gr. of fulminate of mercury was attached to half of a thawed stick and the other half was placed 8 in. from it, the latter would be exploded when the former was fired. If, however, a whole stick of frozen dynamite was placed 8 in. from a half stick of thawed dynamite and the latter was fired the frozen stick remained unaffected. In fact it was not until the frozen material was placed within 1 in. of the piece fired by the cap that it could be exploded. When sticks of frozen and of thawed dynamite were blown into the air with black powder it was found that the former took about three times as long to burn as the latter. Tests of this character seem to prove that frozen dynamite is not sensitive, yet even when it has been benumbed by the cold it should be handled with great care. It is best not to become familiar and careless with anything of such a violent temperament.

EXCESS CHANGES CONDITIONS

In fast steamers resistance does not increase with the cube of the speed, and there are certain higher critical speeds at which resistance is less. Nearly 100 years ago in England a man running express passenger canal boats had them towed by galloping horses at a speed of nearly 14 miles an hour, claiming this was easier than a slower speed. He was ridiculed by scientists who opposed the law of cubic increase of resistance. A bet was made, dynamometers attached, and up to 8 miles the law held good; but above 8 miles the canal boat began to climb out of the water, so that at 14 miles the actual resistance was small. This was the origin of the hydroplane boat. A wise Kansas mare hitched to a plow, if it pulled heavily, would look back, take in the situation, and increase her speed. The plow immediately pulled easier because the greater speed flung the clinging earth free of the mold board, thus greatly lessening friction.—*Harrington Emerson.*



AIR LIFT FOR TRANSPORTING SAND

An application of the Pohle air lift to raising and transporting the sand from cyanide tanks was recently made at Burbanks Main Lode mine in West Australia. The sand had to be carried across a public road, requiring a lift of 23 ft. 3 in. It was decided that a submergence of 63 per cent. of the total length of water pipe was required, which in a single-stage lift would have required a pit 39 ft. 6 in. deep. For this reason a two-stage lift was adopted, reducing the depth of pit required to 15 ft. 6 in.

The air supply for each lift is regulated by floats, so that a nearly constant level is maintained in each head box, and no air is blown to waste. The two lifts combined use 47 cu. ft. per min. of air; discharge 320 lb. sand per min., and require 800 lb. water per minute. This means 6.8 lb. sand are discharged per cu. ft. of air. The air used was drawn from a large receiver. In testing the air lift, this receiver was filled to a gage pressure of 70 lb. per sq. in., and was then shut off from the compressor, and the fall in pressure in a given time noted. During this time no air was drawn from the receiver for any other purpose. Mine water was used for sluicing, and the amount available was only little more than sufficient to carry away (along a V-shaped launder having a fall of ⅞ in. per ft.) as much sand as one man could shovel into the discharge door of the vat. The sand is heavy, and rapid motion is necessary throughout to prevent it settling; the proportion of water to sand is about 2½ to 1.

SAND FORMERLY SHOVELED

Before the air lift was put in, it was the practice to shovel the sand through the bottom discharge doors into trucks; with the air lift one man empties the vat in considerably less time than two did with the trucks, no time having to be lost in changing and waiting for trucks. The vats hold 30 long tons and, with one man shoveling, they are emptied in 3½ hours, using 45 to 47 cu. ft. of free air per minute. Each discharge door has a 4-in. socket screwed into it, and the door is never removed. From the bottom of the socket a pipe leads down vertically with an elbow just above the launder; inside the vat a pipe is screwed into the top of the socket long enough to reach above the top edge of the vat. To discharge the vat the pipe projecting through the sand is unscrewed and pulled out, leaving a convenient hole through which to start sluicing. To avoid the risk of having more sand sluiced into the launder than the water is able to carry along, from 25 to 30 per cent. of the total added water is supplied to the highest end of the launder running under the discharge doors.

Both sections of the lift are of the same dimensions, except in hight, and consist of a 6-in. cast-iron pipe (which constitutes the well) with a 3-in. wrought-iron pipe inside, extending from within four inches of the closed bottom end of the 6-in. pipe, up to the required hight of lift. The air pipes are ¾ in., though ½ in. would be ample; they are carried down the pit outside the 6-in. pipes, and are turned up at the bottom through the center of the dead end of the bottom of the 6-in. pipes. They extend upward for 10 in. in the 6-in. and for 6 in. in the 3-in. pipes. The nozzle ends of the air pipes are closed and twelve hacksaw slits are cut across each of the ends, the cuts extending round about one-quarter of the circumference of the ¾-in. pipe and cut at an angle of 45 deg., thus giving the air an upward direction.

The lift has worked well from the start and has caused no trouble or delay. When the water supply fails a ½-in. water pipe (which is kept connected by flexible hose to a supply having a pressure of about 50 lb. per sq. in.) is passed down the 6-in. pipe which is cleared almost as fast as the ½-in. pipe can be lowered. Two or three minutes is sufficient to clear it at any time. The only wearing parts are the 3-in pipes, and these, having no bends, are likely to last a long time. The consumption of air may be taken as about 50 per cent. more than the best pump would use when in perfect condition. Unlike sand pumps the air lift remains in perfect condition.

The added water is heated to a temperature of 95 deg. F. by passing a part of it over exhaust-steam pipes on its way to the lift. This heat, no doubt, adds to the efficiency of the lift.

AIR DRIVEN CORE DRILL IN A ZINC MINE

By Frank W. Sansom.

Joplin, Mo., has always been a field into which manufacturers and operators of core drills have hesitated to enter. Several attempts have been made to utilize the diamond drill, but they were apparently unsuccessful. The principal difficulties seem to have been encountered in drilling through pockets and crevices, in which the diamonds were likely to be torn out and lost.

The shot drill was tried in this district several years ago apparently with no better success, the principal difficulty being that the drill could make almost no headway in some of the hard flint encountered. There are no authentic records available regarding these attempts, but they must have been discouraging, or later attempts would certainly have been made.

CHURN DRILLING USED IN THE PAST.

The churn drill is widely used, and is satisfactory from a mere drilling standpoint, but the records obtained are not reliable. Many good mining properties have been condemned, and many poor ones recommended on data obtained by churn drills.

The drilling is almost always done by contract; speed is about the only factor considered; and the holes are not cleaned thoroughly nor often enough, so a thin rich stratum often appears as 4 or 5 ft. of workable ore. This would not be so misleading but for the fact that the ore-bearing ground, being much softer than the rock above or below, is cut much easier, so the diameter of the hole at this point is greatly enlarged, and shows more ore than it should. The jar of the tools and wash of the water also tends to enlarge the hole at these rich places, and the mineral runs down to greater depths, making a false and misleading record. With a core drill this is impossible as the cuttings are not depended upon for the record.

USE OF THE CORE DRILL.

The objections above noted, and many others, made the need of a core drill very real and imperative. The improved methods of prospecting, and the growing desire among progressive and uptodate operators more thoroughly to exploit and block out their ore bodies, will doubtless create a further demand for better and more extensive drilling.

Since a majority of the mines in the district are working in deeper hard-ground orebodies, the principal difficulties with which the core drill will have to contend are the extremely hard rock here encountered; crevices, open and mud pockets, shelly flint, etc. It is probable also that the difficulty of overcoming local prejudice against new methods and machinery, and the increased cost of drilling, will be no small problem.

INTRODUCTION OF THE CORE DRILL.

As a bit of history it is pertinent to mention here the events that led up to the introduction of the core drill by this company. About a year ago they introduced an innovation in churn drilling. Their present workings are at a depth of 240 ft., but an old deep drill hole showed ore to a depth of 300 ft. The management conceived the idea of installing a drill underground, in order to save a depth of 240 ft. of drilling and the attempt was entirely successful. Three holes were drilled, showing workable ore to a depth of 300 ft. The problem of sinking the company's shafts to such an increased depth, and the expense attending the opening of new workings was such an important one, that it was thought best to try to secure more accurate information regarding the deeper run of ore before attempting extensive operations.

The ground drilled was limestone and flint, and seemed to offer no theoretical obstacles to core drilling, other than extremely hard rock, and occasional small pockets. These the company was satisfied could be surmounted by the core drill, so they purchased from the Ingersoll Rand Company a Davis-Calyx class F-1 shot drill. The drill bores a hole 4¼ in. in diameter, makes a 3¼-in. core and has a depth capacity of 800 ft. A drilling expert was sent to install the drill and train a local crew to operate it.

The drill was lowered into the ground and set up without difficulty, and, contrary to all prophecies concerning this drill, and the usual delays encountered in installing machinery under new conditions, it started without trouble. The driving engine was first operated by steam but later by compressed air, and ran perfectly with either.

Five holes have been completed to date, the first to a depth of 90 ft. from the floor of the mine, or 330 ft. from the surface. The others were drilled to an average depth of 300 ft. The drill is now operating on the sixth hole.

CHARACTER OF GROUND DISCLOSED.

The character of the strata penetrated was white, gray, and brown limestone, white, blue, and black flint, varying in hardness in the order named, the limestone being the softest, and the black flint the hardest; all of the rock being similar in character to that found on the 240-ft. level of the mine. The black flint in this formation is reputed by all men who have worked in this mine to be as hard or harder to cut with the rock drill than any rock in the entire district. The hardest materials encountered by the core drill were balls or nodules of blue and black flint bedded in the limestone.

Zinc blende, or jack, was the only ore found. It occurred in pockets and horizontal seams from one to six inches in thickness; vertical and inclined fissures; and disseminated through the limestone and flint. The only unusual occurrence noted was that disseminated through the limestone, something unknown in the upper workings of the mine, and rarely found anywhere in the Joplin district.

CHARACTER OF CORES.

The cores varied in length up to 30 in., the average being about six or eight inches. The broken nature of the cores was due to the numerous cracks and fissures in the rock. No difficulty was encountered in picking up the broken pices of core, as they readily worked into the core barrel, and were held there by the solid core coming immediately under them. One of the principal objections to the shot drill for this district was in drilling through pockets, in which case it was predicted the shot could not be kept under the bit, hence the drill would not cut. A number of pockets were drilled through, some as much as a foot and a half in depth, and no serious difficulty was noted.

SPEED OF DRILLING.

The depth drilled per day of eight hours on the first hole varied from two to eight feet, averaging four feet; on the second hole the average was 5½ ft., on the third, fourth and fifth holes, six to seven ft. The best day's drilling on the first hole was eight ft., on the second 13ft., and on the last three holes 17 ft.; the character of the rock was about the same in each hole. The increased average on the various holes was doubtless due to the increased experience of the drilling crew, which became better acquainted with the performance of the drill as the work proceeded.

Of course the hard blue and black flint drilled very slowly, two or three feet per day while drilling in them exclusively, being a fair day's work; while drilling in limestone 15 ft. per day was easily made. One condition that prevented faster drilling was the frequency with which the cores had to be taken out. This was mainly due to the broken condition of the core. After the core barrel became partly filled with broken core, the pieces had a tendency to rotate on each other, thus grinding off the ends. The jack being comparatively soft was thus most easily ground and lost, so while drilling in ore-bearing ground it was necessary to draw the cores very frequently.

Another condition that took time was the comparatively low derricks used. The derrick on the first, second, fourth and fifth holes was 26 ft. high, allowing a break in the drill rods in drawing the tools, of 20 ft. On the third hole the derrick was only 21 ft. high, necessitating a break every 10 ft. The change of rods were 2, 5 and 10 ft., thus the time required for taking out cores consumed at least one-third of the working time of each shift.

THE COST OF DRILLING.

The cost of drilling is figured from the second, third, fourth and fifth holes; the first hole being drilled by a highly paid expert, with two helpers who were learning the work. All the other holes were drilled by one drill-man and one helper. The labor cost on these last four holes was about 95c. per ft.; shot 15c. per ft.; bits, 10c. per ft.; power, repairs, etc., 10 to 15c. per ft., making a total cost per foot of $1.25 to $1.30. This seems to be a high cost when compared with churn drilling at 80c. to 90c. per ft., but when the reliability of records are compared it is considered, by this company at least, a satisfactory and economical investment.

METHOD OF KEEPING RECORDS.

The cores were kept in boxes five feet long holding two cores each, side by side, or 10 ft. of core. The pieces of core were tagged with consecutive numbers, and were thus recorded in the written log of the hole, in which the character of the rock, apparent value of the ore contents, depth, etc., were noted. For the purpose of finding the exact value of the ore, the cores containing ore were ground in a sample grinder, to a ½- or ¾-size, then quartered; one portion was powdered and assayed, the other returned to the core boxes for future records.

The performance of the drill for this company seems to demonstrate beyond question that the shot drill or core drill is eminently practicable for this district, at least in the hard-ground mines. The variety of ground encountered in these five holes, considering the crevices, pockets, and the extremely hard rock, seems to be a broad enough test to warrant the above conclusion.

Probably the best plan for using this drill in this district would be to drill a hole down to the ore horizon with a churn drill, casing the hole where necessary, and then take a core from the ore formation with the core drill. A combination churn- and core-drill rig, or two separate rigs operated in conjunction with each other, would make the drilling cost but little more than churn drilling. Two separate rigs would probably be better so that both could be in operation on different holes at the same time. In such a combination of the two methods of drilling advantage could be taken of the best features of both drills, the churn drill for speed in barren ground and the core drill for a reliable record in the ore formation. Now that the core drill has achieved such practical success in this test, it would seem only a question of time until it would be in common use in this mining district.—*Engineering and Mining Journal.*

GASOLINE FROM NATURAL GAS

Any gas from a sand from which oil is produced will yield a profitable amount of gasoline, ranging in gravity to 82 to 96 degrees. The gravity depends on the density of the gas and the extent to which it must be compressed to obtain best results.

The gas from Bradford sand oil wells is known to produce under present stage of development, from 2½ to 3½ gallons per 1,000 cubic feet under compression of 275 to 350 pounds. The gravity of this product is 86 to 94. Gas from the second or what is known as the Watsonville, Kinzua or Tiona sand yields a greater percentage of gasoline under lower pressure. This is due, so far as pressure is concerned, to the normal or natural rock pressure, which in this particular sand does not exceed 300 pounds, while the initial pressure of the Bradford sand runs as high as 600 pounds. The gravity of the oil in the different sands has some effect on the gas.

The second sand oil being lighter, more of its qualities that are rich in the hydrocarbons are absorbed and carried away in the gas. This may be fully demonstrated by letting the gas from a dry gas sand circulate through oil on its way to the point of consumption, where careful rotation will show, in increased efficiency, what the oils of different gravity contribute in heat units toward enrichment of the gas. Care must be observed in such tests to admit a proper amount of air to secure the best results in combustion.

Gas from the deep gas sands, where the initial pressure would reach 800 to 1,000 pounds, does not yield, under any known system, an appreciable quantity of gasoline. Possibly, under pressure nearly equalling that of the original rock pressure, an excessively volatile product would result, but inability to confine and to hold it would make its manufacture impracticable.

The best results are secured from gas from oil wells that are located in what is known as Gas Pump territory. On these wells a vacuum ranging from 10 to 22 inches, mercury column, is maintained.

WHAT VACUUM DOES.

This vacuum draws not only the gas from

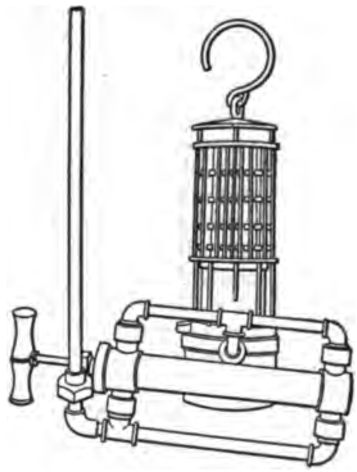
the sand, but converts some of the lighter qualities of the oil into a vapor which assimilates with the gas. This gas under compression of 85 pounds, yields 4½ to 5 gallons of 92 gravity gasoline per 1,000 cubic feet. Increased pressure proportionately decreases the quantity of gasoline and raises the gravity. Under 165 pounds pressure 1,000 cubic feet of gas produced 3 to 3½ gallons of gasoline.

The gravity of the gasoline may be lowered to 78 degrees by proper treatment of the gas before it is put under pressure. It is a fact also that any gas which comes from an oil-bearing sand can be made to yield its product of gasoline under pressure not exceeding 150 pounds. There is an increasing demand for this high test product. For high speed gasoline engines and for the gas lighting machines it has no equal. The belief that the volume of gas is not diminished, and that there is no deterioration is, in our experience, incorrect. The decrease in the volume of gas is in proportion to the amount of gasoline extracted —varying from 10 to 25 per cent.

Assuming that in the process of compression the water and other foreign substances are removed from the gas, and that no heat units are needed to eradicate this waste—there must still be deductions made from its former efficiency in proportion to its impoverished condition. It is true that a cleaner, brighter light is made from gas from which the gasoline has been taken, and it is true, also, that for gas engines this gas is superior, there being no danger of carbonization, but an additional 5 per cent. of the impoverished gas will be required.

NON RUSTING OF STEEL IN CONCRETE

The risk of the rusting of steel reinforcement in concrete has been widely discussed, and equally positive statements are made that it will and will not rust. The Concrete Institute has just issued a draft report upon this question. It is affirmed that if proper precautions are observed rusting will not occur. The materials used must all be of good quality and be well and scientifically mixed. The concrete should be mixed fairly wet and well packed, so that it fills the mold completely and leaves no voids. Sand more or less coated with salt should be washed, and salt water should not be employed for mixing. The stone or other aggregate should be as non-porous as possible. The aggregate should all pass through a ¾-in. mesh, and no coating of concrete should be less than ½ in. Where the concrete is much exposed to moisture the minimum thicknesses of concrete covering the reinforcement should be increased by 50 per cent. Paint, oil and thick rust should be removed from the reinforcement before it is put into its place. It is pointed out that these precautions are considered from the point of view of corrosion only.



TESTING FOR GAS IN COAL MINES

It is well known that the goaves of a coal mine are constant sources of danger from the collection of gas in them. They are also dangerous to inspect, owing to falling roof. In order to test these places in safety, Joseph Smith, inspector in the Phelps-Dodge mines, at Dawson, N. M., has invented the apparatus shown in the accompanying illustration. In using this device, the inspector carries enough ⅛-inch pipe with him to reach into the dangerous places. The pump is then connected to this pipe and the gas forced into the attached safety lamp, where the flame is watched. If the roof falls while the test is being made and the pipe cannot be withdrawn, it can be abandoned as a negligible loss. The pump can be used with any safety lamp by putting the pump discharge against the wires and working the pump, but it is arranged to fit the Wolf lamp.

The apparatus can also be used as a demonstrating device by taking any small tank, say an old fire extinguisher, putting a small quantity of gasolene in it and drawing air through this tank and through another small tank in series, which serves as a mixing and storage tank, into a lamp. Any desired flame thus can be shown to fire bosses in entire safety. —*Engineering and Mining Journal.*

COMPRESSED AIR AT HIGH ALTITUDES

Mons. G. Trefois, in *Revue Universelle des Mines,* discusses mining conditions at high elevations, referring for illustration to the Sentein lead-zinc mines in the French Pyrenees. altitude 6,500 to 8,800 ft., and the Caylloma silves mines in Peru, altitude 16,000 ft.

The most noticeable and potent feature at these altitudes is the reduced atmospheric pressure, this at 8,150 feet being 27 per cent. less than the normal pressure at sea level, and at 16,300 feet the reduction being 45 per cent. The rarified atmosphere detracts from the efficiency not only of workmen and animals, but also of gas and compressed air engines.

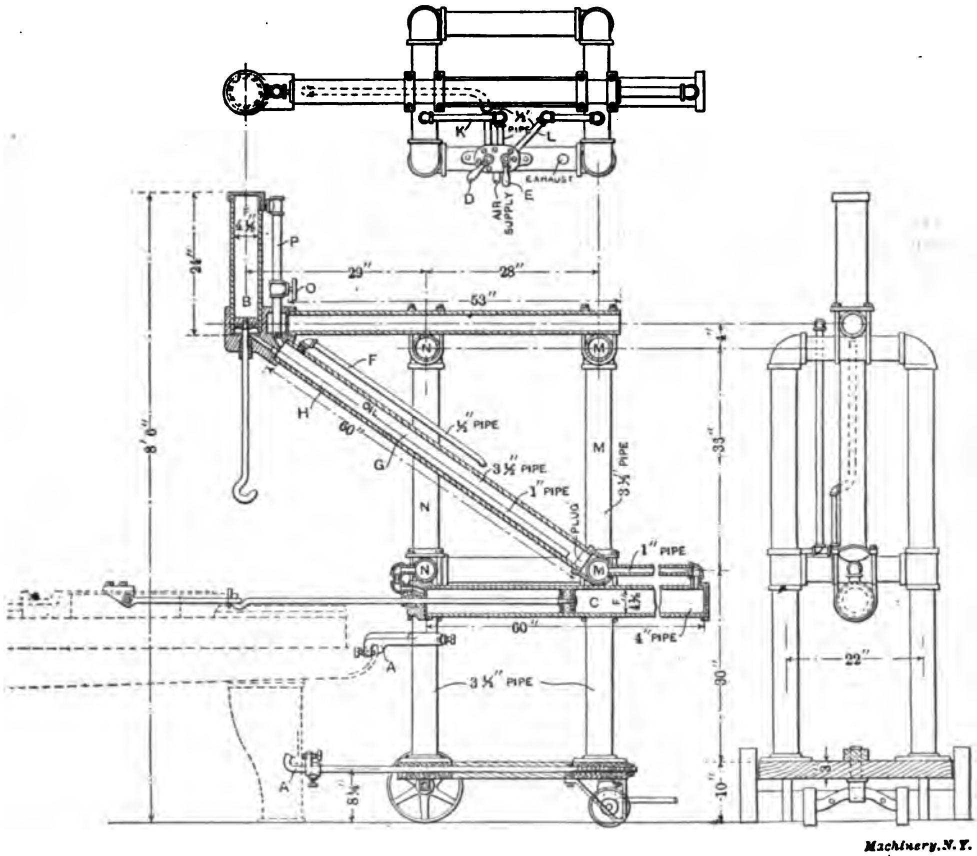
As now understood, mountain sickness is the cumulative result of two physiological phenomena: A congestion of blood in the lungs, whereby the movements of the chest and diaphragm are made more difficult, and a more rapid respiration, due to the necessity for inhaling a larger quantity of oxygen while the atmosphere actually contains less of it. It is plain that the effort thus required will diminish the amount of useful work that a man or animal can render. Relatively slight differences in elevation produce marked effects. Thus, at Sentein, the Bulard mine at 8,150 ft. is worked during the summer by laborers who during the rest of the year are engaged at the Bentaillou mine, at 6,500 ft.; the author estimates that the decrease in efficiency attributable to the diminished pressure of air alone, amounts to about 15 per cent., and yet the workmen are all accustomed to the conditions from their youth. It is not possible to make so close a comparison of efficiencies in the case of the Caylloma mines, since the men engaged in the mines are mostly Indians from the neighborhood, while those working at lower elevations are men of a superior type. The manager of these mines estimates that the loss of efficiency, as compared with workmen at sea level, amounts to about 50 per cent.

Exactly parallel results have been noted in the performance of horses and other animals. At Sentein it required a horse of exceptional strength to make two round trips per day, carrying a load of 50 kg. (110 lb.) a distance of 10 km. (6¼ miles) and climbing from an elevation of 3,260 to 6,520 ft., while in the valley, ordinary horses could readily cover twice this distance, with a load of 100 kg. At very high altitudes horses become disabled, and it is necessary to resort to mules and burros. The usual cost of transporting a piece of machinery weighing 350 lb., requiring a strong mule, is $20; pieces of less weight are carried on llamas at a cost of $10 per ton.

Mines at high altitudes are seldom able to use coal for fuel, owing to the cost of procuring it; wood is the common fuel of such mines. The effects of altitude are to lower the boiling point of water and also to reduce the back pressure of a non-condensing steam engine. At 8,150 ft., water boils at 92 deg. (198 F.) and the back-pressure is reduced to 555 mm. (21.85 in. mercury), and at 16,300 ft. water boils at 84 deg. (183 F.), the air pressure being only 415 mm., as compared with 760 mm. at sea level.

In regard to gas or gasolene engines, the weight of gaseous mixture drawn in at each stroke is approximately proportional to the atmospheric pressure, and while the author has not studied the question experimentally, he estimates that the loss of efficiency in such an engine will be about the same as in the case of an air compressor, amounting to 17 per cent., at 8,150 ft., and 25 per cent. at 16,300 feet. The efficiency of an engine using compressed air, owing to the diminished back pressure, is somewhat increased, but as this efficiency, in an air engine working underground, is seldom over 50 per cent., little of the energy lost at the compressor is regained through the fact that back pressure is diminished.

The highest railway point in the world is claimed for the Morococha branch of the Central Railway of Peru, which reaches an altitude of 15,865 ft. and has the highest station in the world at Ticlo (the junction with the main line), 15,665 ft. The maximum grade on the line, extending from the port of Callao, is 4½ per cent.



PNEUMATIC SCRAPING RIG.

PNEUMATIC HYDRAULIC APPARATUS FOR MACHINE SHOP SCRAPING

In the construction of precision machinery one of the most responsible operations of the shop is the scraping of the sliding surfaces so that they will fit accurately over practically their entire areas. This somewhat tedious operation consists in first rubbing the two surfaces together and then taking them apart and scraping away the initial spots which bear traces of contact. Upon rubbing the surfaces together again the areas of contact will be found to have been increased, but still to require successive rubbings and scrapings before the contact is satisfactory. The successive lifting off and replacing, and the working back and forth sufficiently to indicate the contact make the job a tedious one.

The apparatus here shown, the cut being reproduced from *Machinery,* was specially designed at the Jones & Lamson shops, Springfield, Vt., for this service. It is a combination hoist and pulling and pushing machine operated by compressed air in combination with oil, the air applying a pressure upon the oil which in turn exerts the required pressure upon the operating pistons and ensures steadiness and precision of operation. It is all mounted upon a truck so that it can be conveniently moved from one machine to another.

A lathe bed and slide to be fitted appear at the left of the cut. The machine is securely fastened to the lathe by the clamps *AA* as shown. The cylinder *B* is the hoisting cylinder, and cylinder *C* for the pushing and pulling. Valve *D* controls the pressure in cylinder *B* and valve *E* in cylinder *C*. When valve *D* is opened the air enters through pipe *F* into the oil chamber *G* from which the oil pressure is transmitted to the under side of the piston in cylinder *B*. When the piston and load is to be lowered the air is discharged and the oil returning to reservoir *G* by means of the small pipe *H* prevents a too sudden drop.

When the horizontal movement is to be used the valve *E* admits the air pressure either to pipe *K* or to pipe *L*, from which it is transmitted to the oil in the reservoir formed by the pipes *M* and *V*, respectively. When the pressure is on *N*, the piston moves to the right, pulling the slide, and when the pressure is on *M* the piston pushes the slide in the opposite direction; the air pressure when admitted to one side of the piston being released from the other side. The pipe *P* and the hand-wheel-operated valve *O* permit any oil that may leak by the piston in cylinder *B* to return to the oil reservoir *G*. At the upper end of pipe *P* there is a small vent hole permitting the air above the piston to escape when the hoist is in operation.

CUTTING PROCESSES

Perhaps there are few things commonly done and generically described by a single word which can differ in character so widely and so essentially as do the various cutting devices and operations employed in the industrial arts and elsewhere. The typical cutting, and what the word first suggests, is that which is done with a sharp knife. The perfection of simplicity and ease in cutting is when we can say of anything that it cuts like cheese.

Next to the knife, and not very near it in kind, is the saw. The wedge action of the knife is here abandoned at once, and the teeth of the saw tear and drag the material. The cutting of the grindstone and the emery wheel is almost pure abrasion, so that the wear of journals and slides is a kind of cutting as far as it goes, and when the surfaces become dry and the abrasion is rapid cutting is the word we use for it. A cold chisel driven by a hammer has something of a wedge-like action when cutting soft steel or other tenacious metal, but when it gets to cast iron it rather breaks than pushes the material away; in cutting stone the breaking of the material is more pronounced, and still we call it cutting. Then comes the percussion rock drill, which could never cut stone as a knife cuts, but still works its way rapidly into the rock by its crumbling or pulverizing of the material.

All these ways and means of cutting have their special lines of employment, and in these lines neither could take the place of the other. The rotating twist drill would be worthless in a granite quarry, and the percussion rock drill could not penetrate steel plates or shape the surfaces of castings to precise dimensions in the machine shop. The different processes and apparatus have developed and have found their different employments in obedience to specific demands.

Perhaps nothing ever appeared more clearly responsive to an actual and well defined need of the worker than did the core drill. It is the earth sampler or taster, and tells the planner of great works, which will involve the cutting away of masses of rock and the penetrating to unfamiliar depths, what material will be encountered, so that he may make calculations and preparations in advance. It also tells the seeker for veins and beds of valuable minerals to be mined where he would waste his labour by penetrating and where he might be richly rewarded.

It is a curious thing that, to meet and satisfy this new requirement, we find cutting instruments and cutting processes still different from any of those above enumerated. The cutting of the diamond drill may best be characterized as a scraping action. The surface is scratched and the material is dragged away, being finely comminuted by the process of removal, so the result is the same.

The action of the shot in the Calyx drill, the successful and established rival of the diamond drill, would, at first, seem simple and evident enough. The individual shot, of course, become rollers, and as they pass over the surface, each bearing only upon a minute portion at a time, they crush or disintegrate by the rolling pressure, and the water washes the stuff away. This would seem to be very far from explaining the action when cutting through iron and steel, and we do not here attempt an explanation. Tools, like men, are judged ultimately by their record, and the records in this case not only of actual accomplishment, but of the cost of it, are indisputable. The records of the comparative costs of the cutting or abrasive or crushing elements, whichever we may choose to call them, give the "shot" drill a vast advantage, especially in the production of cores of such diameters as would be prohibitive by any other means practically available.

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EVERYTHING PNEUMATIC

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CONTENTS

McDONALD, THE SUBWAY BUILDER

John B. McDonald died in New York on March the 17th. At the time of his death he was receiving a salary of $50,000 per annum under a five-year contract with the Interborough-Metropolitan Company, and though he will always be known as the builder of the subway he is known throughout the United States as a contractor of rare skill and achievement. He was a poor Irish lad, with but little education, though when he died he was a Doctor of Sciences.

McDonald had a fine personality and was in every sense a good fellow; he was exceptionally companionable, and these characteristics, together with indomitable courage and energy led to his success. We learn from his career how a poor boy, with limited education, but with an abundance of energy and courage and no unusual ability, could push himself to the front and achieve renown and wealth. He was not in the class of shrewd, able, close-calculating contractors. His old partner Ryan, of the firm of Ryan & McDonald, was of this class; McDonald's great faculty was in the pioneer work leading up to and closing a contract, in getting financial backing and in securing sub-contractors or others to do the practical work in the contract which he controlled.

An incident of McDonald's career, which has never been published, occurred at the time of the building of the subway. The writer recalls distinctly a conversation at luncheon in New York when McDonald said that he had just attended a meeting of the board where the question of deciding the proper lengths of the subway stations was up for consideration. He said that he had much difficulty in getting them to increase the lengths of these stations. "Make them twice as long as your engineers have planned," said McDonald, "for the possibilities are very great. This subway," he said, "will be too small in a few years to take care of the traffic, and the stations will all be too small." This seems to have been prophetic, in view of the work which has been going on during the past year in lengthening the subway stations at an expense far beyond what the work would have cost if done when the subway was built.

It is easier to find men who can do good work than to find men who can make others do good work. McDonald was a director of men. He got the best work out of others; he was a man instinctively of high integrity, too honest to make a large fortune out of his opportunities, too kind, generous and unselfish to accumulate. This barefoot boy passed away at a time when his career was at its height and when he was still young. He was buried from St. Patrick's Cathedral on Fifth avenue, New York. One's friends must be legion to fill this cathedral, yet it was packed to the doors by an audience that represented all the walks in life. It was distinctively a New York crowd; the man who carried a pick sat with bowed head by the side of the banker or the judge, and as the great doors of the cathedral swung open and the casket was borne into the aisle, preceded by bankers, judges and business men, the muffled notes of the cathedral chimes sounded the dirge:

Swift to its close ebbs out life's little day,
Earth's joys grow dim, its glories fade away.

And at that moment the power that animates the subway was shut off, the trains came to a standstill and all was dark.

W. L. SAUNDERS.

CHANNELING IN SHAFT SINKING AND TUNNELING

In the *Engineering and Mining Journal* of March 18, the statement is made that Mr. G. E. Wolcott has proposed a method of breaking ground in shaft sinking, drifting and stoping by the use of channeling machines, and it is suggested that the channeling machine used in quarries might replace the usual rock drill.

The suggestion is not new, as the Patent Office records bear ample proof. One of the original patentees on this subject proposed a plan by which a series of concentric channels, some 3 inches in width each, might be cut in the face of a heading or shaft and the material removed en bloc. The difficulty in this, as in all cases where channels are to be cut in rock, is to provide a machine for the purpose. It is an easy matter, for instance, to channel stone in quarries or open cuts where the space is unlimited and where the channeling is usually downward. Machines for this purpose are mounted on a track, they weigh several tons and consume from 15 to 40 H. P. in operation.

Channeling downward is the easiest way to channel, because the weight of the reciprocating parts aids the cutting. The greatest difficulty involved in any kind of channeling is to maintain the bits against a force of blow which is consistent with rapid progress. The wide use of channeling machines in quarries is due to the fact that the kind of stone quarried is usually soft or crystalline in structure, as for instance, marble, limestone and sandstone. Little or no progress has been made in channeling granite, because the material is hard and the progress slow, a hard blow on a chisel point working in an open channel resulting in steel breakages which make it necessary to either reduce the force of the blow or enlarge the width of the cut so as to admit of heavy steels, either of which alternatives entails slow progress and prohibitive expense. It is because of this that the harder rocks can be quarried at less expense by the usual process of drilling and blasting.

Another difficulty is that a machine to do expeditious channeling in a mine or heading occupies so much of the space that it is in the way when mucking is done, or when the material is removed. It must be taken entirely out of the way or shunted off on a siding.

It is really a mistaken idea that there is anything practical about channeling the rock out of a heading. It can be done, but it costs money to do it and that makes it prohibitive. Nobody is likely to pay a high price in mining work in order to get smooth walls to his tunnel or shaft. What is wanted is progress in excavation, economy of work and not aesthetic conditions. It is plain that dynamite when exerting its influence in a drill hole will aid in removing rock cheaper and better than a channeling machine. The channeling machine belongs to a class of work where saving of the rock taken out is important and where the shock of the blast might be serious.

This brings us to the consideration of a limited amount of channeling in order to reduce the shock of blasting, and here is the practical line on which to work. Instead of seeking to cut out the entire heading let the channeling be directed to make, say, a single cut in the heading, through the center vertically or horizontally, or at the bottom, as preferred. This channel might not be over 2 or 3 inches in width, but when made into the face it would make a double bench out of the heading. It would be a release line for the blasting to work to. It should reduce the shock and the amount of powder required. This cut or channel is so simple that it can be made with a machine which is little more than a big rock drill working radially on a column or bar. Such a machine can be channeling while the rock drills are putting in the side holes, so that the whole operation is co-ordinate. A machine in this class, known as the Radialax, is used expeditiously in coal mines and in headings where the material is reasonably soft. It is hoped that its adoption will extend to rock headings and in that way substantially reduce the brutal shocks of heading blasts and minimize the liability of falls in mines which are frequently due to constant, heavy blasting.

W. L. SAUNDERS.

FOR CONTINENTAL RECIPROCITY

The reciprocity negotiations which are now under way between the United States and Canada are believed by many and will undoubtedly mark the beginning of an international agreement between the Republics of the western hemisphere, whereby free trade will be established and all restrictions of trade removed between these countries. Such an agreement cannot fail to result in a closer union of the countries concerned and do more towards their pan-Americanization than all of the other movements combined that have been inaugurated towards this end. At the present time the United States is combating with the problem of the high cost of living and seeking by legislation a means to reduce the prices on commodities controlled by monopoly. On the other hand the Latin-American countries afford the most promising export field for the industrial products of the States and if the barriers of trade were removed these products would find a greater field here and be able to compete more satisfactorily with manufacturers of Europe. The mineral and agricultural products of Mexico would find a ready sale in the markets of the United States and with the vast opportunities which the country affords in this direction a great development would take place. Not only would this movement be true of Mexico but all of the Latin-American countries and a trade would be induced which would be profitable to all nations concerned. The removal of the high import duty on zinc ore by the United States and the admission of manufactured steel commodities free of duty by Mexico, would result in an increase in trade along these lines amounting to millions of dollars annually and the same would be true of other commodities. It is to be hoped that this reciprocity movement which is now under way will not stop with Canada but spread throughout Latin-America as it would mean the beginning of a new era of commerce between these countries.—*Mexican Mining Journal.*

DR. RAYMOND RESIGNS

The resignation of Dr. Rossiter W. Raymond as secretary of the American Institute of Mining Engineers has been accepted by the council of the society. He is thus relieved from the onerous executive duties which have steadily increased and which suggested extensions of the societiy's work must still further augment. Dr. Raymond has been appointed secretary emeritus of the council, his services being retained for special editorial and other duties. We could wish that with his marvelous literary facility he might be able to make some valuable and enduring contribution to the world's treasures of autobiography and reminiscence.

Dr. Raymond was one of the founders of the Institute and in 1871 was elected vice-president, becoming also president the same year upon the resignation of David Thomas and being successively re-elected in the three following years. He has been secretary of the society for 28 years.

Dr. Joseph Strothers, the new secretary, has been connected with the institute as assistant secretary for eight years and as editor for five of those years. He was editor of *Mineral Industry* for four years and for many years was on the teaching staff of the department of metallurgy of the School of Mines of Columbia University.

EUROPEAN TUNNELS

The Loetschberg tunnel is approaching completion, the headings having met March 31st. Advancing at the rate of 27 feet a day on the north side and 19.3 feet on the south side, the tunnel has been driven with remarkable uniformity of progress. On the north side water continues to flow at the rate of nearly 50 gallons per second, and the temperature is 81 degrees, Fahr., while on the south it rises to 90 degrees. The French are preparing a project for driving another tunnel through Mont Ceuis at a much lower level, at the same time reducing the gradients of the approaches. Another tunnel in course of construction and offering interesting features is the one through the Pyrenees connecting Aix-les-Thermes on the Midi line with Ripoll in Spain. From Aix-les-Thermes the railway follows the Merens Valley, and then, to avoid the heavy gradients at Saillens, it makes a complete turn round the Sagnens mountain. The line is then cut through the mountain sides until it reaches the Hospitalet Station. Over this part of the route the line is carried through short tunnels and under rock to protect it from snow and avalanches. From Hospitalet begins the biggest part of the undertaking, consisting of a tunnel 5,330 m. long through Puymorens. On the Spanish side good progress is made through granitic rocks; but on the Hospitalet side the schist rocks contain considerable quantities of water, which necessitates timbering, and the walling and roofing of the tunnel with concrete. It is expected that the new Trans-pyrenees line will be complete in four or five years.

AIR CONDITIONING

The mechanical control of the atmospheric conditions in buildings is of comparatively recent origin. While the necessity for pure air within enclosures has been recognized for many years, efforts have been chiefly confined to delivering outside air without treatment and to removing vitiated air, little attention having been given to the quality of air supplied. It seems to have been the idea that as long as the quantity of air suplied to a building was sufficient all requirements had been met, and there there was either no neeed of controlling the quality of the air or that such control was too costly to undertake. Now, however, it is recognized that efficient air conditioning really involves the regulation of temperature, of humidity and of purity. A supply of clean, fresh air, properly tempered, has a decidedly beneficial effect on the health of the operatives in a factory, and hence upon the amount and character of the work turned out. In foundries, storage-battery plants, potteries and various other manufacturing establishments, it is necessary to remove fumes or dust to protect the workmen. Aside from this hygienic aspect it is well known that in certain factories the successful operation of the manufacturing processes is to a large extent dependent upon the atmospheric conditions in which the work is conducted. This is especially true of the manufacture of textiles, gelatine products, photographic films and confections. In other places, such as coal mines and flour mills, the removal of fine particles of floating dust is imperative to prevent explosions, and it is in connection with the prevention of coal-mine explosions that air conditioning becomes such an important question. In cities where air is polluted by dust and smoke, no system of air conditioning can be complete that does not involve the use of air purifiers which consist either of cloth filters or of washers; the latter removing dust or other floating matter, and to a certain extent the soluble gases, by means of sprays or films of water. Air can be supplied to buildings by mechanical means with great uniformity as to quality and quantity, and in many cases the increased efficiency of employees more than offsets the cost of installation of the necessary ventilating plant.—*Enginerring Record.*

WORLD'S GLYCERINE SHORTAGE

By W. Cullen.*

Most people know that the basis of the explosives which are consumed on the Rand, and indeed throughout South Africa as a whole, is nitro-glycerine. One might even go further and say the same holds for mining throughout the world, but this was not always so. In spite of the invention of compositions which were alleged to be many times as strong as nitro-glycerine, this body and explosives having it as their base now occupy a position which for rough and ready work is absolutely unchallenged, and will probably remain so. Nitro-glycerine, as you know is made from glycerine, which is a by-product of the soap and candle industry. It is not so very long ago since it was run to waste, and this continued until indeed nitro-glycerine found its place in the world of explosives. Now it has a value of £100 to £110 a ton, and the reason for this phenomenal advance may well

*From the Journal of the Chemical, Metallurgical and Mining Society of South Africa.

be asked. The question is easily answered. Quite apart altogether from the unique position of nitro-glycerine explosives as compared with others, their consumption as a class has increased enormously during the past two decades, but the phenomenal increase has been during the past decade. Every power which has a standing army has adopted powder which contains nitro-glycerine in greater or lesser proportion. This applies to the Japanese, among others, and Dr. Weiskopf is now manager of the factory where the explosives are made for the navy. Then, take our own South Africa. Within the last ten years the consumption has more than doubled; in Canada during the same period it has probably quadrupled, and even in the older European states the increase during the same period has been phenomenal. Then the Panama canal itself could take the entire production of Modderfontein or Somerset West. All this increase would not matter so much if the industries from which glycerine comes as a by-product were expanding correspondingly, but this is not so. People may be using more soap, but it is questionable whether they are using more candles. At any rate there has not been an expansion corresponding to that in the consumption of explosives, so the only thing which could possibly happen has happened. There is a shortage and prices have soared up. Some people are unkind enough to advance other reasons, but the one I have given is the true one and can be verified by independent examination. The position in a very short time, if it is not to-day, is that there is not enough glycerine to go around. The outlook is exceedingly serious, and that is why I sound this note of warning. People in the "know" have been trying to find a substitute for blasting gelatine for the past few years, and I am giving away no secret when I say that none has been found as yet, nor do I think it will be. Gelignite and gelatine dynamite do not offer so much difficulty, but I cannot give you the composition of any of the "substituted explosives" because I do not know them myself yet. I am safe in saying, however, that the existing processes at Modderfontein will be profoundly altered, as they will be in almost every factory in the world. How about mining? If a substitute for blasting gelatine is not found will our mining methods want modifying? My impression is that they will want profound modification. We shall have to find this out, and it is imperative that we start doing so now, for the changes which I have indicated will come about very soon. I appeal to mine managers and others to let us have facilities for carrying out experiments, and to assist us in every way they can, because although I am rather the reverse of an alarmist I must give it as my considered opinion that the position is a most serious one. Certainly explosives will not be lower in price for a very long time to come.

MAKING PERFECT BLUE PRINTS

Many novel and patented devices have from time to time been designed for the purpose of ensuring clear blue prints when printing in large frames. One of the simplest of these has been in use in a Belgian factory for many years, and has proved satisfactory in every way. In this factory the prints, which are in many cases of huge steam engines, have to be made an exceptionally large size, and the difficulty of ensuring perfect pressure of the paper in the frames is overcome by using thin rubber cushions the size of the frames, which are placed between the paper and the wooden back. Air is then blown into these cushions by means of the mouth, which gives just sufficient pressure to ensure perfect contact, without bulging the wooden back or the large glass front of the frame. By using this simple device the largest prints can be produced with perfectly sharp lines all through, and spoiled and blurred prints are entirely avoided.—*The Dodge Idea.*

SPIDER-WEB FISHING NETS

It is no longer possible to doubt that the natives of New Guinea use spider-webs for fishing-nets. A medalist of the Royal Geological Society, who has been traveling in New Guinea, reports that the natives bend the tip end of a long bamboo rod in such a way as to make a loop five or six feet in diameter. They set up this arrangement in the forest where the spiders are thickest, and wait for the insect to weave her web in the loop. The web has a mesh about one inch square at the outside, which gradually decreases in size to not more than an eighth of an inch square at the center. The native uses this as a scoop-net as he stands in the stream and dips the fish out as they come near. It is strong enough to hold fish weighing a pound. The spider which makes it has a body about the size of a small hazelnut, with legs that spread out two inches.

WATER IN MINES

The depth at which water may be reached in an undeveloped mine, and the amount that will be present when it is reached are very uncertain. At many mines the water-level is surprisingly near the surface; altitude and topography have little influence. For instance, on Mount Union, southeast of Prescott, Arizona, the water-level in mines not drained by adits is close to the surface. This is at an altitude of nearly 8,000 ft., though down the valley of the Hassayampa river, which heads on Mount Union, there are mines over 209 ft. deep in which no water has been found. Some mines make a large volume of water between the surface and the 1,000-ft. level, but little or none below that depth. The Silver Islet mine, situated on a small island in Lake Superior, was worked to a depth of 500 ft., and was a remarkably dry mine.

COSTLY COMPRESSOR SAVING

In driving the Rivermont Tunnel on the Lynchburg cut-off of the Southern Railway, as described in a recent issue of *Engineering Record,* an unfortunate experience resulted from the use of steam instead of compressed air. A section of tunnel 360 ft. long, driven with much difficulty, was lost as the result of a fire which destroyed the crown timbering and threatened for a time to wreck the entire tunnel. A steam-shovel operated by steam had been allowed to stand in one place for some time, with the result that the timbering immediately above was dried out and took fire either from a spark or from the heat of the exhaust. An air-compressor plant had been installed, but the capacity was not great enough to supply both the drills and the shovel, and steam was therefore used for the latter in preference to installing an additional compressor. The decision to use steam was believed justified because of the large amount of water in the ground, resulting in thorough saturation of the timber as soon as it was placed. Had there been no change in the ground conditions the use of steam in the shovel might have been unattended by mishap, but the driving of the tunnel served to drain the water from the ground, and the creation of air currents through the tunnel after the headings met tended further to remove the moisture.

NOTES

A mixture of Pintsch gas with air is explosive within a gas percentage range of 5 to 13 per cent., and it develops its maximum power at about 9 per cent.

Mineral wool is glassy slag blown by compressed air into minute hair-like shreds. It is used as a non-conductor of heat for fireproofing and similar purposes. This is entirely different from steel wool, which consists of very fine steel shavings mechanically produced.

Experiments made by Russian investigators prove conclusively, according to *Practical Electricity and Engineering* that rubber is best preserved by immersion in distilled water. The preservatives tried were distilled water; lime water; soda, glycerin, carbolic, and boric acid solutions; alcohol; ammonium carbonate and benzine vapors; air; and vaseline and talcum powder.

A flight of stairs has been erected in Paris over which 14,000,000 persons have shuffled without so much as scratching the surface. These steps are almost as imperishable as if they had been built of huge diamonds, for in the concrete of which they are constructed a generous proportion of carborundum has been introduced, and since carborundum is almost as hard as the diamond, it has given the concrete a wearing quality which no marble or granite could possibly approach.

A power transmission plant is being erected at Lauchhammer, Germany, designed to generate current for transmission at a pressure of 110,000 volts, which is stated to be the highest voltage used for power transmission in Europe. The current transmitted is three-phase; the generator pressure is 5,500 volts, which is transformed up to the transmission voltage by four transformers, each of 6,800 kilowatt capacity.

According to Consul General Alexander M. Thackara, of Berlin, the greater number of factories use acetylene for welding in preference to hydrogen. Although the prices of acetylene and hydrogen are practically the same, German engineers claim that it requires from three to five times as much hydrogen as acetylene to do a given piece of work, while hydrogen is not suitable for welding pieces more than 0.215 in. in thickness.

In the molten state aluminum absorbs nitrogen; the hotter the metal the greater is the absorption. The absorption of nitrogen from the atmosphere may be readily appreciated if a mass of aluminum skimmings be wet with water. Within a short time the mass will smell strongly of ammonia, showing that the water has been decomposed by the aluminum and formed ammonia from the nitrogen in it.

The term Baume gravity, which is in familiar use among petroleum operators and refiners, is apt to be confusing to those who are not acquainted with the method by which the system of units was established. For liquids lighter than water, among which is mineral oil, the Baume measurements are opposite to those of specific gravity. That is to say, the greater the specific gravity of the oil, the lower the Baume measurement, and vice versa.

Lifting gravel from a depth of about five hundred feet by means of compressed air is soon to be attempted on the property of the Crowley Brick Company, near Crowley, La. A pipe and device, such as are used in bringing oil to the surface in wells in Texas and Louisiana, are being installed by L. L. Lyons and John Burgin, who are experienced men in oil lifting operations. It is claimed that the gravel can be lifted from this great depth at comparatively small cost.

The loss of power in a gas engine owing to its installation at considerable elevations above sea level may be roughly estimated at about 3⅓ per cent. for each thousand feet. The decrease in barometric height is about one inch for 950 feet of altitude. This means that the weight of a given column of air will decrease by about one-thirtieth at the same time The weight of fuel taken in per revolution we may assume will be decreased in the same ratio, and also the number of heat units available.

In order to make his storage battery absolutely fool-proof, Mr. Thomas Edison devised a machine for abusing the battery in every known way, but Mr. Edison had to admit that when it came to inventing methods of abusing electrical apparatus, he could not compete with the "fool" operator. Try as he would to forestall every conceivable method of injuring the apparatus, some stupid man would devise a new and unthought of method for putting it out of business.

A motor fuel for aeroplanes should be chemically pure, of the lowest possible specific gravity, of the highest possible heat productivity, free of constituents with a high boiling point, and should not deposit any soot in the mechanism. The new petroleum product, aerobenzine, is of exceptional value. Its specific gravity should be from 0.620 to 0.590, and it should boil with the heat of the hand. The lower its specific gravity the purer it is. Aerobenzine must be kept in thick-walled hermetically sealed vessels that can stand great pressure.

From recent experiments in Germany it appears that, at a sufficiently high temperature, every kind of glass is completely soluble in water. Upon pressure, glass dissolves in water at 410 degrees, F. Seawater at a depth of 660 feet will not boil at that temperature, and if it penetrates the earth's crust where the temperature is equally high it will, apart from the pressure, liquefy the silicates or glassy rocks. The experiments point to the conclusion that at a depth of about five miles silicates in contact with water are virtually liquid, and that the level of aqueous fusion is five times nearer the surface than is that of igmous fusion.

The total output of all the air compressor plants employed on the Panama Canal work during the year ending June 30, 1910, was 7,227,203,513 cu, ft. of free air and the average cost was 4.03 cts. per 1,000 cu. ft.

Compressed air sewage ejectors were installed a few years ago in Guildford, England, to raise sewage from low lying areas and permit it to discharge into the basins at the sewage treatment works. There are eight of these ejectors in use with capacities ranging from 50 to 1,200 gals. per min. The compressed air for operating them is furnished by a power station, located adjacent to the town refuse destructor. The waste heat from this destructor generates sufficient steam to drive the air compressors which raise the sewage.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 7.

985,792. SUCTION AIR-STRAINER. ALEXANDER ENGLAND, Wilkinsburg, Pa.

985,864. CONTROL-VALVE FOR WATER-JACKETED PUMPS. WALTER V. TURNER, Edgewood, Pa.

1. The combination with a water jacketed pump for compressing fluid, of means governed by the starting and stopping of the pump for controlling the admission of water to the water jacket of the pump, said means being also adapted to cut off the admission of water upon a pre-determined reduction in the pressure of the compressed fluid.

985,945. VACUUM-CLEANER. JOHN FRANCIS SHEA, Philadelphia, Pa.

985,957. RECEIVING APPARATUS FOR PNEUMATIC-DESPATCH SYSTEMS. HAROLD D. WATERHOUSE, Norfolk Downs, Mass.

985,965. PNEUMATIC CLEANING APPARATUS. ERNEST L. B. ZIMMER, Minneapolis, Minn.

985,966. DEVICE FOR TAKING MOISTURE OR OTHER VAPORS OUT OF GASES. HORACE W. ARNOLD, Vancouver, Wash.

985,972. TRACK-SANDING DEVICE. FREDERIC D. BOWEN and MENAN C. HAGLER, Monett, Mo.

985,986. MEANS FOR REMOVING AIR FROM HYDRAULIC TRANSMISSION-GEARS. RUDOLF EISERMANN, Berlin, Germany.

986,048. APPARATUS FOR REGISTERING THE FLOW OF FLUIDS. ALFRED J. DIESCHER, Pittsburg, Pa.

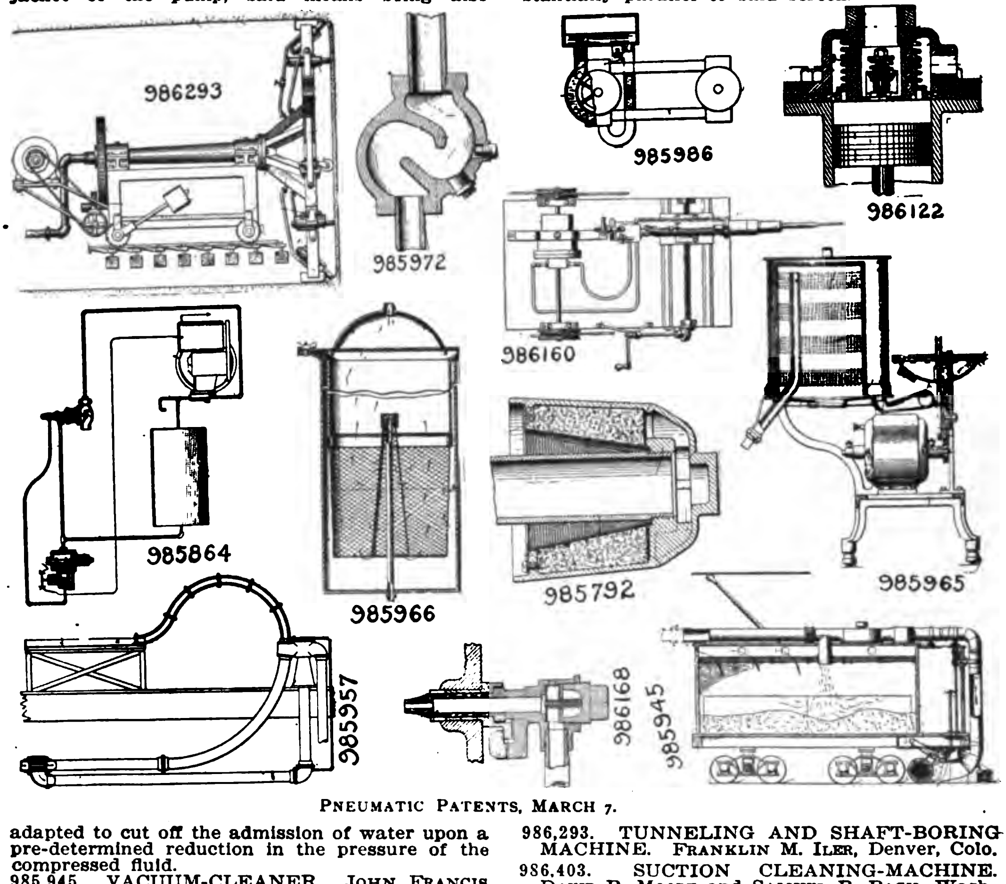
986,098. PNEUMATIC OPERATING DEVICE FOR STREET AND STATION INDICATORS. PERRY T. SPINDLER, Chicago, Ill.

986,122. VALVE MECHANISM FOR AIR-COMPRESSORS. JOHN ASTROM, Fort Wayne, Ind.

986,160. PNEUMATIC-HAMMER. CHARLES B. FRENCH, Kingston, Pa.

986,168. LOCOMOTIVE TRACK-SANDER. JOHN H. HANLON, Somerville, Mass.

1. In a pneumatic track sander the combination of a substantially horizontal conduit leading to an air nozzle, a screen located in said conduit and a second conduit entering said first conduit at a point just behind said screen and substantially parallel to said screen.



PNEUMATIC PATENTS, MARCH 7.

986,293. TUNNELING AND SHAFT-BORING MACHINE. FRANKLIN M. ILER, Denver, Colo.

986,403. SUCTION CLEANING-MACHINE. DAVID P. MOORE and SAMUEL B. PACK, Washington, D. C.

986,423. FLUID-METER. EDGAR P. COLEMAN, Buffalo, N. Y.; Robert H. Coleman, administrator of said Edgar P. Coleman, deceased.

MARCH 14.

986,495. PROCESS OF MAKING GAS. JOSHUA JOHN NIX, Alhambra, Cal.

1. The method herein described, of making a combustible gas, which consists in precipitating carbonaceous material into a receptacle, heating

said carbonaceous material with a restricted supply of air, inducting into said receptacle a supply of powdered carbon by aid of a partial vacuum, and supplying to said first-mentioned carbon and said powdered carbon within said receptacle a supply of steam.

986,502. ROTARY COMPRESSOR. AMANDUS CHARLES ROESSLER, Wandsworth Common, London, England.

986,577. APPARATUS FOR THE PRODUCTION OF COMPRESSED AIR. MICHAEL KIRILLOWITCH KIRILLOFF, Bakou, Russia.

1. The combination, in apparatus for the production of compressed air, of a bottomless bell, a tubular extension connected at the upper end thereof, a closing cap for the upper end of said tubular extension, and a concentrically arranged receptacle within the aforesaid tubular extension fitted at its lower end with a valve for effecting communication between the bottomless bell and said concentric receptacle, substantially as set forth.

986,663. ARTIFICIAL-GAS BURNER. JACOB WEINTZ, Cleveland, Ohio.

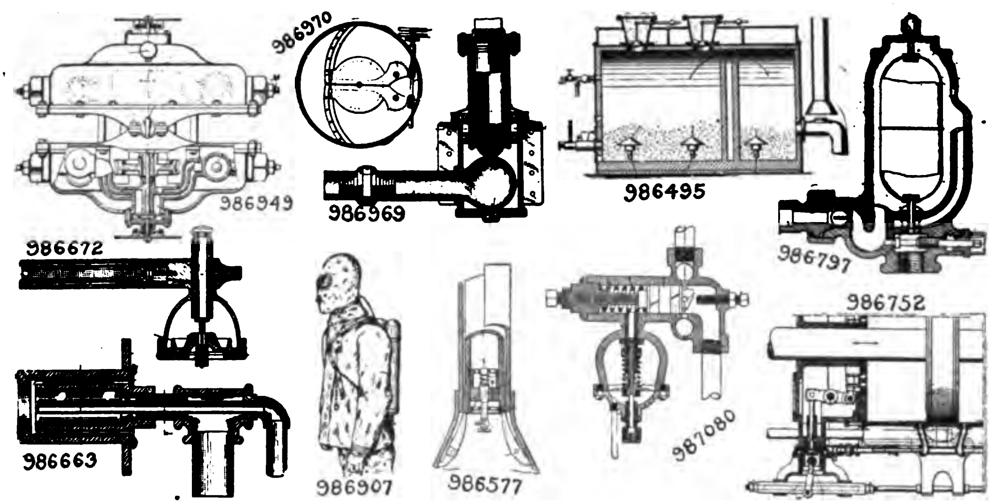
1. A gas burner, comprising three concentric tubes having a common orifice, a gas supply pipe connected with one of the tubes, an air supply pipe connected with another of the tubes, the rounding channel in communication with the chamber, a steam pressure outlet from the channel, a piston chamber and a piston therein, adjustable means to limit the piston's movements, resilient means to force the piston to close the steam pressure entrance, and cushion its return movement; an air pressure entrance to the piston chamber, a spindle valve adapted to close said entrance, and a diaphragm operative by air pressure to move away from the spindle valve and open the air pressure entrance to the piston chamber.

MARCH 21.

987,137. APPARATUS FOR BLOWING GLASS CYLINDERS. HARRY F. HITNER, Mount Vernon, Ohio.

987,158. POWER-GENERATOR. WILLIAM J. NEILSON, Elmhurst, N. Y.

1. A generating chamber, a perforated mixing chamber therein, means for injecting air into said mixing chamber, means for injecting hydrocarbon into said mixing chamber including a coil surrounding said mixing chamber, and means for injecting water into said generating chamber including a perforated coil surrounding the said mixing chamber, for the purpose and substantially in the manner described.



PNEUMATIC PATENTS MARCH 14.

third tube being divided into a plurality of longitudinal passages communicating at their outer ends with the atmosphere, and means for controlling such communication.

986,672. COMBINATION PRESSURE-GAGE AND PUMP CONNECTION FOR PNEUMATIC TIRES. DAVIS BARNARD, Los Angeles, Cal.

986,752. BLOWING-ENGINE OR COMPRESSOR. GUSTAV B. PETSCHE, Philadelphia, Pa.

986,797. STEAM, AIR, AND WATER TRAP-VALVE. JOHN E. BOEGEN, Berwyn, Ill.

986,907. RESPIRATORY APPARATUS FOR FIREMEN OR OTHERS. CHARLES E. CHAPIN, Elmhurst, Cal.

986,949. PNEUMATIC HOISTING-ENGINE. JOHN S. SHIELDS and WILLIAM LAMB, Detroit, Mich.

986,969. VEHICLE-SPRING. CARLOS ESCALANTE and JOSE PATRICIO SIRGADO, Merida, Mexico.

986,970. AIR-LOCK. WILLIAM H. FLAHERTY, New York, N. Y.

987,080. STEAM AIR-PUMP GOVERNOR. WILLIAM K. RANKIN, Philadelphia, Pa.

1. In a steam air-compressor governor, a chamber having a steam pressure entrance, a surrounding channel...

987,160. CONSTANT-PRESSURE INTERNAL-COMBUSTION APPARATUS. EDWARD P. NOYES, Winchester, Mass.

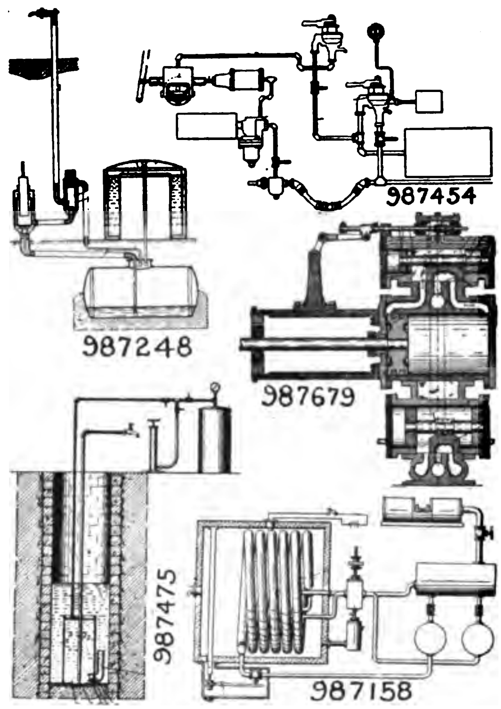
1. A generator for constant-pressure internal-combustion motor-systems comprising a closed combustion-chamber, a burner at the entrance thereof having passages for compressed air and fuel, an automatic resistance-valve at said entrance operated by the pressure of one of said fluids for controlling one or more of the fluids, and means in the path of one of the fluids immediately back of the point of issue thereof for producing a twisting motion of said fluid in the combustion-chamber.

987,248. DEVICE FOR FEEDING LIQUIDS. CARL MARTINI, Berlin, Germany.

987,454. AIR-BRAKE. JOHN W. ERSKINE, Mount Hope, W. Va.

987,475. WATER-DISTRIBUTING SYSTEM. HERBERT EDWIN MARTIN, Colorado Springs, Colo.

1. A water distributing system, comprising a tank adapted to be immersed in water, and having on its inner side near the bottom a ball valve, a pipe leading from near the bottom of the tank out through the top thereof and provided with a faucet, an air pipe leading from the top of the



PNEUMATIC PATENTS MARCH 21.

tank, a compressed air tank to which the air pipe is connected, an air pump, a flexible pipe connecting the pump with air pipe, and valves in the air pipe, one on each side of the connection of the pump with the said pipe, the valve farthest from the air tank being a three-way valve and having an opening in its casing with which one of the ports of the valve is adapted to register.

987,575. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. OTTO HIGEL, Toronto, Ontario, Canada.

987,679. AIR-LIFT DISPLACEMENT PUMP. FRANK S. MILLER, Indianapolis, Ind.

1. In a displacement pump system, the combination with a pair of tanks having inlet and delivery pipes, and a compressor having delivery pipes leading into the two tanks, of a valve for controlling flow of air to and from said tanks, an air meter arranged between the compressor and said valve, and intermediate connections between said meter and valve for controlling th movement of the valve.

MARCH 28.

987,729. LIQUID AIR-LIFT. AUGUST LONG, Richmond, Va.

987,820. VACUUM CLEANING APPARATUS. PITMAN W. PARKER, San Diego, Cal.

987,837. APPARATUS FOR DRYING GRAIN. GRAY STAUNTON, Chicago, Ill.

987,870. PUMPING MECHANISM FOR VACUUM-CLEANERS. ABRAHAM LINCOLN FRAME, Reading, Pa.

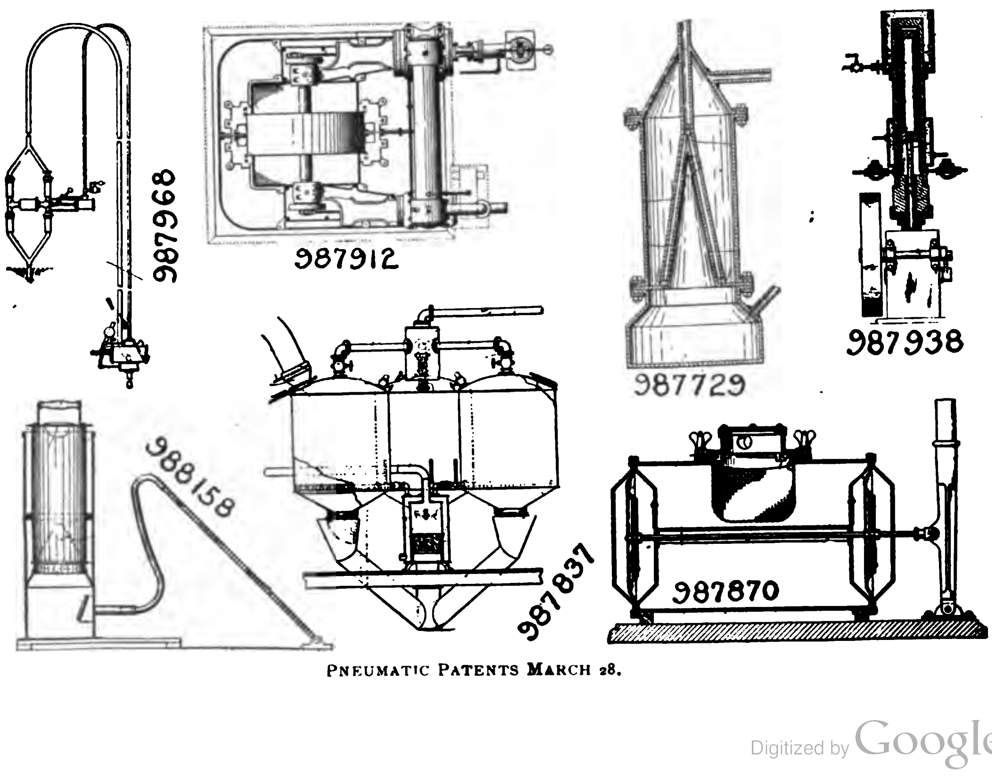
987,912. AIR-COMPRESSOR. WILLIAM PRELLWITZ, Easton, Pa.

987,938. HEAT-ACTUATED GAS-PUMP. CHARLES A. ANDERSON, Chicago, Ill.

987,968. METHOD OF SIPHONING FLUID. ROWLAND W. DAVIES, Pittsburg, Pa.

987,990. CONTROLLING DEVICE FOR PNEUMATIC PIANO-PLAYERS. HENRY S. HORNBECK, Elizabeth, N. J.

988,158. SUCTION DUST-REMOVING APPARATUS. HARRY WHITFIELD, London, and SAMUEL LAING WHITFIELD, Bedford Park, England.



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COMPRESSED AIR MAGAZINE

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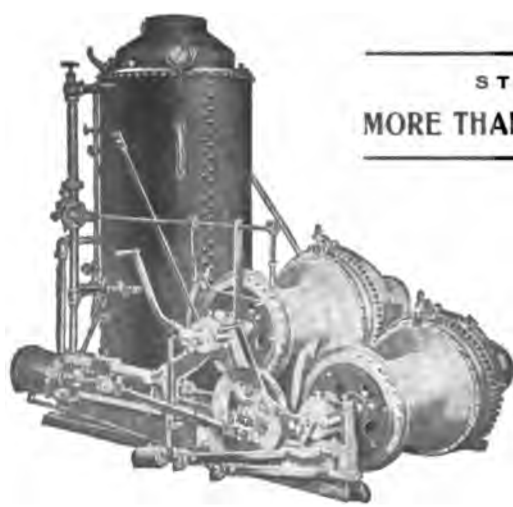

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV | JUNE, 1911 | No. 6

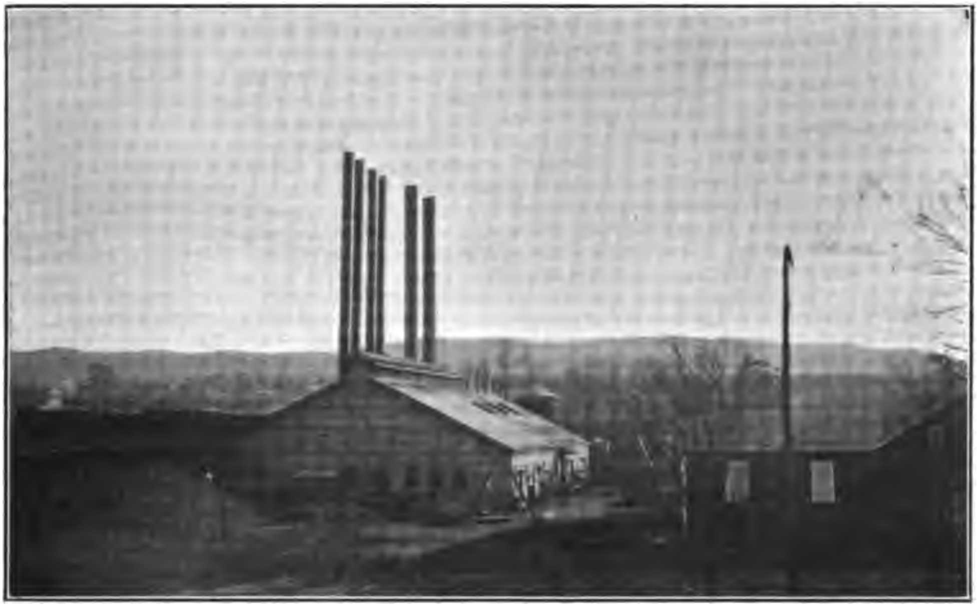


FIG. 1. COMPRESSOR HOUSE AT HIGH FALLS, N. Y.

THINGS WORTH WHILE IN COMPRESSED AIR PRACTICE

By Frank Richards.

To those most familiar with compressed-air practice in the United States, it would seem that the possible economies and the best efficiencies have been worked out and adopted quite slowly, if not almost with reluctance. And yet the period covered from the beginning of the modern, and now general, employment of compressed air for power and other purposes is not much more than a quarter of a century. It was adopted at first upon compulsion and not by choice. For the driving of rock drills in tunnels and mines there was no other means in sight, and its employment became imperative also for resisting the inflow of water where men were employed below water level, for example in the sinking of caissons for bridge piers and other foundations.

These and the numerous other industrial uses of compressed air which have so rapidly developed have made a sure and permanent business for compressor builders; yet, while compressed air was thus adopted with the evident assurance that its employment was to continue and to constantly grow, there was rarely any apparent attempt to get the most out of it for the least possible cost. The compressing plant, almost always steam driven, was generally of a provisional or temporary character and wasteful in nearly every particular. The typical air compressor of that day, the standard compressor of the most prominent builders, was a plain slide-valve steam engine with a single-stage air-compressing cylinder; steam was furnished by any old boiler which could be made available; engineers and firemen had a hard time of it, and compressed air was charged and discredited with the wastefulness of the entire system.

Without going into figures at all, it is quite safe to say that, in typical and entirely up-to-date plants of the present day, the air is delivered much more satisfactorily and reliably, and at not more than one-third of the net cost for fuel and labor as compared with the majority of plants of only 20 years ago. This astonishing advance and improvement has not come in consequence of any new discoveries which have been made relating to principles involved in compressing, transmitting or using compressed air, nor of any revolutionary mechanical inventions in this field. Practically all that is known about air, its properties and its action under given conditions was known already to scientists and investigators, and it has now become known and been practically applied by engineers.

FIG. 2. INTERIOR OF COMPRESSOR HOUSE.

THE PRINCIPAL ECONOMIES AT THE STEAM END.

In the steam-driven air-compressing plant, the improvements have been greater in the steam drive than in the air compression. Although, owing to the character of the work, a large air-compressing plant is frequently to be regarded as a temporary one (as, for instance, for the tunnel and subway and railway station excavations of New York City, or on the large contracts of the Catskill Aqueduct) still it is found to pay to install all the devices and arrangements of an economizing character which would belong to the most permanent lines of employment.

In the magnificent installation of the T. A. Gillespie Co. for the Rondout Siphon, at High Falls, N. Y., part of the new Catskill Aqueduct system, all the familiar steam economizing devices were employed, such as high-pressure steam (150-lb.) and compound steam cylinders, with condensers, feed-water heaters and economizers. This installation, by the way, is believed to be the largest high-pressure air-compressing plant in the world.

It is customary to think only of the fuel saving in such a case as this, but the labor saving also cuts a figure which quite compels notice. Here were ten large duplex Corliss, compound steam, two-stage air Ingersoll-Rand compressors running day and night up to full capacity, developing over 4,000 HP. and delivering 24,000 cu. ft. of free air per minute compressed to 110 lbs. gage, using 100 to 110 tons of "birdseye" coal per day, with hand firing; and yet the entire operating force, including engineer-in-charge, was only eight men to each 8-hr. shift.

Fig. 1 gives a general view of the exterior of this plant and Fig. 2 shows as much of the interior of the compressor room as it seems to be possible to get into a single view. As descriptions of this interesting plant have been published.* it is not necessary here to go more into details, except upon the special topic before us, and thus we come at once to one of the things worth while which are there employed, but which are not as generally adopted as they should be.

AFTERCOOLERS.

An aftercooler is a desirable addition to an air compressor. It at once brings the air down to nearly normal temperature, thus reducing its volume. This saves pipe friction and sometimes even permits the use of a line pipe of somewhat smaller diameter. In the High Falls plant, there is a large and efficient aftercooler connected to each pair of compressors, through which all the air passes before entering the distributing pipe. One of these after-

*COMPRESSED AIR MAGAZINE, June, 1909.

FIG. 3. AFTERCOOLER AND RECEIVER.

FIG. 4. INTAKE AND DELIVERY PIPES.

coolers with its companion air receiver is seen in Fig. 3. The air from the compressors enters the aftercooler at the top and passes out of it at the bottom into the air receiver, and then out of the air receiver near the top at the side toward the wall through a pipe which cannot be seen in this view.

The cooling surface provided in the aftercooler consists of a large number of vertical brass tubes of small diameter, and as the water is inside the tubes, with only sufficient head to cause the proper circulation, while the air pressure is outside the tubes, they can be made, and are made, very thin. These tubes are accurately spaced to gives the same air space around each, and as the symmetrical grouping of circular figures naturally assumes the hexagon, the steel shell of the aftercooler is made of this shape (as shown in Fig. 3) to correspond, leaving about the same air space around the tubes as between them. The total air space corresponds to the capacity of the air pipe, so that in the movement of the air through the aftercooler all the cooling surface of the tubes is effective without the use of baffle plates or other devices. The water circulates upward through the tubes while the air flows downward around them, the final cooling of the air thus being done by the coolest water.

In the view of a part of the outside of the compressor house, Fig. 4, we see the air pipes leading from the receivers down to the line pipe in the ground. The upright boxes, against

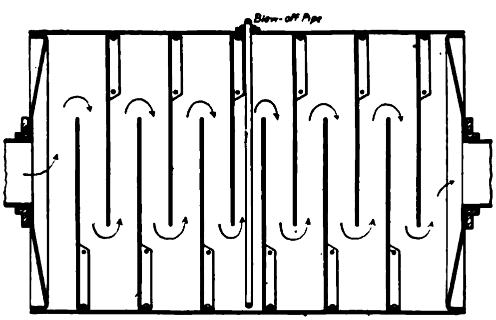


FIG. 5. SEPARATOR IN MAIN.

the building with wire gratings at sides and top enclose the air intake pipes.

SEPARATING THE WATER FROM THE AIR.

Besides the cooling of the air and the reduction of volume effected by the aftercooler, a more important service expected of it is the

FIG. 7. AIR PIPE CROSSING HIGHWAY.

elimination of the surplus water in the air after compression. All free air as taken into the compressor contains much moisture, the normal amount being say, one-half as much as would completely saturate it. Then when the air is compressed, as in this case, to one-eighth of its normal volume, there is certain to be a lot more water than the air will sustain. This surplus water, if not got rid of, becomes a source of serious trouble both in the transmission of the air and in the ultimate use of it in drills or elsewhere.

When the air is at its highest pressure and at its lowest temperature, as it should be just after passing the aftercooler, both the high-pressure, or reduced volume, and the low temperature are conditions which reduce the moisture-bearing capacity of the air, and then is the time when the air will surrender the greatest amount of water. Water and oil are accordingly deposited in the air receiver and can be drawn off as frequently as the accumulation may demand.

This is quite simple in the telling of it, but in practice only partial and unsatisfactory results are secured by this arrangement. Water in air, when not in sufficient quantity to saturate it, is evenly distributed all through the air as invisible vapor. After the saturation point is reached, the surplus water will still be distributed all through the mass of air, but this time as actual and to some extent visible globules of water. These are, of course, heavier than the air and in time would descend through the air as a kind of rain and accumulate along the line of pipe or in any largement of it, and the air passes through it in the regular course of business. As it passes through this separator it zigzags up and down past the baffle plates and deposits the water upon their surfaces. This water accumulates in considerable quantities, and is drawn or blown off by the little vertical pipe shown in the sketch. The baffle plates at the bottom of the separator have holes or passages through them so that all the accumulated water can reach the blow-off pipe. On account of the pressure always existing in the separator, the water may be drawn off from the top, as shown, as easily as from the bottom.

FIG. 6. KETTRING SEPARATOR IN PIPE LINE.

containing vessel when the movement was sufficiently slow and protracted. In the rush of the air through the ordinary receiver or pipe line, however, all the water has not the time to settle, and much of it may be carried along to where it will constitute an annoyance or a source of much inconvenience.

SEPARATOR IN PIPE LINE.

This was just the experience at the High Falls plant. The water could not be satisfactorily removed at the receivers and there was trouble at the drills. Then the separator, the design and operation of which are sufficiently indicated in Fig. 5, was connected into the pipe line near the power-house. The pipe being horizontal, this is simply an en-

The plant of another Catskill Aqueduct contractor, that of George W. Jackson, Inc., contract No. 54, near Dunwoodie, N. Y., is quite different from the one at High Falls. This contract covers about three miles of tunnel, in clean, solid rock, driven from three shafts and a portal, giving seven headings to work at. The compressor plant comprises six two-stage Ingersoll-Rand compressors with a total free-air capacity less than one-half of that at High Falls. These compressors are driven by electric motors which take current from a power-house in the city of Yonkers.

There are no aftercoolers here, so that the air as it leaves the compressors and passes through the receivers is not then cool enough to surrender its moisture as it should. As it flows along through the pipes, however, its temperature soon falls and the water, as we might say, forms a rain in the pipe and accumulates in a flowing stream along the bottom. As the pipe it not level but follows the ups and down of the ground surface, opportunities for drawing off the water are offered at the low points, and at several of these points effective separators or draining chambers have been inserted, designed by Mr. N. R. Kettring, the master mechanic who had charge of the installation.

This separator is a simple cast-iron cylinder with flanges to which cast-iron heads are bolted. The heads are bored eccentrically, as shown, and threaded for the pipe. The eccentricity brings the top of the line pipe at the top of the cylinder, so that the water accumulates in the bottom and may be drawn off as required. The line pipe is partly 8-in. and party 6-in. The same size of cylinder is used for either size of pipe, the heads being bored and threaded for either size as required. The cylinder is 20 ins. in diameter and 5 ft. long.

On a smaller pipe line I have known a satisfactory water pocket to be formed by inserting in the line a tee of about double the pipe diameter and bushed at each end to fit the pipe. In the side opening of the tee, pointing downward, was inserted a short piece of pipe the full size of the tee, closed at the bottom with a cap and a draincock.

In Fig. 6 we see one of Mr. Kettring's separators picturesquely located at the low point of the 6-in. pipe line between shaft No. 1 and the portal at the northwest end of this contract.

TIGHT PIPING.

Fig. 7 is the portion of the line just beyond the view in Fig. 6, this view being taken from the other side of the pipe. The line is here carried over a highway much frequented by automobiles and other traffic. From this point, the pipe is led by an easy slant to the ground, along which it then descends steeply until the scene of Fig. 8 is reached at the side of and immediately overlooking the portal approach.

In these three views, we get a glimpse of perhaps one-eighth of the main pipe line for this contract, suggesting the difficulties encountered in the piping job as a whole. The piping is all bottle-tight, and it may be said that if tight-piping could be had here it can be had anywhere, and air leakage is not a thing which should be expected or permitted.

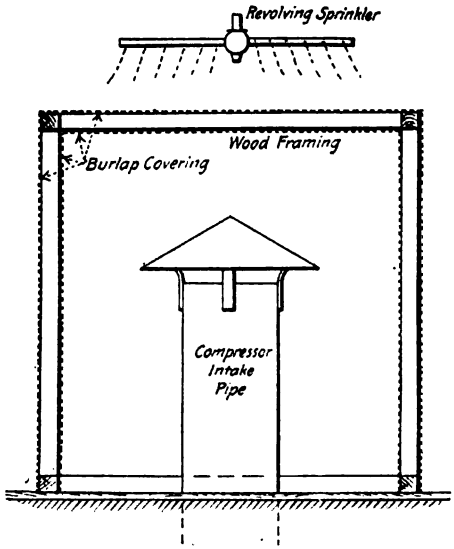


FIG. 9. INTAKE STRAINER AND COOLER.

REHEATERS.

The air receiver seen in Fig. 8 is 54 ins. in diameter and 12 ft. high. Similar receivers are located at each of the shafts, to steady the working pressure and also to provide a final opportunity for the accumulation of any water that may still be uncollected.

In Fig 8 is shown also a reheater by which the air is heated before passing to the air-operated steam shovel where it is used. There are ten of these reheaters installed upon this contract, located as near as possible to the pumps, hoists, etc., where the air is used. They considerably increase the volume of the air just before it does its work and also prevent the possibility of freezing up at the exhaust Reheaters are of course not used for the air consumed in the tunnel itself for driving the drills, and are generally inapplicable where the air is used only intermittently. Especially for driving pumps, however, the saving by the use of reheaters is quite appreciable, although even for this service reliable figures from actual practice are elusive.

FILTERING AND COOLING INTAKE AIR.

It need not here be said that air as it enters the compressor cylinder should be as cool and as free from dust as possible, and in perhaps the majority of the more recent installations some attempt has been made to secure this condition, but more might and should be done. The arrangement adopted is usually merely to lead in an air conduit from outside the building and to so protect the opening that cats cannot be sucked in, or to pipe from the roof instead of taking the air from the engine room itself.

An interesting and effective device for securing cool and pure air for compressors is in use at a plant of the Associated Oil Co., at Kernville, Cal., in the Bakersfield oil district. This, or its equivalent, was an absolute necessity there, as the region is hot and the air is always loaded with dust. The device is so eminently common-sensible, and in use has proved so satisfactory that it is to be recommended for general adoption.

This air filter and cooler is located outside the compressor house, with the hooded intake air pipe standing up in the middle of it as shown in the sketch, Fig. 9. There is just a rectangular frame, or skeleton, made of light scantlings put together by a carpenter. The four sides and the top of the frame are covered with common burlap, tacked on, and the inside is similarly covered, with the thickness of the scantling between the two layers of burlap. This provides on every side two separate filtering surfaces for the air to pass through. Right over the center of the frame is located an ordinary revolving lawn sprinkler, with vertical axis, which slowly turns and keeps all the surfaces constantly saturated and dripping with water. The burlap in this case soon catches so much dust that it can be scraped off in considerable quantities, so that it is frequently necessary to souse the filter, inside and out, with a hose. The frame can be easily lifted off the intake and turned over to expose the inside for the washing.

This device not only effectually separates the dust from the air but cools it, through the evaporation of the water, and the air enters the cylinder in unusually good condition. The intimate contact of the water with the air and the probable absorption of more or less water by the air has no effect upon the dryness of the air after compression. For in any case the compression and the subsequent cooling of the air will leave it more than saturated, so that there will surely be free water in the air to be gotten rid of, and a little more or less will make no difference.—*Engineering News.*

FIG. 8. RECEIVER AND REHEATER.

THE AIR BRAKE UP TO DATE

By A. Stucki.

Stopping a heavy passenger train running at a speed of about 70 miles per hour within 1,000 feet is a record which is usually not fully appreciated, and the innumerable tasks which forced themselves upon the Westinghouse Air Brake Company during the last 40 years called for an almost unlimited resourcefulness and ingenuity. There are several other air brake companies which are also entitled to a great deal of credit, but the above mentioned company having been the pioneer in this field, their equipment will be mentioned in a brief way.

As matters stand now on freight trains the automatic brake is used exclusively; i. e., each car carries its brake cylinder and its air reservoir and, in case the train breaks in two, the brakes are automatically applied. These reservoirs are charged from the engine through the train pipe, and the control of application at each car is obtained by varying the pressure in the train pipe. If reduced, the brakes go on, if restored, the brakes release and the reservoir is re-charged. In order to reach the last cars of a long train quickly, and in order to get a higher average pressure into the brake cylinder in case of emergency, a great reduction in the train pipe pressure will set the valves, called triple valves, so that the train pipe helps to fill the brake cylinder up to a certain point, and by so doing reduces its own pressure, and consequently the reduction travels much quicker towards the rear of the train than would be the case if all the air would have to escape through an opening at the engine. This feature has been found to be so valuable that in order to meet the requirements of controlling the long trains of to-day it is now applied, to a certain extent, in ordinary service stops. The only difference is that the air in rushing from the train pipe into the brake cylinder is passing through a restricted opening. The *K* triple valve of the above mentioned company is of this construction.

On passenger cars safety is doubly important. The fact that at high speeds the brake shoe pressure can be greater without sliding the wheels than with slow speeds, has been made use of in designing the high speed brake. Here a high braking pressure is first applied while the train is moving fast, and as it slows down the pressure in the brake cylinder is gradually allowed to escape through the opening of the high speed reducing valve. Of course the system is based on the automatic principle all the way through.

With the cars still increasing in weight and moving at ever increasing speeds, another system has been developed whereby a large additional reservoir is placed under each car to be used only in emergency cases. The class *L* triple valve used in this case has a by pass valve which is operated by a large reduction in the train pipe pressure, thereby allowing the air from the additional, or supplementary, reservoir to help the ordinary or auxiliary reservoir to fill the brake cylinder. In an ordinary or service application, this by pass valve is not moved and the air from the auxiliary reservoir, and a restricted amount from the train pipe, alone enter the brake cylinder. In order to be sure that the pressure in the brake cylinder does not exceed a predetermined amount, a safety valve of large capacity is also used. This is called the controlled system.

The locomotives of later designs are so equipped that they may be operated in unison with the automatic brakes used on all trains, or they may be operated independently from the train. In this latter case straight air is used, as this affords the simplest and best means to graduate the braking pressure at a short range. A specially designed distributing valve allows but one system to be cut in at any one time. This equipment is commonly called the *E. T.* equipment.—*Engineers' Society of Western Pennsylvania.*

LOW RATES OF THE NEWHOUSE TUNNEL

The management of the Newhouse tunnel, which extends from Idaho Springs to the Gunnell mine in Gilpin county, Colorado, has announced reduced terms for ore transportation through the tunnel and for compressed air, the avowed aim being to stimulate operations along the route. The Newhouse tunnel traverses more than four miles of country.

The new terms provide for a decrease of 20 cents per ton in the transportation of ores valued at $6 per ton or less, and a flat reduction of about 50 per cent. in the charges for compressed air. These new rates, according to the officials of the tunnel company, barely cover the actual cost of supplying the service at this time, but it is expected that a much greater volume of business will at once result.—*Mining World.*

WORK ON PRACTICAL LINES

By W. L. Saunders.*

Back in New Jersey a gentleman visiting one of the public schools was unexpectedly asked to make an address. While standing before the school, endeavoring to collect his thoughts, he said: "Now, boys, what shall I speak about?" A little fellow on the front row with a shrill voice called out, "What do you know?" When President McNair honored me with an invitation to make this address I accepted so promptly that it did not occur to me at the time to ask what he wanted me to talk about. To my later letter asking this question came the following reply:

"The subject we have uniformly left wholly to the speaker. The young men whom he addresses will shortly after begin leaving the college for jobs of some sort in the mining world. Whether he speaks along lines suggested by that fact, or upon some particular phase of mining life, or of the engineer's general relation to things, seems to us not so important as that he speaks of something which makes a strong personal appeal to him, and on which, because of that fact, he can appeal to the men before him."

The position taken here is a very wise one. His letter is a classic. Lord Burleigh could not have given, and did not give, better advice to his son; Hamlet did not more wisely instruct the players. Reading between the lines I find that President McNair has really asked me the question "What do you know?" for surely the things which appeal most strongly to us and, because of that fact, incline us to talk about them, are the things we at least think we know. The position is not an easy one for the speaker, though on the face of it he appears to have a wide latitude.

Had such an invitation been extended to me thirty-five years ago when I, a blooming youth of nineteen, walked out of college and down Broadway with a diploma in one hand and with the thumb of the other cocked under the armpits of my waistcoat, I should have seized the opportunity to tell of the things that appealed to me, the things I knew. I should even have demanded the privilege of talking overtime!

---

*Address to students of Michigan College of Mines, April 20, 1911.

But with my present limitations and in that humility of mind which comes with experience, you may take comfort in the fact that your president has, through his instructions to me, safeguarded you. The audience is safe because the speaker is limited. You are free, for instance, from the danger of an attempt to deliver a baccalaureate sermon by one to whom a bacchanalian feast makes a stronger appeal. You are spared the lash of the golden rule because it has appealed very strongly to me in my life that if you do unto others you will surely find that these others will do you.

For what you are about to receive you should therefore be thankful to your president, for it might have been worse.

I once saw somewhere these headlines, "Great opportunities," and as I was looking in that direction I eagerly read the following: "A man with a good rosewood desk, a new typewriter, a fountain pen, lots of linen-wove paper and leisure, has it in his power to make a great literary reputation for himself, if he can only think of something to write." I had everything on the list, with leisure in abundance, but for the life of me I could not qualify in the last item. Here was my first ambition blasted. Dr. Koenig knows that as a student the rhythm of pentameter verse had more charm to me than the sizzling jet on an ugly piece of charcoal in a blow-pipe analysis, or the homely bubbling of H_2O in a cast iron tripod. After a whole course under so good a teacher as Dr. Koenig my chemical knowledge was summed up in these few words, so sweet yet so sad:

"O, come where the cyanides silently flow,
And the carbonates droop o'er the oxides below.
Where the voice of potassium is heard on the hill,
And the song of the silicate never is still.

Come, oh come,
Tum te tum tum,
Peroxide of soda and uranium!"

And yet, and yet—I say it more in joy than in anger—they gave me the degree of E. M.—Mining Engineer! I rather think that Dr. Koenig and others of the faculty of science would have agreed to have still further distinguished me by adding R. I. P.

My first personal appeal to you is that poetry is a good antidote for insomnia—a joyous pastime, but not a passport to prosperity. It is said that men should eschew evil and do good. Rather would I advise you to eschew poetry and be good, lest you fall a victim to the wrath of the gods, as it is written in the scripture "To him that hath shall be given, and from him that hath not shall be taken away even that which he hath."

At the risk of being charged with egotism I am going to give you the next step in my career. Opportunity opened the door to me in the offer of a position as chainman on an engineer corps in or near New York. In this work, it soon appealed very strongly to me (and because of that fact, I want to appeal very strongly to you), that my college training gave me no knowledge of the practical things in life. I could lay out a pipe line on paper, but I could not lay that line on the ground. I did not know how to handle the tools, how to lead joints and a hundred other things that an uneducated workman, little above the scale of a day laborer, knows all about. Of equal importance and of greater regret to me was the evidence that not having mixed with workingmen I was not competent to handle them. I was not in touch with them and did not know how to discriminate between men. To do good exexutive work one must know men. We cannot handle men properly without knowing them. We can never understand men through the study of books. All the colleges in the world could not have given Napoleon that rare faculty by which he placed the right man in the right place and at the right time.

"The monarch mind, the mystery of commanding,
The birth-hour gift, the art Napoleon."

Ability is a broad term. We have the ability of the student to reach the highest place in his class; we have the ability of the scientist to uncover the hidden things in nature, of the inventor to put that knowledge to practical ends and to advance the progress of the world. We have the ability of the engineer who designs a great bridge; of the architect who plans a building; the sculptor and the painter; the poet and the author; the editor, the financier and the business man; but that ability which is to be most desired, that ability which it is within the power of almost all men of common sense to cultivate; that which represents the well rounded man, the highest ability of all, is executive ability. It is far easier to find men who can do good work than to find men who know how to make others do good work. The man who works does only one man's work, while he who knows how to get work out of others does the work of hundreds.

One is like the actuary in an insurance company. He makes the figures on the basis of which business is solicited; the other is the manager of the company who handles the reins so that success follows the enterprise. We know by experience that it is easier to design a Panama Canal than to build one. The man who is now so successfully doing this work is a type of the great executive. He is greater as an executive than as an engineer. He could not be the executive that he is had he not learned to study men by mixing with all classes.

I dwell upon this appeal with emphasis because of its great importance. It should be your first post graduate lesson if you seek the higher planes in education and in life. The fact that you have a good scientific education does not give you the least advantage in doing executive work. The man of equal general abilities who, while you have been at college, has been mixing with and studying men, is ahead of you as an executive, but the training that you have received and the knowledge gained, if you are not spoiled, should enable you to out-distance him after a few years. To do this you must get back to earth, you should be willing to begin at the bottom, to carry your candle and pick. In doing this you become not a common but an uncommon laborer.

Let me give you an experience, an incident of my life which has in principle been duplicated many times. A young man walked into my office to seek a position. He was a clean cut, manly looking fellow of culture and refinement. He told me that he had just graduated from Cornell University and wanted to work in the shops.

"Do you know what that means?" I said, "You will have to work in overalls, mix with the men, obey orders, go in and out at the blow of the whistle, do what you are told to do and all for apprentice's wages."

"I know exactly what it means," he replied. "I ask only for an opportunity to begin at the bottom in a business which I believe to be a progressive one and where I may have a chance to grow."

That young man in a few months was receiving machinist's wages of from $2.50 to $3 per day, saving most of it and attracting attention because of good work and steady habits. To-day he holds an executive position at a large salary. The men under him respect him and are productive because they know that he understands not only his work, but theirs. A college education he once said to me, "is like the foundation of a building, of no practical value unless one goes on with the work above it."

My next personal appeal is that men should strive to work always on practical lines. Separate the chaff from the wheat—cut off all ruching from your garment. Our great business, said Carlisle, is not to see the things that lie dimly at a distance, but to *do* that which lies plainly at hand. Men at college are engaged in abstract studies, much that is done is not tangible. This is good work and well worth doing in our educational life, but when this foundation is built and we stand upon it in the field of life our first concern should be to do things; to get results that tell. If a pump is out of order, fix it, and then talk and plan to prevent a recurrence by improving conditions. Get results with the instruments at hand for it is only a poor workman who quarrels with his tools. The time to mend the nets is not while the fish are running, for a small catch is better than none at all.

It is work, work well done, work done on practical lines, that tells. Work is the handmaiden of success, it counts more than genius, more than ability. Mr. Edison was once approached by an admiring lady who said, "Oh, Mr. Edison, it must take so much inspiration to be a great genius!" He put his hand to his ear and asked that the remark be repeated as he did not understand it. This was done and quickly came his reply, "Madam, it takes two per cent. inspiration and ninety-eight per cent. perspiration."

While working on practical lines we should not forget to work also on lines of greatest efficiency. The best engineering is that which accomplishes a result in the most economical manner. It is only a bad designer who puts more metal into an engine than is required for the work performed. Every pound of coal wasted for power or fuel may shorten life in the world. The man most valuable about a mine or mill is he who helps to lop off a fraction in the cost of producing the metal. This is the age of scientific efficiency, of conservation, of industrial economies. Men need not work a whit harder, but through the use of machinery and better methods of work, greater results are obtained. After all it is only a question of study, of stopping the leaks and striving to concentrate on lines that produce. One should always try to touch the spot.

DEODORIZING SEWER GAS

The city of Winnipeg, Manitoba, has found it necessary to adopt some means for diminishing or abolishing the objectionable odors which emanate from the sewers and assert themselves in streets and residences, and last year a satisfactory test was made of the Beeman deodorizing machine, ten of them being placed in sewer manholes, where they were in operation for three months.

The machine consists of a reservoir containing wood alcohol, the fumes from which impinge upon a disk of platinized porcelain 1½ inches in diameter. This disk, when heated cherry red, remains incandescent so long as the alcohol fumes are supplied to it, which fumes are changed into formaldehyde during their passage over the disk. In addition to the reservoir and disk there are a series of baffles and protectors through which both the formaldehyde and the air from the sewers must pass and which insure a thorough mixing of the two. The whole machine measures about 20 inches in diameter and 40 inches high and is suspended within an air-shaft from the sewer or in the sewer manhole. In the machines used in Winnipeg it was found that one gallon of wood alcohol, costing 62½ cents, lasted nine days. It is suggested that it would not be necessary to place such an appliance in each manhole, but that if one were placed, say, in every fifth manhole the openings in the other four could be closed. City Engineer Ruttan reported that sufficient formaldehyde was produced to deodorize the sewer air that emerged from the manholes. The city of Winnipeg has recently contracted for 50 of these deodorizers at $75 each.

APPLICATIONS OF THE AIR LIFT

By Harry L. Glaze.*

The air-lift is in general use in pumping and metallurgical plants, but is little known to those engaged in other mechanical pursuits. A better knowledge of the air-lift among mechanics and mechanical engineers would result in the development of many more uses for this valuable principle.

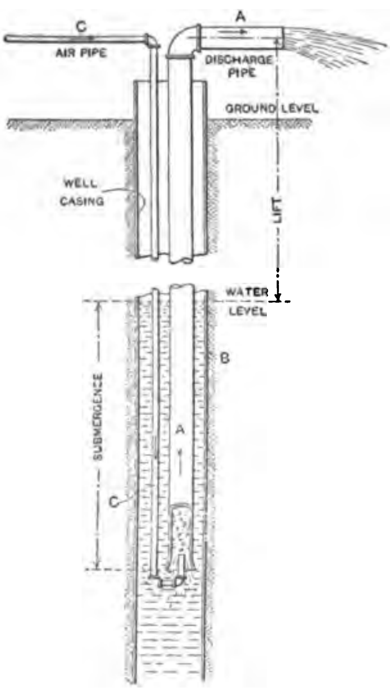


FIG. 1. AIR LIFT PUMP.

The action of the air-lift is simple and easily understood, but many theories have been advanced by various authorities to explain the phenomenon; the explanation following is perhaps the one most widely accepted. In order to consider the principles involved it will be necessary to refer to Fig. 1, which shows the air-lift as ordinarily applied to pumping from wells. Here *A* shows a pipe which serves as the discharge pipe to carry the water out of the well, *B, C* is an air pipe which carries the air from the compressor and introduces it into the open end of the discharge pipe, which

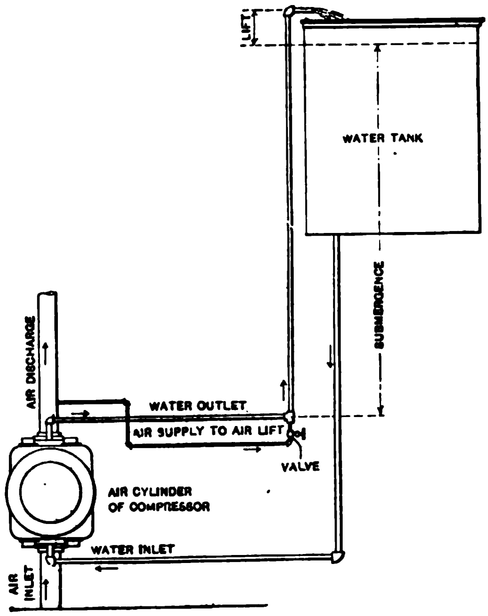


FIG. 2. CIRCULATING WATER IN CYLINDER JACKET.

is usually made with a slight bell at the bottom; this air pipe is bent up so as to pass a short distance into the discharge pipe. It will be noticed that the discharge pipe is submerged in the water, and upon the amount of this submergence depends the efficiency of the pump.

The action is as follows: Air is introduced into the air pipe *C* under pressure sufficient to overcome the static head of the water from end of the pipe to the surface of the water; this head is called the "submergence." The distance from the surface of the water to the highest point that the water is lifted is called the "lift." When the air issues into the water contained in the discharge pipe it breaks up into small bubbles which form, by virtue of the violent action, what is virtually an emulsion of air and water. This emulsion is lighter than water and of course it is forced up into the discharge pipe by the weight of the water outside and will be made to issue from the top of the discharge pipe with considerable violence.

The results obtained are improved but very little by the various fancy and expensive devices on the market which are made for attaching to the lower end of the discharge pipe.

The best results are of course obtained when the submergence exceeds the lift; in fact, the

*Address: Young Construction Co., Los Angeles, Cal.

efficiency of the system varies directly as the ratio of lift to submergence. In deep-well pumping, the conditions are seldom ideal for a high efficiency, but when the simplicity of the whole arrangement is taken into consideration one can readily appreciate its advantages. Although but few wells are drilled deep enough below the water level to give a greater ratio than 1 to 1, there are a great many large air-lift pumping plants in California working on both water and oil. An efficiency of 35 per cent. may be considered about the average of the results ordinarily obtained.

The air-lift has as many faults as virtues, but when it is possible to rig up some old junk-heap of a compressor and a few pieces of rusty pipe, and produce a good, steady and dependable pump, it is worthy of consideration. Even the absence of valves would enhance the value of it to any one who has ever pulled about a mile of casing and pump rods out of the ground to get at the worn-out valves and leathers of an old deep-well pump.

THE AIR LIFT AS A WATER CIRCULATOR.

So much for the water-pumping air-lift. Consideration will now be given to the possibilities of applying the principle to the mechanical arts. Fig. 2 shows a novel method of circulating the cooling water in an air compressor. The engraving is self-explanatory, and the working of the system shows the same simplicity as does that of the other members of the air-lift family. A slight opening of the air valve will serve to create a brisk motion of the water in the pipes and cooling jacket. A cooling tower might be provided if the water showed a tendency to become quite hot. This cooling tower could be placed upon the tank and the air-lift pipe raised so that the water would flow over the slats of the tower and into the tank. This scheme may be applied to the cooling of ice machines, ammonia condensers, gas engines and transformers.

THE AIR LIFT AS A WATER AGITATOR.

Fig. 3 shows what is called the Pachuca or Brown agitator, which is used very extensively in cyanide plants for mixing and agitating the finely-ground ore or "pulp" with the cyanide solution. The Pachuca tank consists of a tall cone-bottomed steel tank which has an air-lift in the center and a small pipe for introducing air. The use of the air-lift is, in this case, simply to agitate the pulp and bring it intimately into contact with the cyanide, although the air has a beneficial effect in supplying the oxygen necessary to bring about the dissolving of the gold and silver. The time of agitation is usually sixteen hours, but the tendency is toward continuous agitation in several Pachuca tanks operated in series, the pulp running slowly from one tank into the other through the series, the rate of flow be-

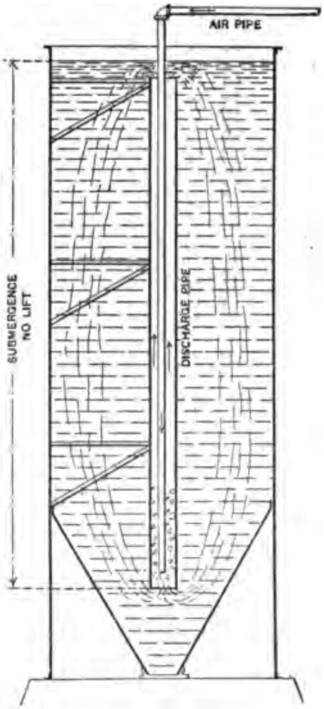


FIG. 3. STIRRING CYANIDE SOLUTION.

ing regulated to conform to the time it takes to dissolve the precious metals.

In the case of the Pachuca tanks, the air-lift works under ideal efficiency conditions for the submergence exceeds the lift. No system of mechanical agitation can compete with the Pachuca tank, and it will be seen that wherever agitation is to be carried on, the Pachuca tank can be used, provided that the action of air is not harmful to the substance being handled. The air-lift will handle almost any amount of solids, slimes, or sands in the solution and this would recommend it for pumping such things as pulp, mud or any liquid containing solids which are hard on plunger pumps.

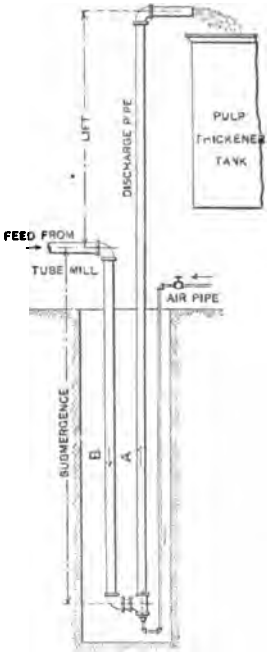


FIG. 4. ELEVATOR FOR LIFTING TAILINGS.

Fig. 4 shows an application of the air-lift, in which it is used to raise the tube-mill tailings into pulp thickeners or classifiers in ore milling plants. The vertical pipes shown are placed in a pit so as to give at least a 1 to 1 submergence. Air is admitted at the bottom of the pipe *A* and the pulp comes in at the top of the pipe *B* down which it flows, and is elevated in pipe *A* by the action of the air.

Many other applications of the air-lift are at present in use, but they all work upon the same principle. These four examples will suffice to give some suggestions which it may be possible to turn to good advantage.—*Machinery.*

Overland Limited, April 26.—Just passed a grading outfit. They were hauling gravel in wagons. Wagons all of the same size, same weight. Some wagons were drawn by three horses, others by two mules. I understand that after a horse has been six months on the job, if his conduct is exemplary and his ability warrants it, he is promoted to mule.

MIKE,
—*Chicago Tribune.*

PNEUMATIC HAMMER COAL PICKS IN A GERMAN MINE

During the past twelve months pneumatic hammer drills have been extensively employed for coal-winning at the Mont Cenis Pit, Herne, over 100 of the Westfalia type (fig. 1) being now in use. This pattern differs from other makes in the provision, inside the cylinder head, of two piston valves *a*, which admit the compressed air in front and rear of the working piston *e* alternately. The advantage claimed for this form of valve gear is that during the working stroke the compressed air enters the cylinder direct, thus precluding all adverse eddying, reflux, throttling, etc., of the entering air. Since the two valves operate independently and there is no instant, in any position of the piston, when the compressed air is admitted to both sides of the cylinder simultaneously, the result is that not only is the percussion force of the piston augmented, but the consumption of compressed air is also reduced. The valve pistons, being extremely light, act very quickly, and as they have only a very short stroke, a large number of powerful blows are delivered per unit time. The pressures in the cylinder are not subjected to any sudden alteration, but increase and diminish gradually, and the hammer drill consequently works quietly and uniformly, and above all with a very slight "kick."

Compressed air is admitted to the tool through a piston valve *b*, which opens as soon as a gentle pressure is applied to the lever *d*, but cannot leak, being pressed against its seat *e* by the pressure of air in the supply pipe. Owing to the position of the lever *d* inside the handle, the valve cannot open accidentally by contact from the outside. The working piston *e* is of the differential type, the diminished forward end preventing the air from escaping when the tool becomes worn. Space is provided in the front end of the cylinder at *o* for the the formation of a cushion of air, which softens both the rebound impact and the kick. To protect the user from dust stirred up by the exhaust air, the exhaust discharges into the annular space *f* at the handle through several holes, an arrangement that also keeps dust out of the cylinder and lessens wear. The bit *g* is protected from expulsion by a screw cap *h*, and by changing the front bush, either round or

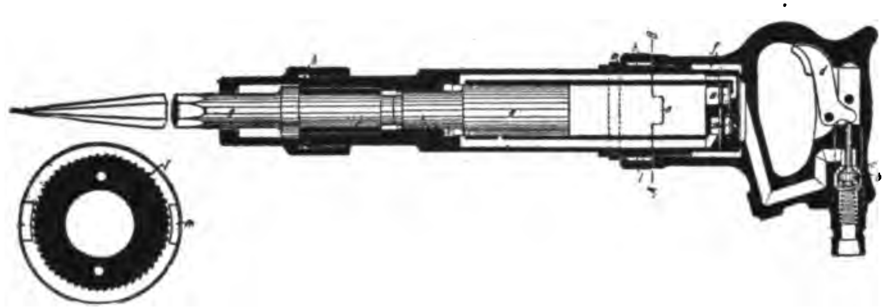


FIG. 2. FIG. 1.

WESTFALIA PNEUMATIC COAL PICK.

square bits can be used. In order to prevent any play in the screw connection between the handle and the working cylinder, this connection is formed of an internally-toothed ring *k*, which engages with teeth *l* on the periphery of the cylinder, and is prevented from turning by two diametrically opposite stops *n* (fig. 2). The ring *k* is held in position by a spring *m*.

The weight of the hammer drill without bit is about 14¼ lb., and the consumption of air is equivalent to 2 to 3 horse-power of the compressor motor. The air pressure is 5½ to 6 atmospheres at bank and 4 to 5 atmospheres at the drill.

The Chief application of these drills in the Mont Cenis Colliery is in the gas coal seams, which dip at an angle of 50 to 70 degrees and are very hard to work. The roof consists of brittle clay shale, the floor in some of the seams being pyritic shale, and soft creepy material in others.

Before the introduction of the hammer drill into the colliery in question, the No. 2 seam—consisting of an upper bed of 12 in. and a lower one of 20 in. to 24 in. of coal separated by 2 in. to 8 in. of parting—could not be worked at all, and the other seams, about 40 in. thick and interspersed with parting, were only attacked in a few working places, the coal being got down by undercutting and blasting. Since the action of the hammer is similar to that of the pick, it brings down the coal, after undercutting, in large lumps, and owing to the steep pitch of the seams the hewers are able to work standing, the hammer being conveniently held against the coal face, generally with one hand. As compared with the pick, however, the output of the hewers is increased by 25 to 30 per cent., the proportion of round coal is raised from 10 per cent. to about 20 per cent.

The practical experience gained at the Mont Cenis Colliery goes to show that the hammer drill is specially adapted for the working of steep seams, but in flat seams the hewer has to work in a less favourable position, the drill being heavier than the pick and having to be pressed firmly against the face (this it does by its own weight in steep seams), whilst in these circumstances the kick of the drill is a source of inconvenience. Nevertheless, it will do good work, even in seams dipping at less than 30 degs. where the coal is too firmly bedded to get down with the pick, or where the adjacent rock is unsuitable for the application of shot-firing. The output is superior to that obtained with the pick, except where the coal is too soft. In the case of hard coal deficient in cleats, the hammer drill cannot replace shot-firing.

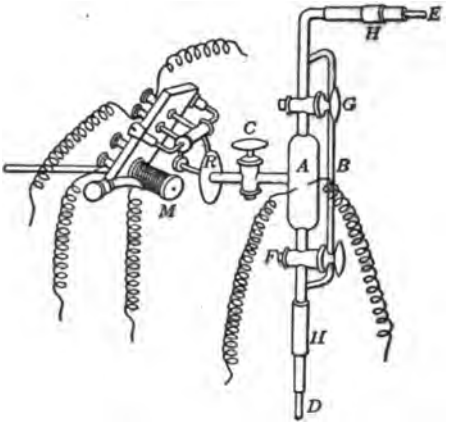
The chief advantages of the hammer drill are found to be that it enables coal to be won from seams previously unworkable, and gives a higher proportion of round coal at less cost per ton. At the colliery in question, about one-fourth of the total coal raised is now won by the use of hammer drills. For the successful introduction of this method of working, the great point is to overcome the conservative objection of the men to any novelty, and their fear that it will lower their earnings. At the Mont Cenis pit the hewers who agreed to work with the hammer drill were promised the same tonnage rate for the first four months as they had hitherto received for working with the pick—and during that time their average earnings showed an increase of about 60 per cent., a circumstance that assisted in overcoming the prejudice of the rest.

To enable the men to use the tool to the best advantage, and to teach them how to cope with the various contingencies arising in the course of the work, a few specially skilled workers have been selected as instructors to gangs that adopt the hammer drill. Another condition essential to success is the provision of a sufficient number of spare hammers (about 20 per cent.), so that there is no need to stop working in the event of any of the hammers getting out of order. The upkeep of the hammers should be well looked after on the premises; and the compressor plant must be equal to the duties imposed upon it, and the air pipes of sufficient diameter (not less than 1 in. in the gate roads).

LABORATORY METHODS FOR OBTAINING PURE OXYGEN

The National Bureau of Standards having need in its chemical laboratory of a large quantity of practically pure oxygen gas obtained it by the electrolysis of water. The positive electrode was suspended in an ordinary round quart bottle with its bottom removed. This bottle was provided with a hollow metal stopper which formed part of the electrical connection between the positive electrode and the outside main. The electrolytic apparatus was placed outside the building, and as the hydrogen given off at the negative pole was not needed, it was allowed to go to waste.

The oxygen gas escaping through the hollow stopper under a pressure of only a few inches of water was conducted through a long copper tube to a purifier containing platinized quartz. Although this purifier was used constantly no impurities were found in the gas. From the purifier the gas was conducted through a valve-head to a two-liter cylinder of heavy brass lined with nickel. This cylinder was suspended in a bath of liquid air at atmospheric pressure. Fresh made liquid air boils at about 9 deg. C., lower temperature than oxygen, and this difference was sufficient to cause the oxygen to liquefy. When the brass cylinder was filled with liquid oxygen, the current was shut off from the electrolytic apparatus, a common steel flask was connected up with the valve head, the liquid air bath removed, and the liquid oxygen at once began to vaporize owing to the heat received from the surrounding atmosphere. When the gage on the valve-head indicated sufficient pressure the valves were closed, and another flask was substituted for the filled one. The oxygen thus obtained was found more than 99.9 per cent. pure. It will be seen that oxygen produced in this way is as near absolute purity as is possible. It is an expensive process, however, and cannot compete with the liquid air rectification process.



EXPLOSIVE GAS TESTER

The gas tester shown in the sketch (described by N. Teclu, *Zeit. f. Prakt, Chem.*) is intended to be located in a safe place and at a distance from localities where explosive gases may be suspected to exist. Referring to the cut, *A* is an explosion pipette with safety packings of wire gauze at *H H,* and provided with a by-pass *B*. The end *D* is connected by a composition or tinned iron pipe to the point from which the air is to be obtained for testing and the end *E* is connected with a pump so that a continuous current of air is drawn through. The cocks *F* and *G* are closed (the current still streaming through the by-pass) and the spark from an induction coil passed between the wires. If no explosion occurs, it is because the proportion of combustible gas is either above or below the explosive limit. Should it be above, then on opening for a while the cock *C*, enough air will diffuse in to cause an explosion on sparking again. Should it be below, then if *F* and *G* are opened and sparks passed while the gas is streaming through, flame will be seen in a darkened room with a proportion of combustible gas considerably below that necessary for explosion. If the explosion be made to take place with the cocks *F* and *G* closed and *C* open, and the suspended iron plate *R* closing the side tube, the force of the explosion will drive *R* against the electromagnet *M*, which will hold it, and electrical connections made by this contact may be made to ring a bell at the place tested, and thus give warning.

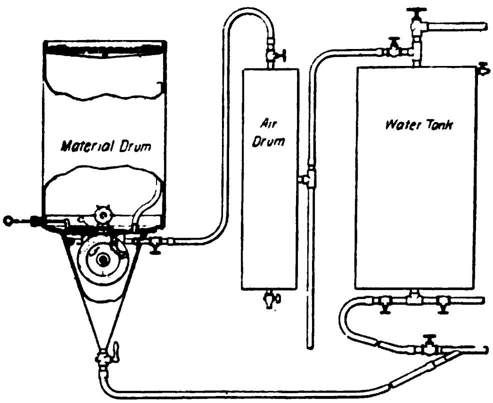


FIG. 1.

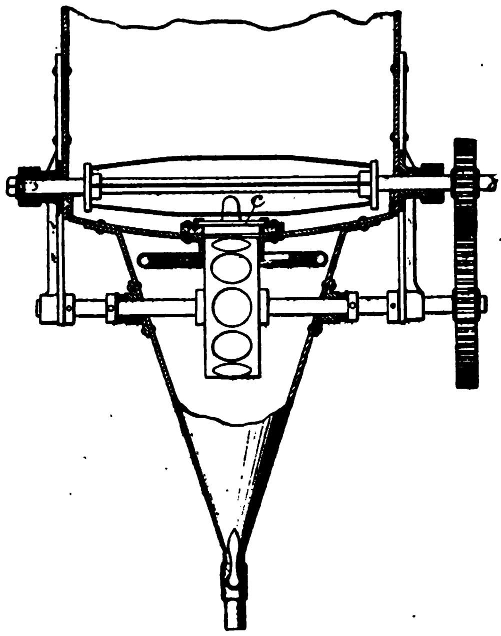


FIG. 2.

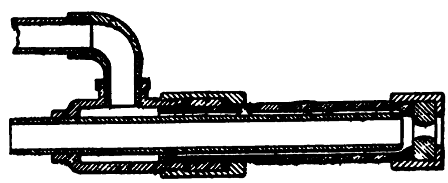


FIG. 3.

THE CEMENT GUN

The cuts here adapted from *Engineering-Contracting* show a new apparatus which is coming into use for depositing concrete in layers, or for coating and protecting purposes, by the use of compressed air.

Figure 1 is an elevation of one form of the apparatus showing the receptacle for dry material, the air drum and the water tank. The sand and cement are mixed in a proportion of about 1:3 and placed in the material drum. It is fed through a hole in the bottom of the drum into the hemispherical pockets of the feed regulating wheel and drops into the conical shaped chamber below, which terminates in the hose carrying the material to the nozzle. The air drum is connected to the conical shaped chamber and an equalizer pipe connects this chamber with the material drum. The water tank is also connected with the air drum so that the water and material is forced to the nozzle under the same pressure. Figure 2 is a section through the feed chamber taken at right angles to the section shown by Fig. 1. Figure 3 shows one form of nozzle used with the apparatus. In this type of nozzle the material is blown through the center pipe and the water enters a chamber surrounding this pipe uniting with the material just at the point of leaving the nozzle. The air pressure used depends upon the density of the mixture desired, from 30 to 40 lbs. per sq. in. being sufficient for all ordinary purposes. The operator stands several feet from the surface to be covered.

One of the first pieces of work done with the apparatus was the coating of the Field Museum at Jackson Park, Chicago. This building was one of the old stucco structures of the World's Fair and contains 38,000 sq. yds. of surface which was coated about 1-16 in. thick. The highest point which was covered was about 180 ft. above ground. An ordinary painter's scaffolding was used for the work, some parts being worked from ladders. The work was accomplished in 36 days with a gang of 5 men, consisting of 1 engineer, 2 feeders and 2 nozzlemen. This was at the rate of 1,055 sq. yds. per day for the entire work.

Other examples of the work with this machine have indicated that a wall 1-in. thick and 200 sq. yds. in area can be made in a day.

In practice the cement is shot against a surface made of building paper, covered with a coarse wire netting. The cost of this material, the cement and sand necessary for a 1-in. wall and the labor of putting it on is estimated to be between 15 and 18 cts. per sq. yd. of surface.

The appartatus is made in different styles and capacities by the General Cement Products Company, 30 Church street, New York.

EXPLOSIVES USED IN MINING

The following is a concise presentation of elementary or general information concerning the explosives of various classes commonly used in mining operations. It is the introductory portion of an elaborate "to be continued" article appearing in *Mining World*, prepared by Robert Bruce, Brinsmade, Professor of Mining Engineering, State University, Morgantown, W. Va.

An explosion may be defined as a sudden expansion of gas. The substances which we call explosives are so unstable when exposed to a suitable flame or shock that they suddenly change into many times their original volume of gas with the evolution of heat. If the change to a gas takes place in the open, there is a flame and a whiff or a report. It is only, however, when explosives are set off in confined spaces like drill-holes that they do their chief work in mining. Consequently a blast or explosion may be said to be a rapid combustion in a confined space.

Explosives have two essential constituents, namely, combustibles and oxidizers. They may be broadly divided into three classes according to the relation which the combustibles bear to the oxidizers. Class I includes the mechanical explosives, or those in which the ingredients constitute a mechanical mixture; class II includes the chemical explosives or those in which the ingredients are in chemical combination; class III includes the mechanico-chemical explosives which are formed of a mixture of class II and an absorber.

METHODS OF FIRING EXPLOSIVES.

Explosives are set off by two means—ignition and detonation. Because through ignition the combustion is transmitted by heat alone, it gives a slower explosion than one started by detonation which transmits the reaction by the rapidity of vibrant motion. By their nature class I is adapted to ignition, and classes II and III to detonation.

Ignition is commonly performed by squibs, fuse or electric igniters. A squib is really a self-impelling slow match, made by filling one-half of a thin roll of paper with black powder and the other half with sulphur. For their use in blasting, a drill-hole *ab*, Fig. 1, is loaded with an explosive *bc* and before filling the hole with the tamping *cd*, a needle *ac* is inserted into the explosive so that when it is withdrawn, a hole of a larger diameter than the squib is left through the tamping from *a* to *c*. The squib is then inserted in this hole with the sulphur end out, and when lit the slow-burning sulphur allows time for the miner to escape before the powder of the squib takes fire and its reaction forces the

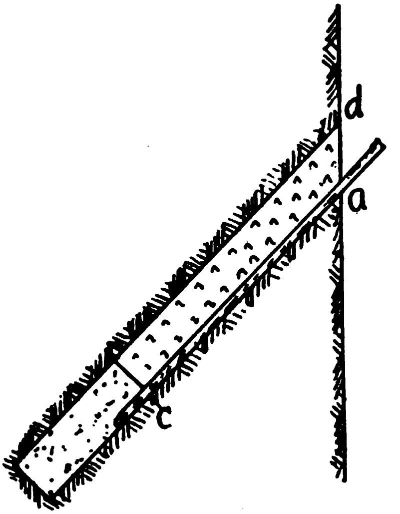


Fig. 1.

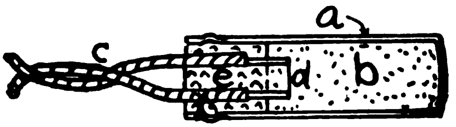


Fig. 2.

squib along the holes to ignite the powder at *c*.

A fuse is merely a thread of black powder wrapped with one or more thicknesses of tape. In loading the hole, Fig. 1, the fuse would be inserted in place of the needle *ac*. A fuse burns commonly at the rate of 2 ft. a minute. Therefore a sufficient length should be used in the hole to allow the miner to retire in safety, after splitting and lighting the outer end, before the flame reaches the explosive at *c*.

The electric igniter consists of a shell *a*, Fig. 2, enclosing a charge of fulminate mixture in *b* and of sulphur cement in *e*. The copper wires *c* pass through *f* and enter *b* where they are connected by a platinum bridge at *d*. For ignition, the shell *a* is made of pasteboard and the igniter is placed within the explosive while the wires extend outside the hole to a blasting machine. The last is simply a small armature revolving between its poles and sending a current through the igniters in the circuit when its handle is shoved down. All the common electric igniters on one circuit are exploded simultaneously, but a recent invention is a delay-action igniter, which permits electric firing in sequence.

Detonation is performed by fuse and cap or by electric caps. A blasting cap is simply a cylindrical copper cup with a small charge of fulminate mixture in its bottom, the fuse being inserted into the cup and fastened to it by crimping pincers. The cap is then inserted into one cartridge of the explosive and its attached fuse tied firmly to it by a string, in order to make a primer which is placed near or on the top of the explosive. The loaded hole will then resemble Fig 1, the explosive being in *bc*, the cap and primer at *c*, and the fuse along *ca*. Lighting the fuse is the same as for ignition, only the fuse now fires the cap whose explosion detonates the explosive.

The electric cap resembles the electric igniter, Fig. 2, but has a copper instead of a pasteboard case *a* and the quantity of charge of fulminate mixture at *b* is increased as the sensitiveness of the explosive diminishes. The electric cap is inserted in and fastened to a primer-cartridge like fuse and cap, the electric cap being fired by a blasting battery in the same way as the electric igniter.

LOADING AND TAMPING.

A mechanical explosive like black powder usually comes in bulk. For loading it is poured into a cartridge (the size of the hole) which is made by rolling a piece of paper around a pick handle. For damp holes the cartridge must be oiled, or soaped on the outside. This paper cartridge is pressed down into the hole by a soft iron tamping bar whose tip should be an expanding copper cone grooved on the edge for the purpose of allowing the copper loading needle or fuse to pass. Tamping bars with iron tips or iron needles are highly dangerous in formations containing pyrite or other hard minerals, on which the iron might strike a spark, and their use is therefore prohibited by law in many places.

A mining explosive of class II or III is handled in paper cartridges which can be ordered of a diameter to fit the hole. Before loading they are slit around lengthwise to permit of the explosive taking the shape of the hole when it is pressed down by a tamping bar which should be of wood for these explosives, instead of copper-tipped iron, on account of their being more sensitive to any shock than black powder.

In coal mines, coal dust is commonly used for tamping black powder, but this is a very unsafe practice in dangerous mines, for a windy or blown-out shot will have its normal flame increased, both in length and duration, by the ignition of the tamping. The best materials for tamping are a fine plastic clay or loam and ground brick or shale, and although sand is too porous to do well for black powder, it answers for higher explosives but must be confined in paper cartridges for use in uppers.

Water is used as tamping for nitroglycerine and high explosives in wet down-holes, but it is little better than nothing. The fact that higher explosives will break rock without any tamping has caused many miners to abandon tamping them altogether on account of the ease of recapping untamped charges in case of a misfire. Mechanical explosives must be tightly tamped, nearly to the collar of the hole, or they will blow out instead of breaking the rock, and although the tamping may be shortened with detonating explosives, as they become quicker and stronger, a short length of tamping adds to the efficiency of the highest explosives.

Where only quick-acting explosives of classes II or III are at hand and it is desired to blast with the slow action of class I, the object can be partially obtained by special methods of loading. These methods provide an air cushion between the explosive and the rock and tamping by either having the stick of explosive of considerably smaller diameter than the drill hole or by having a very porous cellular tamping to separate the tight tamping from the explosive.

* * * * *

The practical usefulness of explosives depends upon (1) their cost of manufacture; (2) their safety and convenience as regards transportation and storage; (3) method necessary for their loading and exploding; (4) their exploding pressure; (5) the rapidity with which they explode; (6) the length and temperature of the flame. These six factors will now be discussed seriatim. Factor (1), or the cost, is often the most important factor in commercial operations like mining although for purposes of war it is often little considered. Factor (2) or safety, affects the desirability for all purposes, the more sensitive the explosive, the higher the freight rate by rail or boat, and if sensitive beyond a certain point, it cannot be shipped thus at all. Those explosives which, like dynamite, freeze at ordinary winter temperatures are at a disadvantage as are also those which, like black powder, are handled loose and can be easily ignited by a spark struck by a hob-nailed shoe on a floor spike. Some explosives, like imperfectly washed guncotton, are liable to explode by spontaneously generated heat, while others become dangerously sensitive if exposed to the sun during shipment. The desirability of explosives belonging to either of these last two mentioned classes is plainly discounted because of these attributes. The next factor (3) or loading and exploding, is important in connection with conditions such as prevail in dangerous coal mines (where an open light is prohibited), in subaqueous blasting (where both explosive and exploder must be unaffected by water), or where misfires could not be corrected. Factor (4), or the pressure, is what determines the real effective breaking force of the explosion, but it is modified in practice by (5), or the rapidity of the explosion. Slow and fast explosives are comparable to presses and hammers for forging steel. The former exerts its pressure gradually until the strain exceeds the tensile strength of the material and the rock gives way along a surface of fracture. The latter gives a sharp quick blow which will shatter the surface of rock exposed to the explosive before any fracturing action is exerted on the blast's burden of rock.

The slow explosive will detach the rock in large masses while the fast type may crush it to bits. Black powder is an example of the first and nitro-glycerine of the second. Explosives with all graduations of rapidity between these extremes are on the market. The fastest explosives are applicable where the rock is very hard to drill as, for example, in the case of certain Lake Superior hematites, or where a tremendous force must be exerted from confined spaces as in breaking the cut for development passages; also where a shattering rather than a fracturing action is needed, as in chambering the bottom of drill holes or in shooting oil wells. The slowest explosives are used in quarrying, for the purpose of detaching monoliths, or in consolidated or soft rock which can be fractured by a slow, pressing movement but only dented by a quick hammer blow.

Factor (6), or the flame and temperature, is an important consideration for blasting in gassy or dusty coal mines. The so-called "permissibles" are explosives made to fall below a minimum legal requirement as regards length and temperature of a flame. When one considers that a permissible like carbonite gives, in practice, a flame height of 15.8 ins. and a flame duration of 0.0003 seconds, as compared with 50.2 ins. and 0.1500 seconds respectively, for black powder, we can see how much safer the permissible is to use.

THE WAVES OF THE AIR

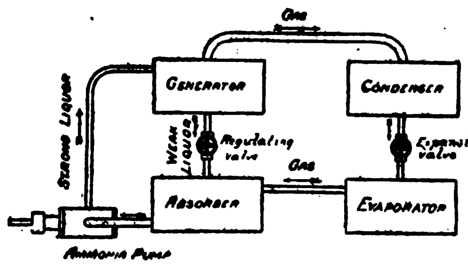
We hear much from the airmen of "air waves," but the subject is of interest aside from aviation. As a matter of fact, we have our being submerged in "waves" to which the greatest waves of the ocean are mere ripples in point of size. When a current of air blows across a water surface water waves are produced, and when a current of air blows across a surface of quiet air, or air having a different motion from the first current, then air waves will be produced. These atmospheric waves have all of the phenomena of water waves—troughs, crests, foaming breaking and spraying—but since the qualities of air and water are so different, the air waves have dimensions more than twenty-five hundred times those of the corresponding water waves. Thus, the greatest ocean waves of, perhaps, twenty-five feet, would have atmospheric counterparts extending upward a distance of ten or twelve miles above the earth's surface. The passage of these huge air waves would be felt by us, since they would cause a stirring up of the air at the earth's surface somewhat similar to that produced by the passage of water waves over shoal places. The undulating movement of such air waves would account in part for the intermittent gusts of wind that we notice so frequently in storms. The presence of these waves is also indicated by the existence of certain kinds of regularly formed cloud groups, in which each cloud marks the crest of an air wave.

COOLING AND DRYING BLAST FURNACE AIR IN WALES

The cooling and consequent desiccation of the blast which has been so profitably applied in American furnaces has been adopted also in North Wales by the Brymbo Steel Company, where a refrigerating plant has been installed by Messrs. Ransoms & Napier, of Ipswich.

It is worked principally by the exhaust steam of the blowing engine. The essential elements of the absorption system used are shown diagramatically in the sketch on this page. Ordinary liquor ammonia is placed in the generator and heated by means of steam. The ammonia gas in solution is driven off by the heat of the steam and passes into the condenser, which may be either of the shell or atmospheric type, where it is cooled and liquefied. From here the liquid is allowed to escape into the evaporator, where it evaporates back into the gaseous form, producing intense cold, the gas so formed passing into the absorber. At the same time the liquor in the generator from which the ammonia gas is driven off, called "weak liquor," is allowed to escape slowly into the absorber, which is kept cool, and there it meets the gas coming from the evaporator and rapidly absorbs it. A strong solution of ammonia is thus formed, which is pumped back into the generator to be heated and the ammonia again driven off and used over again, the process thus going on continuously. In practice, additions are made to the above with the object of increasing the efficiency of the apparatus. The ammonia gas, before entering the condenser, is made to pass through an analyser and rectifier, where the water vapour is condensed and passed back into the generator. A heat economiser is also provided to cool the weak liquor before it enters the absorber, and at the same time heat the strong liquor before it enters the generator.

The evaporator may either be of the shell or continuous pipe coil type. In this the heat is abstracted from the air to be cooled, by evaporation of the anhydrous ammonia. The air is dried on its way to the blowing engine by drawing it over the cooling coils. In this way the moisture contained in the air is deposited and frozen on to the pipes. The frost is thawed off sections of the coils at regular intervals by the incoming air while the sections are cut off the machine. The use of brine is dispensed with, both for abstracting the heat and moisture and for thawing off purposes. The cost of maintaining the



strength of brine by constant evaporation, or by the frequent addition of calcium, is also entirely avoided.

It is impossible at the present moment to determine the exact benefit of the recently-installed plant, as it has not been long enough in operation, although the indications even now are most favourable. As far as the refrigerating plant is concerned, this has worked most successfully right from the start, the moisture in the air being kept constantly below 1.5 grains per cubic foot. The refrigerating machine has been working continuously with a steam pressure of only one pound per square inch. It is therefore hardly too much to say that since the details and construction of these ammonia absorption machines have been perfected in order to make them best suited for working with low-pressure and exhaust steam, advantage can be taken of the latent heat of the steam which is entirely wasted if exhausted into the atmosphere, and in many cases where the steam is at present passed into a condenser from a steam-driven plant, a much better result would probably be obtained by substituting one of these machines for the condenser and making use of the latent heat of the steam for refrigerating purposes. To work these machines with low-pressure steam very liberal surfaces have to be provided, and consequently the first cost is rather more than for certain makes of compression machines. The economy and advantages to be secured by their use are, however, sufficiently important to compensate for the slightly heavier cost. As only a small liquor-circulating pump is required, apart from the water supply, they are almost without working or wearing parts. They are therefore specially suited for long continuous running, and by duplicating the ammonia pump practically all the advantages of duplicating an entire compression machine are secured. No heavy and expensive foundations are necessary, as only a sufficiently strong floor is required to carry the "dead" weight of the machine. The details of construction of the machine are of the best possible character. Those parts which come in contact with ammonia are made almost entirely of steel or wrought iron. The vessels are of the best mild steel, welded throughout with jointless wrought-steel flanges. The tube plates and principal covers are cut from rolled steel plates, and all the connecting pipes are solid drawn with wrought-steel flanges. The speed of the ammonia pump and the level of the liquor in the absorber are controlled quite automatically. Should a glass of the liquor-level gauges break, the valves automatically shut off, and any escape of ammonia is immediately prevented. When the water to be used for condensing and cooling purposes is dirty, and therefore liable to cause a deposit, condensers of the atmospheric type are used, and the machine can be so constructed that all the parts with which the dirty water comes in contact can be cleaned without stopping the machine.

The suggestion sometimes made that absorption machines require more cooling water than compression machines is not correct if the latter are provided with an adequate supply of water. In some cases, however, when a proper water supply cannot be obtained, compression machines are fitted with ammonia condensers of the "evaporative" type, whereby the bulk of the water is used over again. By this means the condensers fulfil the double purpose of condensing the ammonia and re-cooling the water. The economy is, however, secured at the expense of greatly increased power required to drive the compressors, due to the higher temperature of the water going over the condensers. When it is desirable to economise the water, the use of separate water re-coolers is recommended, which cool the water much more effectively. The extra cost incurred in installing this type of cooler is soon repaid by the saving in fuel consumption alone.

AIR SAVES ICE IN STORAGE

The following letter from a recent issue of *Ice* seems to be perfectly self-explanatory:

"Since starting our plant we have been bothered a great deal by the rapid melting of our ice in storage, and when the storage was for a long period the loss was considerable. We noticed at once that the greatest loss was from the cakes at the bottom or on the floor. We finally discovered the cause and then applied a simple remedy.

"The melting was caused by lack of air circulation; the floors being very smooth, air could not circulate under the bottom of the cakes. We bought a lot of lumber 1x4 in. and 2x4 in., and first we placed the 1x4's flat over the joist but did not nail them down; then we laid the 2x4's crossways two inches apart, leaving an air space of 1 inch, sufficient for the circulation of the air.

"The scheme has worked wonders. The melting has been reduced to the minimum; the ice is much easier to handle and when necessary to clean under this second flooring we have only to hook a pair of blocks to one side and raise it."

We can understand how the presence of the air, which is a notorious non-conductor, helped to save the ice, but it is doubtful whether any circulation of the air contributes to its efficiency. Probably the drainage of the water also had something to do with it.

Glenn H. Curtiss has succeeded in building a combination hydroplane and aeroplane with which he can rise from the water or alight thereon. In a number of spectacular trials recently made at Los Angeles, California, he proved conclusively that his machine is eminently practical. As a hydroplane it is estimated to have made a speed of more than forty-five miles per hour on the surface of the water.

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CONTENTS

A SERO-COMIC VIEW OF THE PANAMA CANAL SITUATION*

A sense of duty , mingled with a feeling of regret, is the impulse behind the words which follow:

The writer has a friendly, almost a paternal, feeling for the U. S. Government and for the Canal. He has, at great personal and pecuniary sacrifice, sustained the high-level position of two administrations against enemies who have sought to wreck this great project by an attack upon the very foundations of the Gatun dam in an effort to overthrow that great engineering system of locks for a lower plan of sea level. He modestly claims the ear of the public on the ground that he professes to be an engineer, as he holds membership in all the societies, and that his familiarity with conditions on the Isthmus dates from the De Lesseps era and is founded on several personal visits. Lastly, he is a friend and warm admirer of Col. Goethals.

The fact is that slides, too numerous to mention, have taken place at Culebra, and have already shown themselves in fissures in the paleozoic rocks which form the core-walls of the Gatun dam: It is even claimed that as this formation is of aqueous and not of trachytic origin there can be no hope that the natural calorific effects upon the ground will close the fissures, as has sometimes occurred in metamorphic strata in the earth's crust. Ancon hills is itself affected; no less an authority than Dr. Alarosa having asserted that he has discovered of late numerous cracks, exudations and even traces of lobnitz at the hospital.

The writer has personally estimated that with a rainfall of 116⅕ feet per annum (the average of 99 years on the Isthmus) there is likely to be an erosion through slides and fissures sufficient in 4½ years' time to level Ancon hill and the Gatun dam to the height of the third flight of locks at Miraflores. These figures take no account of the Chagres floods which have been known to greatly affect the difference in tide level between the Atlantic and Pacific Oceans.

A Chagres flood, uniting with the heavier saline mixture from the Pacific and accelerated by a sudden slide from the Bohio might create

*This communication was taken seriously by the New York *Sun* and published on the editorial page on Wednesday, May 24, 1911.

a tidal wave against which the rocks of the Gatun dam would shake like pebbles on the shore at Fire Island.

That these Culebra slides are a serious menace is well known to engineers at Bas Obispo, whose houses are in danger and who are even apprehensive lest the igneous rocks of the tertiary period on the Atlantic end of the Canal be some day swept away, thus destroying all of the old French canal at Porto Bello which forms now the only completed section.

It has been noticed that the President has not paid his annual visit to the Canal; no group of progressive congressmen has gone there, and the new Secretary of War, the titular head of the work, has never been on the spot. Is this because of the fear of a slide? If so, let us not hesitate to appoint a commission, a commission of able engineers who, if they work like beavers, can and will build a dam, greater even than Ashokan or Gatun, and thereby attain the angle of rest for the alluvial algae on the slopes of the Culebra cut.

W. L. S.

INERTIA OF AIR COMPRESSOR INTAKE

.The article bearing the above title, which was given a prominent place in the preceding issue of Compressed Air Magazine, was written by Mr. Snowden B. Redfield, Mem. A. S. M. E., and an associate editor of the *American Machinist*, in whose pages it originally appeared. We wish to express our extreme regret that proper credit was not given when the article was printed; beyond that we are entirely unable to explain or account for the occurrence.

It seems to be quite sufficiently proven that in many cases indicator cards from compressor cylinders of more than one maker do show at the beginning of the compression stroke a pressure perceptibly above that of the surrounding atmosphere, and Mr. Redfield in the article referred to and in one or two which have preceded it shows how the phenomenon may be theoretically accounted for. We are not disposed to magnify the importance of the matter because only the capacity of the machine and not the power economy of the compressor is affected. Another air intake condition of really more importance we have not as yet discovered the means of investigating; that is the actual temperature of the air enclosed in the cylinder at the beginning of compression. There is no compressor within our knowledge which would warrant, or indeed permit, the assumption that there is absolutely no increase of air temperature during admission, or that the temperature of the cylinderful of air when compression begins is not above that of the body of air from which it is drawn.

BARGAINS IN COMPRESSED AIR PRACTICE

Perhaps nowhere in engineering operations can we apparently come so near to getting something for nothing as in some of the details of advanced and up-to-date compressed air practice. In the opening article of our present issue some of these things are spoken of where power economics or other advantages are secured or waste and inconvenience are avoided without any operating expense, the only cost involved being in the providing of the additional appurtenances or arrangements required. The presence of clean, cold water, is indeed called for in limited quantities, but there is practically no consumption or disappearance of the water, and it is just as good for boiler feeding or for any subsequent use as before.

First there is the ordering of such arrangements as will secure the cleanest and the coolest of intake air, which entails but a slight first cost in the installation, while the advantages secured extend through the entire series of subsequent operations.

In two-stage or multi-stage compression, as compared with single stage, the additional cost is in the apparatus alone, while there is a constant saving of power and an avoidance of high temperatures for the working surfaces which pays many times over, and as long as compression continues, for the outlay.

A late refinement in stage compression is the use of a water separator in connection with the intercooler, this also performing an important service without operating charge.

Then there is the aftercooler, which is not only a power saver by its reduction of air volume at the very beginning of transmission, but it is also the conditioning apparatus which makes the air ready to give up its surplus of moisture. A water separator in some form should be either a part of the aftercooler itself or an immediate adjunct to it, and the economic advantage of the combination, again without operating cost, cannot be cast.

The advantage and economy of tight connections and live piping, as compared with a leaky system, can scarcely be said to cost anything either at the beginning or during the continuance of operations except a little ordinary care and skill in erection and a minimum allowance of the same in the maintenance of the plant.

It is not necessary to speak of the reheating of the air immediately when and where it is used, which seems to be only practicable for continuous service. The reheating of course costs a little in fuel, but nowhere in the entire range of thermodynomics is there a greater power bargain offered.

THE REACH OF THE STONE CHANNELER

Looking out from, say, a fifteenth or a twentieth-story window of one of the latest office buildings of lower New York City, one realizes the vast difference between the old and the new constructions, and the wonderful jump which has been made in the building habit in the last score of years.

Large masses of the old buildings still survive, rising quite uniformly to a height of five or six stories, and from the irregular, approximate level of their roofs the new buildings tower a dozen or a score of stories higher. In comparing the new structures with the old, it will appear that there has been not only a complete transformation of building methods, but also a change quite as complete in the materials of construction, the former being largely the result of the latter.

The modern building could never have been even planned until the steel and the stone and the concrete came in sight and became readily and cheaply procurable. The dominant building material of the latest completed century was brick, with wood for the floor timbers, and later iron beams; now bricks are the incidental and the supplemental rather than the most essential element, and stone instead of brick strikes the eye in all the newer city erections.

While there is much wondering exclamation and much glorification over the skyscrapers and the other pretentious and imposing structures of recent years, nothing but ultimate pecuniary profit has dictated their erection. Modern buildings are a great bargain at the beginning, and they are built, first of all, because they are really cheap. It has been said that, where the most pretentious office building of half a century ago cost two dollars per cubic foot of available space enclosed, the corresponding cost of the later erections is not more than one-quarter of that amount.

One of the most persistent and effective cheapeners of stone production for the rebuilding and the upbuilding of our modern cities all over the land is the stone channeler. Not many who walk city streets or who ply their various schemes and activities in the big new buildings have ever seen a stone channeler at work, yet they all must owe a lifelong indebtedness to it for helping to provide the best business accommodations the world has ever known.

The largest single complete structure in the world built entirely of marble, and its exterior all of marble from a single quarry—the Metropolitan Life building, in New York, with its already world-famous tower—owes its existence, among other agencies, to the stone channeler; and it may be said that, without the channeler, while its erection would not have been physically impossible, financially it would have been.

The stone channeler, to a considerable extent, dictates or determines the kind of stone that we shall use for our buildings. While we may fret and worry about the prospective exhaustion of our coal and our iron, we cannot exhaust the stone which may be used for building purposes. Some, however, as the granites, the channeler cannot cut, while others it walks into quite rapidly; and the latter, therefore, is the stone which is becoming all the fashion for general building purposes.

It is a curious thing that, in contrast to the Metropolitan Life building, referred to above, as the product of the channeler, there is rising also in New York one of the most imposing structures designed and erected by man, the Cathedral of St. John the Divine, in whose erection the channeler cannot claim a prominent part. The materials of which, mostly, it is constructed have not been gotten out by the channeler. We may reasonably expect this building to outlive all the others within sight of it; but, according to our modern habits of change, they will, doubtless, all last long enough.

NEW BOOKS

HOME WATERWORKS. A Manual of Water Supply in Country Homes, by Carleton J. Lynde. New York Sturgis & Walton Company, 1911, 280 pages, 106 illustrations; 75 cents *net*.

This is a volume of The Young Farmer's Practical Library and it is in every way so excellent and complete in its treatment of its special topic that it carries a strong presumption in favor of the others of the set, which thus far comprises ten numbers. Practically everything that could be thought of in connection with the sources of water and the means of conveying and using it for house and farm service is here presented in the fullest and clearest, and at the same time in the simplest terms conceivable. There is not a wasted word nor the slightest suggestion of padding.

MEASURING GAS PRESSURES

In the natural gas fields the unit of pressure is ounces per square inch, in manufactured gas distribution, inches of water; and, in high pressure distribution either inches of mercury or pounds per square inch. A convenient table, which might be indefinitely extended, for the comparison of these units may be arranged as follows:

Av. ounces per. sq in.	Inches head of water.	Inches head of mercury.	Lbs. per sq. in. gage.
1	1.7	0.125	0.062
2	3.4	0.250	0.125
3	5.2	0.375	0.185
4	6.9	0.500	0.250
5	8.6	0.625	0.310
6	10.3	0.750	0.375
7	12.0	0.875	0.437
8	13.8	1.000	0.500
9	15.5	1.125	0.437
10	17.2	1.250	0.625
11	19.0	1.375	0.687
12	20.8	1.500	0.750
13	22.5	1.625	0.812
14	24.2	1.750	0.875
15	26.0	1.875	0.937
16	27.7	2.000	1.000

TABLOID FUEL

"It is stated" that experiments are being made by the French ministry of war to determine the efficiency of tabloid fuel. The tabloid is an essence of gasoline distilled on a ratio of .0006 of its original volume. It is reduced to a pasty consistency which may be cut into tablets. The new fuel is called "conpetroline," and is the discovery of a French officer who is an expert chemist. It is said to be non-combustible and non-explosive. For practical use it is diluted with a liquid whose formula is carefully guarded. The tabloid fuel is expected to work a revolution in aeronautics by reducing the weight of fuel that is carried to practically nothing. Scientists have been at work on the problem of concentrating gasoline, alcohol and petroleum many years, and the tablet for fuel is said to solve the problem. It is predicted that the coal bunkers of ocean liners of to-day will be replaced by a few packing-boxes of the new fuel, and thus a great economy of space with no loss of efficiency and an avoidance of smoke will be attainable. These tabloids should certainly possess powerful medicinal properties, but it could never be safe to take one without at least a grain of salt.

THE PARCELS POST

The people who oppose parcels post in America when every other enlightened country of consequence has it, are just as consistent as those who oppose good wagon roads. Those persons are contributing to the express graft which is merely auxilliary to the railroads. The country merchant, even if it were true that parcels post would injure him, is not the only pebble on the beach. In the creation of laws, we must ever consider what is of the greatest good for the greatest number. The farmers are going to buy where they can get the most for their money, whether they have parcels post or not.—*Northwest Farm and Home.*

COMPRESSED AIR ON THE BRAIN

A Washington patent attorney relates an incident regarding perpetual motion that came to his knowledge. He returned from luncheon one day to find two gentlemen waiting in his office. One of them had a huge roll of blue prints, so large that the attorney had to invite them into an unused room, where the plans could be spread out more comfortably. The visitor, who was the inventor, was most eloquent. He had, he explained, an invention of a locomotive which would run by compressed air, the compressed air to be generated inside the engine itself.

The attorney who had listened patiently to these descriptions, gave a quick glance at the other visitor, who perpetrated a very decided wink. This was sufficient for the attorney, who, after some difficulty, got rid of the callers. He promised to look at the plans again at his leisure, and gravely accepted the fee of twenty-five cents which the "inventor" handed him. He dared not decline it, as he realized then that his visitor was mentally unbalanced, and that the refusal of the coin might be the signal for an outburst.

As the "inventor" had left his name, the attorney looked up his files and found that the call had been made by appointment. The man with the perpetual compressed-air engine had written for an appointment, and the attorney scenting a client had invited him to call and bring his plans. There had been no intimation in the correspondence that the man's device was of the character disclosed. The attorney had thus, unwittingly, courted a call from an inmate of St. Elizabeth's, the great asylum for the insane which lies across the Anacostia River from Washington.—*Scientific American.*

NOTES

A coal mine explosion in the Banner mine at Littleton, Ala., April 8, entombed 128 men, none of whom were rescued alive. Of these men, 123 were convict laborers. The damage to the mine itself was comparatively slight, being estimated at $1,200.

It has been shown that, in the ordinary power station, the cost of fuel ranges from 40 to 50 per cent. of the entire operating cost, so that an economy of 10 per cent. on the coal bill represents a saving of about 5 per cent. on the whole cost of running the plant.

It is understood that duralumin, the new alloy, is used for the metal work of the new British naval airship constructed by Vickers, Sons & Maxim. This airship is said to be 560 ft. long, to have a lifting capacity of 21 tons, and to require 706,330 cu. ft. of gas.

More drills are ruined from grit carried to the cylinder from the end of the air hose after it has been lying on the floor than from any other cause. Before attaching, blow out the hose at full pressure, then play directly on the drill attachment to blow off all grit possible.

"It is said" that in a self-balancing aeroplane, invented by J. F. Cooley, it is proposed to use compressed air, not only for starting the motor, but to keep it going long enough in case of failure of ignition of gasolene to prevent the serious accidents which have occurred from this cause in the past.

Electric power has been sold in California as low as 70 cents per hundred kilowatt hours, or, say, 52¼ cents per hundred horsepower hours.

A new and absurd system of tunnel driving has been invented by a Utah man, a patent for which is now *pending* in U. S. patent office. The system is to direct an intense heat against the breast either with fuel oils or electricity, and after concentrating this heat to suddenly direct the cold-air blast against the heated formation.

The heights of the larger chambers in the Mammoth Cave have been measured by toy gas ballons with measuring strings attached and acetylene lamps to show when the roofs were touched. The Rotunda was found to be 40 feet high and the Mammoth Dome one hundred and sixteen feet, while the top of Gorin's Dome could not be reached on account of deflecting air currents.

At the present we have in the United States 350,000 miles of track, 60,000 locomotives, 50,000 passenger cars and 2,000,000 freight cars. The weight of the locomotives in working order has increased from 75,000 lb., in 1870, to 300,000 lb., in 1911, the Mallet compounds weighing even 450,000 lb., and the tractivepower has naturally increased in the same proportion.

For some time the United States Steel Corporation has considered plans for installing a cooling system in each of the hot mill departments of the plants of the American Sheet & Tin Plate Company. At a recent meeting of the Finance Committee the appropriation was passed and work will be started at once, so that workmen in all these mills in the coming summer will have the benefit of this arrangement for introducing cooled air.

Orders have been placed by the Consolidated Gas. Co. of New York and its allied company, the Brooklyn Union Gas Co. of Brooklyn, for 21 Terry steam turbine-driven Sturtevant gas blowers to operate at 2,400 R. P. M. The individual turbines are reported to be the largest yet applied to work of this kind, and the order is the largest yet received for this type of unit.

The British engineering papers are reporting the following performance in metal cutting: One man employed by the Knowles Oxygen Company, Ltd., cut through 42 girders, 15x5 in. section, in 4¾ hours, with a consumption of less than 200 ft. of oxygen and 300 ft. of hydrogen. Reckoning labor at 1 shilling per hour the cost figured out 6 pence per cut.

The chapter on natural gas from "Mineral Resources of the United States for 1909," although unusually late, gives returns more complete than formerly. The industry surpassed in 1909 the record of any previous year, both in quantity and in value. Of the total value of $63,000,000, Pennsylvania led with $20,475,000; West Virginia came next with $17,538,000; Ohio was third with $9,966,938, and Kansas was fourth, with $8,293,846.

It is understood that the Southern Pacific has decided to begin at once the work on the great tunnel to be run under the Sierra Nevada Mountains between Cisco and Donner, Cal. The tunnel will be nearly six miles long. It will shorten the distance of the Southern Pacific across the Sierras, with a better grade and freedom from trouble caused by snow. With the completion of the cut-off to Colfax there will be a double track to that point from San Francisco.

The huge airship which is building for the British navy at Vickers' Sons and Maxim, will be the largest airship yet constructed, the overall length being 600 feet. It is of the rigid type, the framework being built of an alloy of aluminium known as duralumin, which has a strength and hardness equal to mild steel. The ship will have two gondolas, in the first of which will be a motor driving two propellers, and in the second a motor driving a single propeller. The engine power and speed have not been yet announced.

The increasing use of artesian wells as a source of water supply is making a marked improvement in the health conditions in some parts of the Philippine Islands. According to the recently issued Special report of the Secretary of War on the Philippines, 429 wells are already in operation. The dangers incident to drinking raw surface water is well known to all who have had experience in the Islands, and the people have come to appreciate this new source which furnishes a wholesome water without the former precautions of distilling or boiling. A number of experiments have failed to find any water at Iloilo on the Island of Panay.

It is held by high authority that matter is neither continuous nor homogeneous. Hydrogen can be passed into a vacuum tube through an incandescent platinum window. In a similar way sodium passes through glass, and this is a useful fact in the manufacture of vacuum tubes, because sodium can be passed into the tube to absorb the residual oxygen. Hydrogen can pass through cold iron. Matter may therefore be generally regarded as full of unoccupied communicating spaces.

Compressed air works like a charm for cleaning boiler tubes, leaving them as clean as on the day they were put in. This is the verdict of a correspondent of the *Engineer* who had formerly used steam hose for this purpose, but upon the installation in the plant of a large air compressor for pumping water, tried the compressed air method. The air pressure was about 200 lb. per sq. in., and the rest of the apparatus consisted of a ¾-in. hose with a straight piece of ¾-in. pipe for the nozzle.

The Isthmian Canal Commission has contracted for 10,000,000 lbs. of dynamite to be used during the fiscal year ending June 30, 1912. Saltpeter dynamite is specified and an analysis of the materials will be made. If there is a variation of 3 per cent. from the contract strength the dynamite will be rejected, and for a variation of more than 1 per cent. and less than 3 per cent. it will be accepted at a reduction of 15cts. per 100 lbs. for each 1 per cent. reduction from the contract strength required.

We know of a fellow who once, in fun, called himself an "industrial chemist"—quite a high sounding term. When asked what his line was he said that he manufactured carbonic acid gas. Then, he went on to tell that he was interested in the study of how to utilize a certain byproduct, carbon monoxide. In plain English, he meant that he was a fireman. The carbonic acid gas which he manufactured was the CO_2 in the flue gases; the carbon monoxide, what he called "byproduct," was the CO which was formed through incomplete combustion.—*Power.*

On the Lackawanna cut-off between Hopatcong and Slateford, where some of the heaviest cutting and embankment in the history of railroad construction is being done, a huge blast was recently set off which dislodged 19,500 cubic yards of material. A tunnel 4 by 5 feet was driven into the side of the hill and terminated in a cross tunnel of the same section, 91 feet in length. The amount of explosives placed in the tunnel was 21,250 pounds of Judson R. R. P., and 12,000 pounds of 60 per cent. Red Cross dynamite.

A new book of instructions printed in nine languages has just been issued by the Pennsylvania Railroad for the government of employees working on or about the tracks. The 16 rules are first given in English, and following it are translations into German, Greek, Hungarian, Italian, Lithuanian, Polish, Slovak and Swedish. In the average track gang in this section of the country there are from three to six nationalities represented. The poorer classes of immigrants of the present day are not so very ignorant; practically all of the men can read.

A mine disaster at the Pancoast colliery in Throop, near Scranton, Pa., April 7, caused the death of 74 persons, one of whom was Joseph Evans of the United States rescue squad. He was suffocated while wearing an oxygen helmet, presumably due to the failure or interruption of the oxygen supply. The men entombed in the mine were caught by a fire which started in a hoisting-engine room on the lowest level, 750 ft. below the surface. When the fire started, 300 men were at work in the mine. The men killed were in a "blind tunnel," escape from which was cut off by the fire. The bodies of the victims were recovered by helmeted resuce gangs on the day following the disaster. Death in all cases, according to reports, was due to suffocation.

In an effort to find a cheap substitute for rubber interesting experiments have been made with two bituminous minerals, elaterite and tabbyite. Material very similar to rubber can be produced, for which good wearing qualities are claimed when used in automobile tires and elsewhere. Other varieties of bitumens similar to elaterite and tabbyite have recently been discovered. One of these, known as wiedgerite, is a soft, moist material about the color and consistency of liver, which turns black on exposure. Wiedgerite, which is somewhat high in sulphur, is claimed to be especially valuable for the manufacture of rubber substitutes.

The explosives chemical laboratory of the United States Bureau of Mines at Pittsburg, Pa., is contemplating a study of the influence of temperature and pressure upon the rate of burning of time fuse. It has been found that fuse having a normal rate of burning of 27 seconds per foot may, under the influence of pressure alone, burn as fast as 8 seconds per foot. Conditions of temperature may cause it to burn as slowly as 70 seconds per foot. A centrifugal method has been developed for determining the liability of explosives to exude or "leak" nitroglycerine from cartridges. Many accidents have occurred from this cause.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 4.

988,324. SEALING MEANS FOR VACUUM-JACKETS. John L. Fate, Chicago, Ill.
988,345. SANITARY VACUUM CHIP - REMOVER. Louis S. Irgens, Oakland, Cal.

988,352. INHALER. JAMES D. KERR, Greens Fork, Ind.

988,354. VESSEL CONSTRUCTION. ROBERT O. KING, North Tonawanda, N. Y.

1. The combination of a series of air-locks, each comprising a hollow open ended body portion and detachable end-closures, said body portions being of different sizes in cross section to adapt them to be nested one within the other.

988,409. EQUALIZER FOR PNEUMATIC ACTIONS. EUGENE T. TURNEY, Rock Island, Ill.

988,486. PNEUMATIC SEPARATOR. ROBERT MOODIE, Rayleigh, England.

988,604. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

988,614. AIR-LOCK. WILLIAM WALLACE WOTHERSPOON, New York, N. Y.

988,648. GOVERNOR FOR AIR-COMPRESSORS. HOWARD M. P. MURPHY, Pittsburg, Pa.

988,689. FLUID-PRESSURE VALVE. LAMBERT J. BORDO, Philadelphia, Pa.

988,693. SPRAYING APPARATUS. HARRY B. CHALMERS, Dedham, Mass.

means for permitting movement of said pipe section whereby the air within the receptacle is caused to change its direction and thereby carry the material with which it is laden to various parts of the object to be coated therewith.

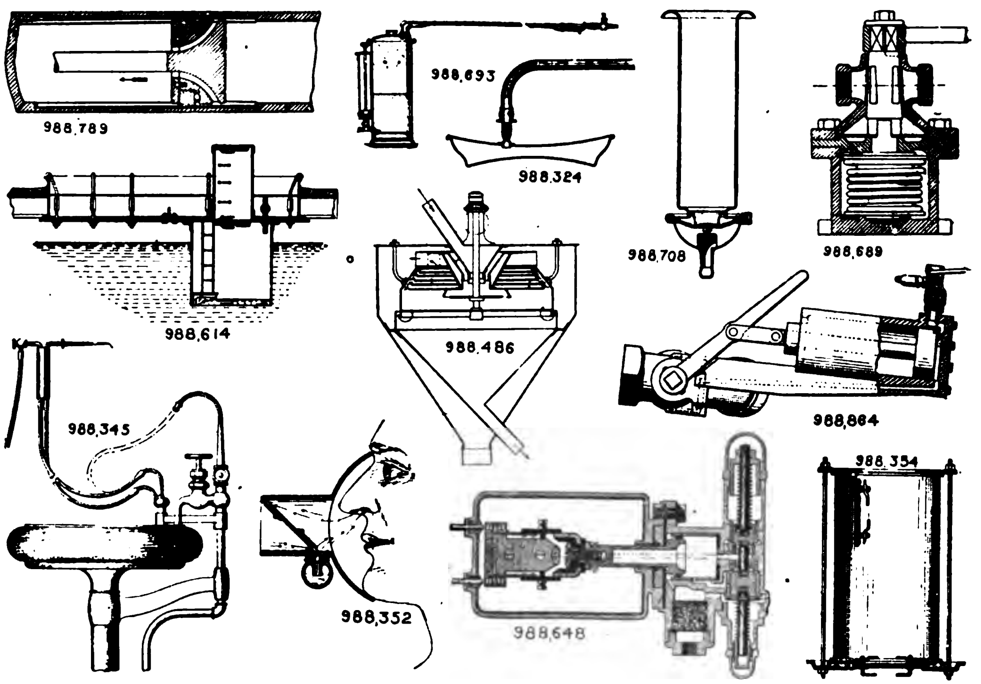
988,998. AIR-BRAKE. GEORGE O. GALBRAITH, Richmond, Cal.

989,051. POWER-HAMMER. GRIFFITH D. ROBERTS, Columbus, Wis.

989,110. SINKING DEEP SHAFTS IN WATER-IMPREGNATED GROUND. FRANK BILLINGS, Cleveland, Ohio.

1. The herein described process of sinking shafts through water-impregnated ground which consists in lowering into the excavation as it is deepened a shaft having an air caisson at its lower end, in draining water from the surrounding ground into said shaft through ports in the walls thereof above said caisson, and in pumping said water from the shaft.

989,152. AUTOPNEUMATIC PIANO. ADAM J. HOBART, St. Johnsville, N. Y.



PNEUMATIC PATENTS APRIL 4.

988,708. MILKING APPLIANCE. JACOB HENRICHSEN and CARL JOHANNES HEMMINGSEN, Copenhagen, Denmark.

988,789. FLUID-BRAKE. OTTO LAUBER, Essen-on-the-Ruhr, Germany.

988,864. AIR-BRAKE MECHANISM. FRANK S. CRAVENS, Lexington, Ky.

988,917. AIR-PRESSURE INDICATOR. HENRY W. WALKER, Syracuse, N. Y.

APRIL 11.

988,978. APPARATUS FOR COATING OBJECTS WITH SUBDIVIDED MATERIAL. GEORGE B. CRAGG, Chicago, Ill.

2. Apparatus for coating objects with subdivided material carried by air, including a receptacle for the objects; a pipe section whose bore is in communication with the receptacle interior; means for effecting forced passage of air through the bore of said pipe section; and

989,174. GAS AND AIR MIXER. FRANK C. MERREGE, Marine City, Mich.

989,250. TRANSMISSION OF SOUND. DELIA M. GRAY, Highland Park, Ill.

989,296. PNEUMATIC STACKER. FREDERICK L. SATTLEY, Indianapolis, Ind.

989,384. AIR-CUSHION FOR PRINTING-PRESSES. ROBERT MIEHLE, Chicago, Ill.

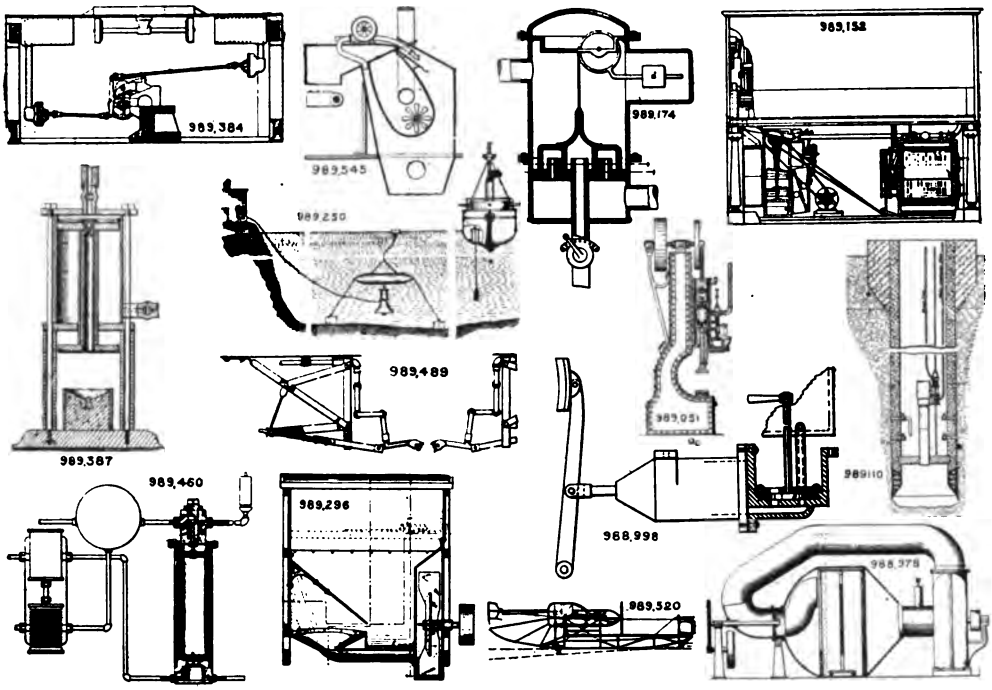
989,387. CASTING-MACHINE. VIRGIL H. MILLS, Hubbard, Tex.

989,460. AIR-BRAKE SIGNAL. GEORGE J. WESTPHAL, Oklahoma, Okla.

989,489. AUTOMATIC SAFETY AIR AND STEAM COUPLING. CARL R. DICK, New Smyrna, Fla.

989,520. FLYING-MACHINE. JOSEPH A. BLONDIN, Los Angeles, Cal.

989,530. SUBMARINE ARMOR. CHESTER E. MACDUFFEE, New York, N. Y.



PNEUMATIC PATENTS APRIL 11.

989,545. APPARATUS FOR SEPARATING DUST, DIRT, LEAVES, AND OTHER IMPURITIES FROM WOOL, HAIR, COTTON, AND OTHER FIBROUS MATERIALS. JOHN HAMPSON, Chilworth, England.

APRIL 18.

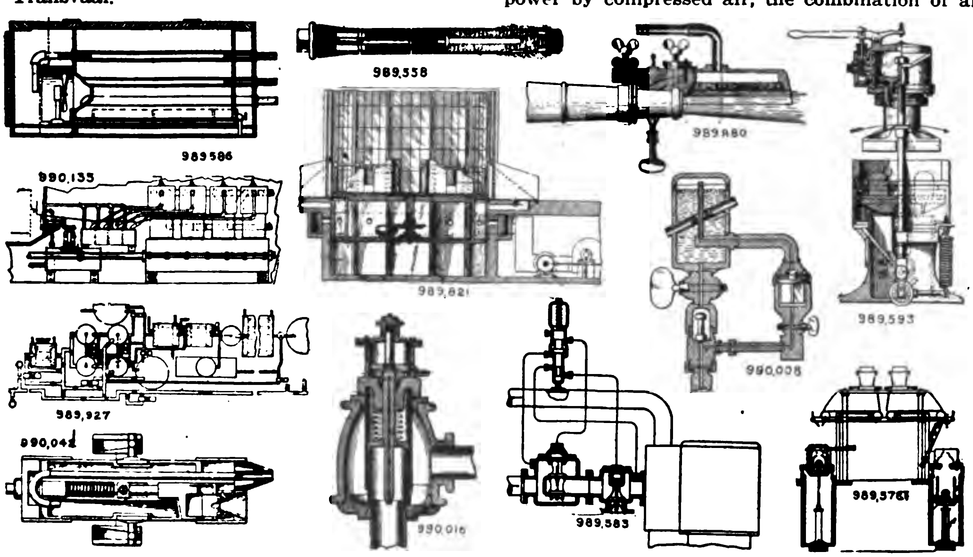
989,558. OILER FOR PRESSURE-FLUID TOOLS. LEWIS C. BAYLES, Johannesburg, Transvaal.

989,562. CAN-TESTING MACHINE. WILLIAM D. BROOKS, Baltimore, Md.

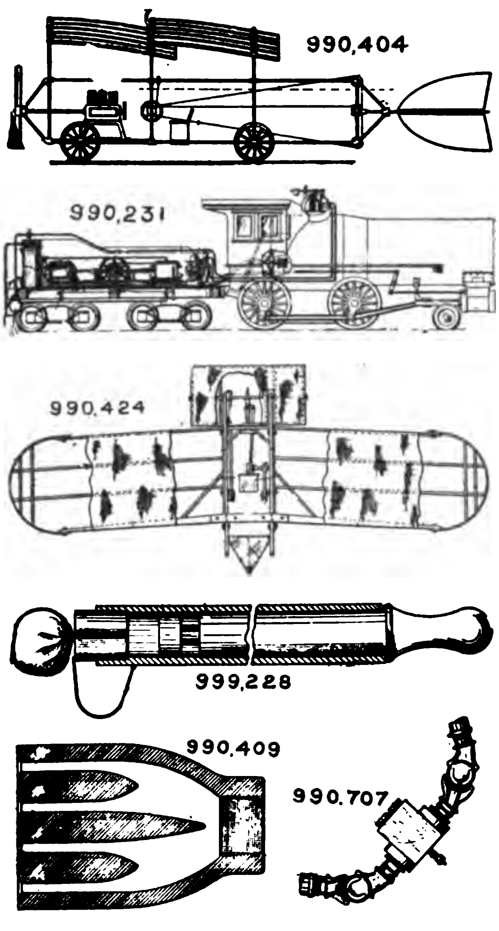
989,578. MOLDING-MACHINE. ALBERT DEVILLE, Charleville, France.

989,583. APPARATUS FOR TRANSMITTING POWER. JAMES DUNLOP, Dennistoun, Glasgow, Scotland.

1. In a closed circuit system for transmitting power by compressed air, the combination of an



PNEUMATIC PATENTS APRIL 18.



PNEUMATIC PATENTS APRIL 25.

air compressor, an isolating valve and an atmospheric valve in said circuit, and pilot valve elements automatically controlled by the pressure in said system for controlling the opening and closing of said isolating and atmospheric valves.

989,586. AIR-COOLING MACHINE. ROBERT H. EASTERLING and WILLIAM A. EARTERLING, Augusta, Ga.

989,593. MOLDING-MACHINE. JAMES J. FITZSIMMONS, Baltimore, Md.

989,821. PNEUMATIC OBSERVATION-TOWER. JOSEPH J. STOETZEL, Chicago, Ill.

1. An observation tower, comprising a tower, having air-tight walls, a piston fitting closely between the walls, rotative passenger carrying mechanism mounted on the piston, and means for pneumatically operating the piston.

989,880. AIR-SUPPLYING DEVICE FOR FIREMEN. GEORGE W. SHAW, Buffalo, N. Y.

989,894. PNEUMATIC INSOLE AND ARCH-SUPPORT. MATTHEW BYRNE, San Francisco, Cal.

989,923. COMPRESSED-GAS GENERATOR. HEINRICH PARZELLER, Essen-on-the-Ruhr, Germany.

989,927. OBTAINING NAPHTHA FROM NATURAL GAS. GEORGE M. SAYBOLT, Jersey City, N. J.

1. The process of obtaining naphtha from combustible gas of natural origin and underground source of the kind supplied by means of wells and pipe lines to cities for consumption therein, which process consists in subjecting such gas in the requisite large amount on the way from its underground sources to its places of consumption and under a high pressure, not less than about thirty pounds to the square inch above atmospheric pressure, to a naphtha absorbing menstruum, and by the aid of the same under said high pressure effecting the separation in industrial quantity from said gas of a natural gas naphtha liquid at atmospheric pressure and temperature and applicable to the uses of petroleum naphtha of similar volatility, substantially as described.

990,008. LUBRICATOR. CHARLES REID, Princeton, W. Va.

1. In a lubricator, the combination with a fluid pressure apparatus; of a lubricant reservoir, means for leading the fluid pressure into the reservoir, a valve for preventing return of said fluid pressure from the reservoir, a lubricant outlet from the reservoir to the fluid pressure apparatus, and a double acting fluid pressure actuated valve controlling the lubricant outlet.

990,016. PNEUMATIC RAIL-SANDER. WILLIAM B. SHULL, Goodland, Kans.

990,042. AUTOMATIC AIR-COUPLING. PETER HALEY, Wellston, Ohio.

990,085. SUBTERRANEAN PUMPING SYSTEM. FREDERICK C. WEBER, New York, N. Y.

2. In a pumping system, the combination of means for creating a fluid pressure and a vacuum, a liquid chamber provided with inlet and outlet valves normally submerged in liquid to be pumped, a pipe connection between said means and said chamber, an automatic reversing valve located in said pipe connection, a balanced duplex piston for operating said valve, a bypass in each head of said piston to permit the equalization of pressure on all sides thereof, supplemental release valves for permitting a predetermined maximum pressure in said liquid chamber to release the pressure on one side of, and thus disturb the balanced pressure on said piston and permit the direct pressure to shift said piston and reversing valve to permit the creating of a vacuum in said chamber and thereby cause the rise of liquid therein through said inlet valve.

990,135. ENGINE-STARTER. CARL HUNT, Indianapolis, Ind.

1. A mechanism for starting combustion engines including the combination with an engine cylinder, of a liquid fuel reservoir, a duct leading from the top thereof to the cylinder, means for forcing air under pressure into the top of said reservoir, a liquid fuel nozzle leading from the lower part of said reservoir to said duct, and a spray plate placed in said duct with an opening spaced from and opposite to the outlet end of said fuel nozzle.

APRIL 25.

990,213. PNEUMATIC DOOR-LATCH-OPERATING MECHANISM. JOSEF ANGERSTEIN and WILHELM BURGERHAUSEN, Munchen-Gladbach, Germany.

990,228. TOY GUN. PETER W. COHRS, Hoboken, N. J.

990,231. AIR-COMPRESSOR. JAMES CROCKER, Birmingham, Ala.

990,404. AEROPLANE. WILLIAM STEMMER, Philadelphia, Pa.

990,409. SAND-BLASTING NOZZLE. JOHN P. WALSH, Boston, Mass.

990,424. FLYING-MACHINE. BRANTLY CHALFANT, Philadelphia, Pa.

990,707. INDICATING DEVICE FOR AIR-BRAKE SYSTEMS. CHARLES L. COURSON, Pitcairn, Pa.

CLASSIFIED BUYERS' GUIDE

Air Cylinder Oil.
Atlantic Refining Co.
Borne, Scrymser Co.
Chicago Pneumatic Tool Co.
Continental Oil Co.
Fiske Bros'. Refining Co.
Galigher Machinery Co.
Standard Oil Co.
Vacuum Oil Co.

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Chicago Pneum. Tool Co.
Curtis & Co., Mfg. Co.
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Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Westinghouse Air Brake Co.

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Galigher Machinery Co.
McKiernan-Terry Drill Co.
Westinghouse Air Brake Co.

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Edw. R. Ladew.

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Cooper Co., C. & G.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.

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Westinghouse Air Brake Co.

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Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Charging Stations.
Baldwin Locomotive Works.
Porter Co., H. K.

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Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

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Clark Co., W. J.
Galigher Machinery Co.

Compressors, Air and Gas.
Bury Compressor Co.
Chicago Pneum. Tool Co.
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Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
National Brake and Electric Co.
Pangborn Co., Thomas W.
Powell Co., Wm.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

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Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.
Powell Co., Wm.
Republic Rubber Co.

Compressor Regulators.
Chicago Pneum. Tool Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.

Core Drills, Diamond.
Sullivan Machinery Co.

Core Drills, Diamondless.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Core Making Machinery.
Pangborn Co., Thomas W.

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Cooper Co., C. & G.
Galigher Machinery Co.
Sullivan Machinery Co.

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Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
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Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

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T. H. Proske.

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Galigher Machinery Co.
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Ingersoll-Rand Co.
Pangborn Co., Thomas W.

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Jos. Dixon Crucible Co.

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Galigher Machinery Co.
Jos. Dixon Crucible Co.

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Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

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Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.

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Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
Pangborn Co., Thomas W.
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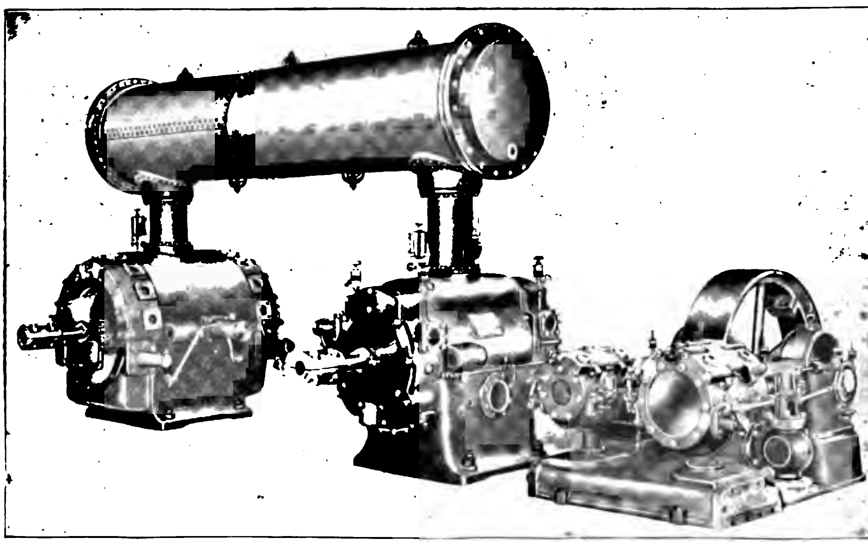

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Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

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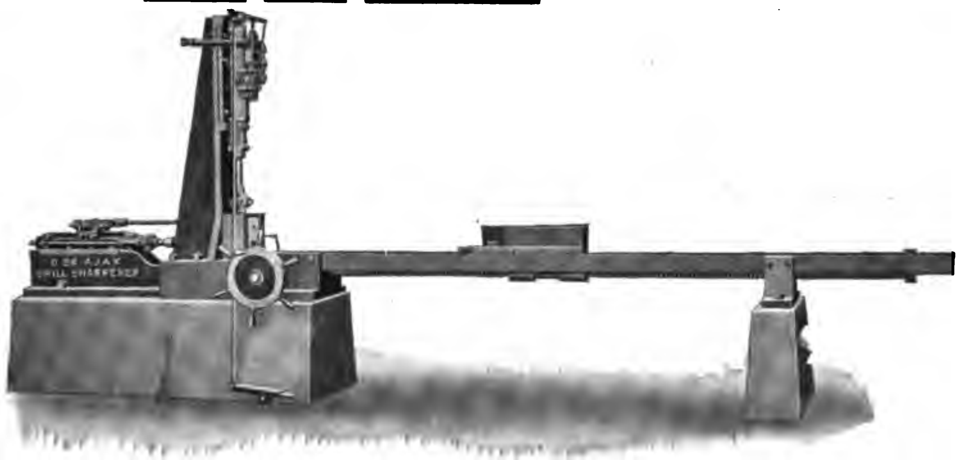

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Vol. XV JULY, 1911 No. 7

BY WHAT RIGHT?

BY FRANK RICHARDS.

The title of this article being a simple question, it is intended to so far correctly characterize what follows, as the attitude of the writer is interrogatory rather than assertive, and it is not much that he wants answered. It is expected that it will appear to be high time for some one to be shaping and putting the question here crudely suggested.

The simple question is as to the permissible retention of the ancient methods of gas storage and distribution, with special reference to the protuberant gas-holder, and this from the view-point of neither the gas producer nor the gas consumer, as such, but of the general and long-suffering public.

Gas, of course, is an established necessity to practically all the people, and all questions as to cost of production and distribution, quality of gas furnished and convenience and reliability of service are to be settled between producer and consumer, with or without the aid of legal enactments, and no one else so far is interested.

It happens, however, that the method of storing and distributing the gas cannot be indifferent to the otherwise disinterested public, for it touches all at more than one sensitive point, and in an objectionable way which should not be tolerated or permitted, except in so far as it may be unavoidable. We have been so familiar for so many years with the sight of the supreme uglifier in every large outlook in every city in the land that we do not realize the unsightliness of it; we do not think to protest against it, or, in fact, in any way to question its presence. Who has thought of asking by what right the gas-holder intrudes, or has suggested its expulsion if its necessity and right are not proven and upheld?

FIG. 1. BY WHAT RIGHT?

The question is so far from ever having been formulated that the gas-holder has never treated the public as in any way entitled to an explanation or a justification wherever and whenever it has chosen to plant itself. It has no doubt at times had to establish certain legal rights to locate, but always upon the unquestioningly conceded assumption of the imperative necessity of it. Is it so necessary and indispensable? If so, it should be "up to" the gas people to prove it in the light of the present century. When it came to proving the necessity of the telegraph poles they quickly fled the city streets.

Few realize how bad the case is, or, indeed, have given the matter any thought at all, and it would seem to be an opportune time to stir things up. Civic pride is becoming alert and restive. We are beginning to take an interest in the appearance and condition of our cities, and many movements are on foot for their betterment. But what shall we do with the gas-holder? Think of the costly viaduct starting from Grant's Tomb, in New York, and connecting to the upper stretch of the beautiful Riverside Drive all completed, and then almost immediately the popping up of the afreet we see in Fig. 1. No one objected or thought of protesting at the time or since, as far as we have heard, because it is a gas-holder, you know.

The work of redesigning, rearranging and permanently beautifying our cities, of rendering them more satisfactorily habitable, so that not only we, the indwellers, but also the incomer and the transient onlooker, shall say it is good to be here, cannot proceed far before we realize that much of our doing must first of all be undoing. We cannot rearrange and upbuild to our liking until we tear down, banish or obliterate the things which, if undisturbed, would render our efforts futile. Objectionable and, but for our familiarity with them, often disgusting features have accumulated and established themselves unchallenged, and yet if they are allowed to remain there can be no real progress toward permanent and satisfactory improvement.

In Fig. 2 we are looking up West End Avenue, New York, a beautiful and high-class residence street which retains its select character all the way up to the end of it, two or three miles to the north. In Fig. 3 we are still looking up West End Avenue, but from a point just a quarter of a mile further down. From the same point, turning to the right, we have Fig. 4, a row of well-built tenements, but only colored people can be found to occupy them. Fig. 5 was their outlook a year or so ago. Since then these unimproved lots, there being apparently no prospect of erecting respectable, substantial, permanent buildings upon them, have mostly been covered with cheap and shabby sheds for storing carts, etc., which city ordinances do not permit to stand in the street at night. Directly opposite these lots, on the other side of West End Avenue, are the primitive rocks of Manhattan, with squatter shanties surmounting them, neither of which, shanties or rocks, it has been worth while to remove. The next block to the north on the same side of the avenue is a lot, without buildings, in which castings and steel work are stored.

Farther away in all directions, for, say, three or four blocks all around these gas-holders, they have been the means of accomplishing, as some might say, a work of great beneficence by so depreciating the property values as to make possible the erection all through the neighborhood of tenements of the cheapest class for the occupation of the minimum wage-earners and of the strugglers for precarious subsistence. If it were not for the blessed gas-holders where would these poor people go?

This is not in the outskirts of the city, but in the heart of it, the location being in the Sixties, while the island is solidly built up for more than a hundred blocks above. There is everything to warrant the presumption that all this section of the city, of which this one group of gas-holders is the center, would be very differently occupied and improved if the gas-holders were not there. Certainly it would all be well and profitably used, which it is not now, and the location, otherwise desirable and easily accessible, deserves a better fate.

We could get pictures of similar character to those here presented from each of the dozen or so of gas-holder neighborhoods of Manhattan, and the same of every other large city, showing them all to be nuclei of desolation and responsible for the depreciation of property values amounting in the aggregate to hundreds of millions of dollars. It is not for the present writer to estimate the amount of this depreciation, but it would be well for real estate experts to be doing some figuring upon the problem.

Suppose that some day there should come to some one the assurance in advance that the gas-holders in the cities would all have to go (and the gas companies are likely to be themselves the first to realize it), what an attractive and promising speculation it would be to quietly buy up all the depreciated property in these gas-blighted neighborhoods.

The gas-holder is simply to-day the survival

FIG. 2 LOOKING UP WEST END AVENUE.

of the unfit, if not of the unfittest, and it seems more tenacious of life than any other thing of which we have record. Nothing can be more certain than that if the gas business were beginning as a new business to-day it would not begin with the absurdly low-pressure service now in use, but it began in that way a hundred years ago and has not changed.

"Little of all we value here
Wakes on the morn of its hundredth year
Without both feeling and looking queer,"

and low pressure gas is queer enough. Just think of it. Ordinary city gas is transmitted and stored and distributed at pressures so minute as not to be measurable in pounds to the square inch, as we commonly measure and record pressures, nor even in ounces, but in tenths of an inch of water.

We happen to have conveniently at hand the figures from a typical city plant. At Syracuse, N. Y., they have about 170 miles of gas mains, from 2 in. to 20 in. in diameter, and the gas

FIG. 3. LOOKING UP WEST END AVENUE.

pressure varies from 1½ in. to 3½ in. of water, these being the limits, or, say, 1-20 to ⅛ lb. to the square inch. In the literature of the gas men the maximum pressure here mentioned is spoken of in the record as 37 tenths of an inch of water. Why, a boy with a tin bean blower could give you double that pressure. A familiar boy's trick is to blow into a burner against the pressure, filling the pipes with air and putting out the lights.

And yet the existence of the gas-holder is absolutely conditional upon the retention of these low pressures, these pressures of a hundred years ago, in storage and in distribution. Any, even a slight, increase of pressure would be death to the gas-holder at once. Take any one of the largest gas-holders, such, for instance, as the one first shown here, and an increase of 1 lb. in the pressure within it would require an addition to the weight on the top of about 2,000 tons. This would give a steel top over 3 in. thick, an effective armor against aeroplane bombs.

It would, in fact, be impossible, for another reason, to carry an additional pound of pressure in the gas-holder, even if it could be weighted down sufficiently. In all candor and seriousness, the modern gas-holder is a magnificent achievement in engineering, and one of the wonders of it is the telescoping feature. When the holder is full and has risen to the top of its guides it is not, as it looks, a single shell, but consists of four or five "lifts," which slide into each other as they descend. To make a gas-tight joint between the lifts there is to each a "water seal" which retains the gas with absolute security, as long as it holds it at all, but if the gas pressure were increased to ½ lb. to the sq. in., or about that, instead of ⅛ lb., the present maximum, the water would all be blown out of the "seals" and the gas would escape as fast as it flowed in.

It is, of course, familiar to everyone that the rate of gas consumption varies throughout the entire 24 hours, what is called the "peak" load coming between sundown and midnight, with a smaller peak in the morning. When the peak is on the consumption is, of course, several times as great as, for instance, in the small hours when the day is young, and a pipe transmission which would be sufficient if it could be continued uniformly all day and all night is altogether unable to maintain the supply when the demand is greatest.

It is said, therefore, and this is the special excuse for the added monstrosities of recent years, that we must have the big gas-holders to take care of the peak load. Certainly, if we retain both the low-pressure transmission and the low-pressure distribution. With the 2 or 3 in. of water pressure the gas cannot be rushed through the pipes. With a pressure increased to only 15 lb. to the sq. in. the volume of the gas would be reduced one-half, and it could be driven along at more than four times the present speed, so that pipes of the same size as now in use would transmit eight times the quantity of gas, or as much in three hours as can now be sent through in the 24 hours. This surely would be at a speed sufficient to take care of the peak load, and supply all consumers at all times without the waiting in gas-holders by the way. In this way we have at once a suggestion for the beginning of reform by the warrant it gives for first of all insisting that no additional gas-holders shall be erected anywhere for taking care of peak loads. We have already a long list of locations where gas is transmitted at high pressures to reinforce existing low-pressure storage systems and avoid the necessity of increased holder capacity.

A Mr. Jones, before the Pacific Gas Association, is thus reported: "One of the ambitions of my life is about to be realized in the construction of a steel bracelet around the city of San Francisco for feeding the low-pressure system. This main is now in the ground and is 16 in. in diameter and 7½ miles long. It extends from the old Portrero Gas Works around the city to the old plant we call the North Beach Station. The line is not yet in use for conveying gas, on account of construction work now going on, but it has been under 60 lb. pressure for over 30 days, and has maintained a constant pressure at uniform temperatures both day and night." The piping was entirely successful for the purpose intended, and the preliminary test gave full assurance that there would be no leakage.

What we are certainly coming to is the entire abolition of the hundred-year-old gas pressures, with the gas-holders which cannot survive them, and the service of gas at so-called high pressures—although they would not be high as compared with steam and compressed air pressures—directly to every consumer. The following from the "Gas World" (Feb 4, 1911), an English publication, is reprinted with approval by the "Progressive Age" (March 1,

FIG. 4 APARTMENTS FACING THE GAS HOLDERS.

1911), an able representative of American gas interests. As will be noticed, it goes far beyond the suggestions of the present writer. The article referred to says:

"The introduction of high-pressure gas, when thoroughly understood, will do more for the industry than ever the incandescent mantle did. Its potentialities—its far-reaching utilities—are beyond all power of description.

"All great changes take place gradually, and it is not to be expected that the change from low to high-pressure gas will be any exception to the rule. Engineers will not jump from 2 in. of water to 200 lb. to the square inch, and yet this is the jump which modern improvements enable any man to take who seriously looks into the question and who realizes what is at his disposal to carry it out.

"With regard to experience, we have at our disposal the record of railway carriage lighting by compressed gas up to 150 lb. or more. In America gas has been distributed at 200 lb. In this country (England) gas has already been distributed at 100 lb., and several miles of mains will be in actual use before many weeks."

FIG. 5. OUTLOOK FROM APARTMENTS ABOVE;

The article quoted then goes on to consider the different distribution of costs under the new system, which we need not go into here. Although the high pressures it refers to are all matters of actual record, and in natural gas transmission the pressures go much higher, it would be sufficient for our present purpose to have only 15 lb. per square inch as a maximum working pressure. This would surely render the gas-holders worthless, and if sufficient pressure were put upon the outside of them by the awakened public they would collapse and disappear, property values would reassert themselves over the desolated city areas, and there would be renewed hope for other reforms to follow.

The gas-holder, it may be suggested, is in a way like our bad spelling, as some call it; our bizarre weights and measures, as the metricists insist; our Fahrenheit thermometer; our decimal, instead of duodecimal, notation: a thing which started wrong, but which has now become so established that change is not to be thought of. In this case a change insists upon being thought of.

It is not necessary to remind anyone that no gas-holders of the gravity pressure type are used, or could be used, in the distribution of natural gas, so that they cannot be imperative for artificial gas. As we have seen, they at once become impossible with any increase of pressure; yet gas consumers are requiring higher pressures. The obsolescent fish-tail burner was satisfied with a pressure of 1½ in. of water; the incandescent mantle gives much more light for gas consumed, but it demands higher pressures. Higher pressures are called for where gas is used for heating purposes and much higher pressures are required for gas engines. Gas should be brought to each consumer at a pressure high enough to require a regulator, and this could be individually adjusted to any pressure required, so that everyone could be using it at its best, according to the use to which it was applied.—*Engineering Record.*

There is a grotto at Pozzuelo, near Naples, into which a man can walk without injury, but in the atmosphere of which a dog becomes immediately asphyxiated. The heavy gas emitted from the soil lies near the surface; the man escapes it, but the dog inhales it with deadly effects.

NITROGEN-FIXING BACTERIA

By E. S. Mather.

Scientists and bacteriologists in various parts of the world have been for many years interested in discovering new methods of producing nitrates, to replace the rapidly diminishing supply and insure the world against gradual starvation. Without nitrates, the plants on which we depend for our food supplies, cannot live.

Three principal elements required by plants are phosphoric acid, potash and nitrates. The first two exist in rocky particles in the soil, and there is no immediate danger of their becoming exhausted. For our supply of nitrates, in the form of nitrate of soda, we are obliged to rely on the saltpetre deposits in Chili, and so great is the demand for this material that the most available portions have already been used up, and the rapidly increasing cost of production will soon place what little remains beyond the reach of the agricultural world.

Much has been said about a new electrical process, by which atmospheric nitrogen is changed into nitrate of lime. This is exceedingly interesting, and of great value, but to depend on such a source, to supply the enormous quantity of nitrates needed for agricultural purposes, is entirely out of the question, and the cost would be prohibitive for such purposes. Homeopathic doses of nitrogen will not raise big crops of corn and wheat.

Let us turn, therefore. from these most interesting manufacturing phenomena, and consider the wise provision that nature has made for just this emergency, namely, the fixation of nitrogen by bacteria, through the medium of legume crops. For in this method lies the solution of the problem, and the next generation will marvel at the folly of their fathers in expending large sums of money for material that could be abundantly supplied almost for the asking.

The discovery of the value of treating the seeds of legume crops with nitrogen fixing bacteria, as a means of enriching the soil in nitrates, is not new, but, like many great discoveries, its general practice has been greatly retarded by crude methods, and premature exploitation, which has prejudiced the minds, not only of farmers, but of the very men in the agricultural experiment stations and colleges, to whom the farmer turns for advice.

The necessity of inoculation is well recognized by the best authorities to-day, but recognition of the advantage of using pure cultures of high-bred bacteria for this work is apparently retarded by the suspicion of commercial cultures and lack of knowledge of the methods employed in their production, and we find many college men advising the farmer to get inoculation for his crops by the crude and expensive method of teaming large quantities of soil from any old field, where the legume they wish to plant has been grown, then distribute the material over the field he intends to plant, and relying on the chance inoculation of wornout and attenuated organisms, with the added advantage of a fresh supply of weeds and soil diseases that have been transferred at the same time, rather than to place high-bred active cultures of the bacteria on every seed that is to be planted, ready to furnish nitrates the minute the seed has germinated.

Exhaustive experiments have shown that legume bacteria existing in the soil often become debilitated and gradually change their habits, losing their power of taking nitrogen from the air and living on the nitrates that are in the soil. They sometimes even become parasitic on the plants.

When the bacteria have been grown in a non-nitrogenous medium directly on the roots of the same kind of plants they are to be used for, their potency is greatly increased, and all the attendant dangers of the soil transfer method are done away with.

The many failures to secure results from inoculation of seeds were largely due to three causes: First, to lack of attention to the great importance of breeding the organisms to secure the strongest and most virile specimens. Second, to crude methods of sending them to the user, and keeping them alive until they could be put on the seeds. Third, to lack of knowledge of necessary soil conditions for their proper development.

These difficulties have been overcome by Dr. G. H. Earp-Thomas, and he is sending to farmers, from his laboratory, in Bloomfield, N. J., cultures of high-bred bacteria, that are guaranteed to keep in perfect condition for long periods of time, and require no further development on the part of the user. The bacteria are simply put on the seed, and nature takes care of the rest. In selecting bacteria for breeding purposes, it is, of course, necessary to watch the development of the different colonies on the roots of the legumes, and it would be manifestly impossible, when working with plants (under ordinary conditions), to pull them up every day to examine them. It was the discovery of a transparent jelly, so delicately balanced that it would furnish a perfect plant food, that has made this work possible. This jelly containes no nitrates except those produced by the bacteria on the growing roots.

Furthermore, no bacteria other than the legume bacteria can grow in this jelly, and it not only makes a perfect method of selecting pure cultures, but its transparent jelly enables the bacteriologist to watch the development of the nodules or colonies of the roots and thus select the bacteria that are most active. By this process of selection and the repeated inoculation of fresh plants grown in the same manner, cultures are produced that have much greater power of fixing nitrates than those usually found in the soil.

Experiments carried on by one of the State Experiment Stations proved that these high-bred cultures would produce from one to four hundred per cent. more nitrates than those usually found in the soil. It is also true that the increased activity of the bacteria means quicker production of nitrates and ample supplies of this most essential material during the early stages of the growth of the plant.

Every form of vegetable life can be improved by proper methods of selection and breeding, and it was the realization of this well-known principle that led to this important phase of Dr. Earp-Thomas' work, and his subsequent discoveries.

Having procured the means of breeding pure active cultures it became necessary to devise some means of preserving them, until such time as they could be used. The earlier attempts of the United States Department of Agriculture, and other people to send the bacteria to the farmer, dried in cotton, had not proved successful, and the bacteria when sent in a liquid preparation in sealed bottles, soon lost their vitality from lack of atmospheric nitrogen.

Were it possible to keep bacteria in good condition in a liquid medium there would still be strong objection to this method, as it is impossible in such preparations to detect the presence of moulds and other contaminations that are dangerous to the nitrogen fixing bacteria. The value of all cultures of bacteria depends very largely on their purity and freedoom from contamination. Dr. Earp-Thomas' method of growing cultures on the surface of the jelly in the bottles in which they are sent to the user enables him to easily detect such imperfections and prevent their distribution.

The invention of a bottle stopper which admits a supply of air through a glass tube containing cotton filter plugs, that keeps out contaminations, yet it is so constructed as to prevent the escape or evaporation of the contents of the bottle, is not simply an ingenious device, but a remarkable contribution to the art of preserving bacteria and protecting the cultures from destructive elements. The development of these methods and processes means that another of Nature's forces has been harnessed for the benefit of mankind, and the question of maintaining the supply of nitrates in the soil is finally solved.

To secure the best results from the use of nitrogen fixing bacteria, some consideration must be given to the conditions of soil that are most favorable to their growth, and the most important is the question whether the land is acid or alkaline.

The development in the land of beneficial soil bacteria of various kinds is to a great extent dependent on proper chemical conditions. Microscopic examination of soil and the determination of the kinds of bacteria that are found therein, will tell the story of its fertility more surely than chemical analysis, as the presence of some form of bacteria is a sure sign of its productiveness, whereas other kinds indicate improper conditions that must be corrected if good results are to follow. It has been found that highly productive land contains large quantities of beneficial bacteria, whereas poor soil is deficient in this respect, but often contains large quantities of organisms that are known to be injurious in their effect on plant life, and destructive to the nitrogen fixing bacteria. The protozoa, and the various forms of fungi yeasts and anaerobes belong to this class. Science has not yet determined the practical means of exterminating all of these forms, but much has been learned about conditions that are favorable to the nitrogen fixing bacteria, and this knowledge is available to every farmer. Good drainage and cultivation are well known requisites for good farming, but the beneficial effect of lime may not be so well understood. Bacteria cannot fix nitrogen in the soil without some base with which it can be combined, and lime is by far the cheapest material that nature has provided for this purpose. Lime also has strong chemical action, and neutralizes the acid conditions of the soil. Land that is acid or sour is fatal to the growth of the nitrogen fixing bacteria, and the corrective use of lime is most valuable. The use of green manures and fertilizers makes the application of lime absolutely essential. Heavy soils require more than light soils.

Loss of nitrogen in the soil is often the result of denitrifying bacteria which exist in heavy wet soils and decaying organic matter. Such conditions can be prevented by proper drainage and the application of lime to lighten the soil, and put it in proper condition for the growth of legume crops that have been inoculated with pure cultures of high-bred bacteria.—*N. W. Farm and Home.*

DESICCATION AIR BY CALCIUM CHLORIDE*

This method of drying the air for blast furnaces has been put into operation at Differdange. The process is as follows:—

A layer of broken calcium chloride, the smaller pieces at the bottom and the larger pieces at the top, rests on a sieve. Within the mass of the calcium chloride and in its lower part is submerged a spiral grating consisting of pipes for the circulation of water. The air to be dried is drawn downwards through the calcium chloride by a fan. The heat evolved by the action of the water on the lime is carried away by the water within the spiral. When the outside pellicle of the broken pieces commences to liquate hydration is stopped and regeneration begun. To do this it is only necessary to attain temperatures between 175 deg. and 235 deg., at which $CaCl_2 + 1\ H_2O$ is formed. It is necessary gradually to raise the temperature in such a manner as constantly to maintain the hydrates in their solid phase.

It is necessary also in the course of this regeneration to be careful not to exceed the temperature of 235 deg., above which the "tardy" hydrate $CaCl_2 + 1\ H_2O$, is formed.

*From a paper before the Iron and Steel Institute of Great Britain, by Felix A. Daubine and Eugene V. Roy, Aubone, France.

It may be seen from the foregoing that it is possible to effect the regeneration of the calcium chloride with sources of heat of comparatively low grade, and that it is possible to employ with this object the waste fumes which occur plentifully in all metallurgical works.

The regeneration of the calcium chloride having been effected by this systematic warming, it is necessary in order to render it again fit for the complete absorption of water vapour to cool it thoroughly. This cooling is quickly attained by a rapid circulation of water in the pipe system. When the temperature has returned to that of the average environment the chloride of calcium has regained all its hygroscopic properties, and is capable of dessiccating afresh the new volumes of air.

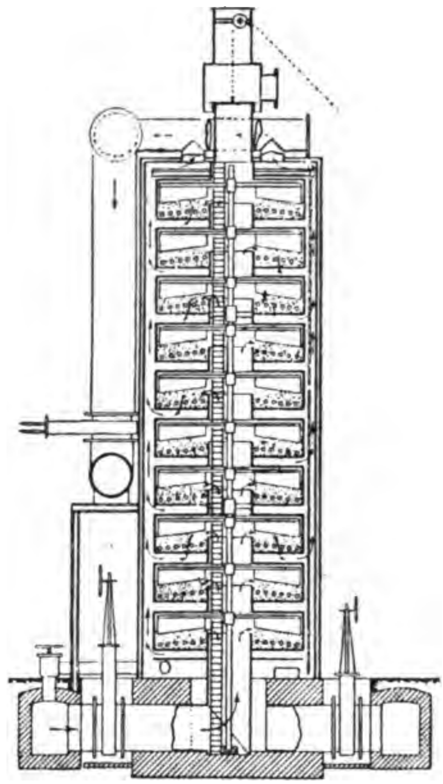
A mass of calcium chloride of 240 kilos. spread out in a layer of 24 cm. in depth, on a square metre of surface, will desiccate 300 cubic metres of air per hour, for four hours, under average conditions of 15 grammes of moisture per cubic metre.

In order to regenerate the calcium chloride from its hygrates, calculation shows that it is necessary to expend about 7.500 calories per kilogramme of water deposited. In practice it suffices to circulate from below upwards—that is, in the opposite direction to the air current—warm air or fumes devoid of dust at gradually increasing temperatures from about 30 deg. to 200 deg. during a period equal to half the length of time of the passage of the air current—that is, for the example given above, for two hours.

Experiment has shown that it is possible in a well-watched and carefully-conducted operation to attain a degree of desiccation such that the hygrometric condition of the desiccated air will be for the average period of passage but 10 to 15 per cent. of its saturation at a temperature of 15 deg.

The problem at the Differdange Works was to desiccate the whole of the air required for the blowing of a blast furnace of 150 tons per twenty-four hours. In the design shown in the cut the blast is introduced by a central well, and distributed in layers by means of the openings leading to different superposed reservoirs. On emerging from the latter it is collected in an annular chamber, whence it is led to the place where it is to be utilized.

In order to be able to regenerate the chloride of calcium on the spot, the central well—or the annular chamber—is connected with a second pipe, admitting air or hot gases. The arrangement of the fans is such that it is possible, at will, either to pass the air to be dried, or the gases which are to serve for the regeneration, through the apparatus, or else to isolate it completely during the cooling down. The apparatus, which is in triplicate, dries 30,000 cubic metres of air hourly, and has the following proportions:—Total area presented to the passage of the blast, 100 square metres per apparatus; number of compartments, ten; depth of layer of calcium chloride in each compartment, 24 cm.; apparent density of the chloride of calcium, 1.0; weight of chloride of calcium contained in each apparatus, 24,000 kilos.; weight of chloride of calcium contained in all three appliances, 72,000 kilos.; cooling surface of the spirals in each apparatus, 170 square metres. These appliances have been designed to work in the most unfavorable conditions—that is to say, to remove, during the summer months, 15 grammes of moisture



CALCIUM CHLORIDE AIR DRYER.

per cubic metre of air during a period of four hours.

At the time of writing this paper the appliances have been working normally for six weeks; but as the season is the end of winter, and as the moisture in the air is not very large, it has been found unnecessary to make as many reversals as were contemplated. Each apparatus receives the blast for six to eight hours. The air, which contains 6 to 8 grammes of moisture before its passage, only contains from 1 to 1.5 gramme per cubic metre on emerging from the apparatus, and this figure remains practically constant from the commencement to the conclusion of the period. Regeneration requires four hours for its completion, and is carried out by means of the waste smoke gases from boilers and from Cowper stoves. These gases, cleaned to the extent of 0.4 gramme per cubic metre, pass directly through the mass of chloride. The temperature is regulated at 30 deg. to commence with, and thereafter gradually raised in conformity with a certain ascertained law up to about 200 deg. In the summer the temperature will be carried to 275 deg. Cooling takes three hours.

The installation has cost a little less than one-quarter of what would have been the cost of an installation for desiccation by means of refrigerating machines. One man for the day shift and one for the night shift are sufficient to handle the apparatus, which is of the most simple description. The expenses of working are thus greatly reduced.

THE INTERCOOLER IN STAGE COMPRESSION

The following article by J. William Jones, Painted Post, N. Y., is reproduced (with some condensation) from the June, 1911, issue of *Machinery*.

In compressing air to 100 pounds gage pressure, the final temperature, assuming the compression to be adiabatic, would be about 485 degrees F. The effect of this increase in temperature is to expand the air under compression to a larger volume, thus necessitating a corresponding increase of work to compress it. After the compressed air has been discharged into the receiver or pipe line the temperature rapidly falls to that of the surrounding atmosphere, and the energy due to the heat generated during compression is lost. In theory, the air should be kept at a constant temperature during the period of compression; but the attainment of this is a practical impossibility in compressors of the present day.

In modern compressor practice, the work is divided between two or more stages, the number of stages depending on the final pressure required, and the employment of an "intercooler" between the different stages to reduce the temperature of the compressed air to the normal between the stages. In effect, this arrangement is equivalent to doing all the work in a single cylinder if it were possible to stop the piston at a certain point of the stroke, reduce the temperature of the air already partially compressed to that of the surrounding atmosphere, at the same time moving the piston forward just fast enough to keep the pressure constant, and then starting the piston again and continuing the compression to the desired pressure.

A sectional view of an intercooler built in accordance with modern practice is shown in Fig. 1. This intercooler consists of a long shell of cylindrical shape containing a nest of tubes through which cold water is circulated. The air enters at one end of the shell from the low-pressure cylinder at a high temperature, passes around and between the nest of tubes and enters the high-pressure cylinder at the other end at a greatly reduced temperature. This cooler is usually placed immediately above or below the cylinders in order to secure the shortest connections possible, the air remaining in these connections being denied the cooling effect of either the cooler nest or the water jackets of the cylinders.

As the intercooler is primarily the medium through which the saving in power is to be derived, it is obvious that unless proper attention is given to all its details the desired effect may not be realized. The essential points to be considered in the design of an intercooler are: Cooling surface, efficient water circulation, volume of cooler, proper deflection of the air around and between the tubes, convenient drains, and accessibility to the tubes.

The amount of cooling surface required is generally based on the quantity of "free air" compressed per minute. As the thermal condition of the air subject to compression is dependent on the final pressure, it is evident that the amount of cooling surface in relation to the free air capacity of the compressor varies with the discharge pressure. Theoretically,, the cooler should have a sufficient amount of cooling surface to reduce the temperature of the air between the two stages to the same point at which it was first taken into the low-pressure air cylinder. In practical working conditions, however, it will be found that the majority of coolers fail to accomplish this result, and a reduction to within 5 or 10 degrees of the original is usually conceded to be good practice.

An efficient water circulation is a matter which requires some thought and consideration, as the water is the agent which absorbs

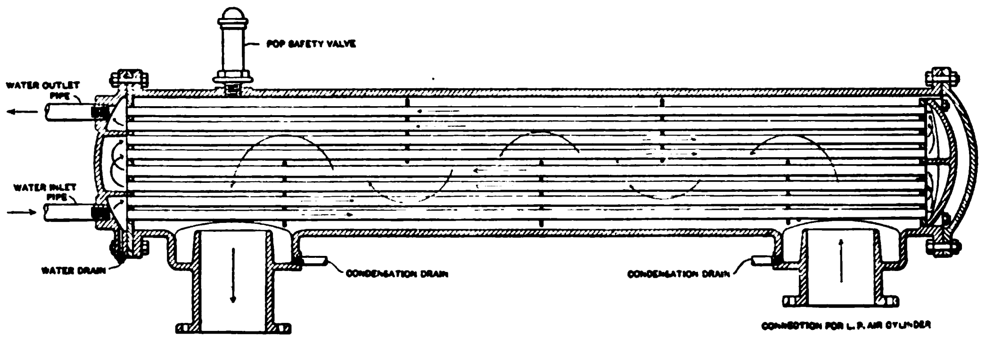


FIG. 1.

the heat units. The flow of the water should be through unrestricted pipes at such a velocity that the maximum number of thermal units is absorbed and carried away by the water. The best practice is to make the general flow of the water opposite to that of the air; the hottest air will then come in contact with that portion of the tubes containing the warmest water, and as the air in gradually cooled it comes in contact with the cooler portion of the cooling nest. In the intercooler shown in Fig. 1, the water circulates the entire length of the cooling nest four times. Entering through the lower pipe attached to the outside water head, the water being deflected by the partitions in the heads, circulates as indicated by the arrows shown on the small pipes. This circulation system is in accordance with the laws of thermo-dynamics; the hot water gradually finds its way to a higher level until it is finally discharged through the upper pipe leading from the outside water head.

It is good practice to make the cooler of such cross-section as to readily admit a free passage of the air after the "baffle plates" have been placed; and then, having determined this area, make the cooler of such length as is required to obtain the necessary amount of cooling surface. It is obvious that a cooler of large volume has advantages over one of smaller volume, even if the cooling surfaces be equal, because the air, in passing from the low to the high-pressure air cylinder, has a longer period of contact with the cooling tubes in the cooler which has the greater volume.

The compressed air should be well deflected in its course through the cooler. This result is obtained by placing several "baffle plates" in the cooler, as shown in the illustration, which deflect the air alternately towards each side, thus bringing the air into contact with all parts of the cooling nest.

There are several small details of intercooler construction which should not be neglected, such as proper drains for drawing off the condensation of the air. The moisture of the air is in the form of a vapor, which when rapidly cooled, is condensed, and should be drawn off at stated intervals. Convenient drain connections should also be provided for draining the cooling nest in case of a suspension of the operation of the compressor at any time when freezing is liable to occur. It will be noticed that the cooler shown in Fig. 1 is so constructed that the entire nest of tubes can be withdrawn at any time for examination or cleaning purposes.

THE THEORY OF STAGE COMPRESSION WITH INTERCOOLING.

The theory of compound or stage compression is very readily understood. In the first paragraph of this article a statement was made relating to the heat produced in the compression of air. For all pressures above 70 pounds per square inch, it is generally conceded that compound or stage compression should be employed. The heat of compression increases with the pressure; therefore, the higher the pressure the more difficult it is to reduce the temperature to a point enabling efficient compression conditions and proper lubrication of the air cylinders. In compressing air to 100 pounds terminal gage pressure in a single stage compressor, the final temperature of the air would be about 485 degrees F., as before mentioned. Some of this heat would be absorbed by the cylinder walls; yet the final temperature would remain too high to insure efficient compression conditions or proper lubrication. The adoption of stage compression with intercooling between the stages, although introduced some thirty to forty years ago, has been neglected by many compressor builders until within the last decade. At the present time stage compression is almost universally employed for all pressures above 70 pounds. unless the compressor is of such small size as to make compounding an uncommercial proposition.

In Fig. 2 is shown a theoretical combined indicator diagram from a two-stage compressor. In this diagram it is assumed that the compression follows the adiabatic curve in both high- and low-pressure cylinders with perfect intercooling between the two stages. The horizontal lines *A B* and *C D* represent respectively the volumes of the low- and the high-pressure air cylinders, drawn to the same scale. The vertical line *A C F* on this diagram will represent pressures to some designated scale. The adiabatic curve *B E K* represents the relation between pressure and volume for any position of the piston, assuming that there is no intercooler employed and that no heat radiates through the cylinder walls. In other words, this curve is the one which compression would theoretically follow in a single cylinder with no intercooling. In this curve the product $P\ V^{1.41}$* is constant, *P* and *V* representing pressure and volume respectively. On the other hand the isothermal curve *B D H* shows the relation between pressure and volume providing the temperature

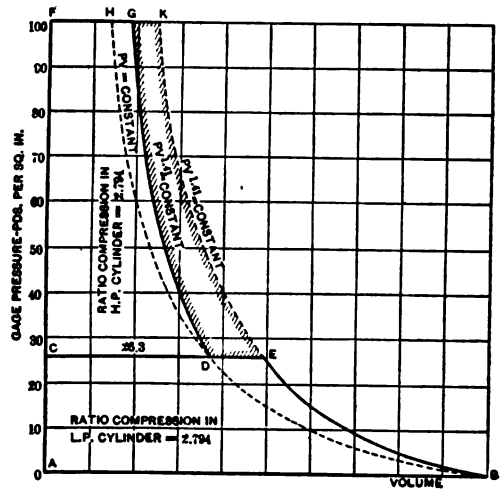


FIG. 2.

of the air under compression could be kept constant so that the product *P V* would also be constant.

Air taken into the low-pressure air cylinder at zero gage pressure, is compressed along the adiabatic curve *B E* until at the point *E* it attains a pressure of 26.3 pounds, equal to that of the intercooler, which allows the discharge valves to open and the air to pass into the cooler. In the intercooler the volume of a definite weight of the air is reduced from *C E* to *C D* so that the volume entering the high-pressure cylinder is less to the extent of *D E*, which is to the same scale as *C D* and *A B*. This means that the given weight of air represented by the volume *C E* at a gage pressure of 26.3 pounds, when cooled to the same temperature at which it was originally taken into the low-pressure air cylinder will be reduced in volume to *C D* providing the pressure of 26.3 pounds remains constant. The air taken into the high-pressure air cylinder at 26.3 pounds is compressed along the adiabatic curve *D G*. At the point *G* the high-pressure discharge valves open, and the air is discharged into the receiver at the desired gage pressure of 100 pounds. The shaded portion represents the power saving effected by the intercooler.

Assuming that a volume of 1,000 cubic feet of free air per minute is to be compressed to a gage pressure of 100 pounds with perfect intercooling between the stages, 153 horsepower is required. Compressing this same amount of

*The exponent 1.41 is the ratio between the specific heat of air at constant pressure and at constant volume.

air in the same time in a single stage requires an expenditure of 180 horsepower. This excess is equivalent to a saving of about 15 per cent. in two stage compression, which can be attributed directly to the intercooler. The actual saving, however, would fall somewhat below the above percentage, due to the fact that there are necessarily more frictional losses in the two stage machine than in one having a single cylinder; also the intercooler cannot be relied upon to reduce the temperature of the air between the stages to the normal in all cases. It is safe to state, however, that the saving in compressing to 100 pounds gage pressure would equal or exceed 10 per cent. in a well-designed compressor. At higher pressures, the saving in power is much more marked.

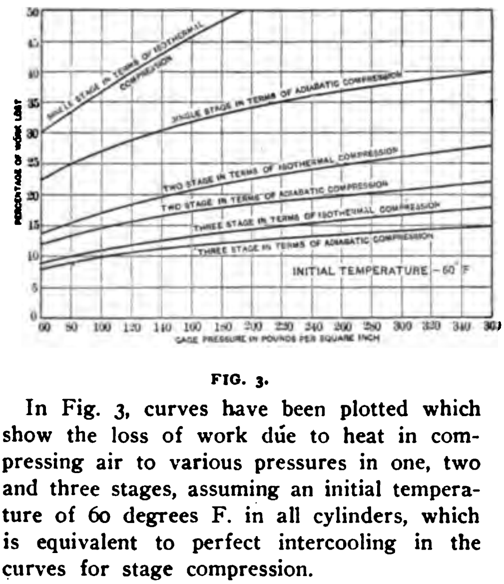


FIG. 3.

In Fig. 3, curves have been plotted which show the loss of work due to heat in compressing air to various pressures in one, two and three stages, assuming an initial temperature of 60 degrees F. in all cylinders, which is equivalent to perfect intercooling in the curves for stage compression.

As previously stated, the intercooler is primarily the medium on which the principle of compound compression is based, yet the saving due to the reduction in temperature between the stages does not constitute all the advantages of stage compression. The maximum temperature in each cylinder is reduced to a point where the heat can be more thoroughly drawn off by the water jackets surrounding the cylinder walls; also, the lower temperature in the cylinders is less liable to affect a good oil, thus insuring good lubrication of the pistons, valves, etc., with easier running conditions, less wear and longer life.

INCREASED VOLUMETRIC EFFICIENCY.

The volumetric efficiency of a compound compressor is obviously greater than that of one having a single cylinder. The compressed air remaining in the clearance space of the low-pressure cylinder, being at a much lower pressure, requires less movement of the piston on the return stroke before the air in the clearance space is expanded to a pressure equal to that of the surrounding atmosphere, which permits an opening of the air inlet valve. As free air is taken into the low pressure cylinder only, the high-pressure cylinder bears no relation to volumetric efficiency. The reduced temperature conditions in the low-pressure cylinder also causes less heating of the intake air when it comes in contact with the cylinder heads and walls, which results in obtaining a denser volume of air at each stroke of the piston, with a corresponding increase of volumetric capacity.

In addition to the advantages already mentioned, the maximum stresses in a compound compressor are reduced to about 55 per cent. of what they would be in a single stage machine compressing to the same pressure. In a single stage compressor having a cylinder of 20 inches diameter compressing to 100 pounds terminal gage pressure, the piston starts against no load and at the end of the stroke meets a maximum resistance of 31,416 pounds. Assuming the compressor to be running at a speed of 150 revolutions per minute, the piston meets this resistance and its release 300 times every minute. On the other hand, a two stage machine compressing to this same pressure with the intake or low-pressure cylinder of the same size as the above-mentioned single stage cylinder, would encounter a maximum pressure of only 9,424 pounds when working against a cooler pressure of approximately 30 pounds. In order to divide the load equally, the high-pressure piston area would be proportioned to the low-pressure piston area in the same ratio as the square roots of their absolute pressures. That is

High pressure area $: 314.16 :: \sqrt{14.7} : \sqrt{114.7}$.
Or high-pressure area $= 112.5$ square inches.

The area 112.5 square inches is equivalent to a high-pressure cylinder diameter of about 12 inches. Compressing from 30 to 100 pounds in the high-pressure cylinder gives a maximum unbalanced pressure of 70 pounds, which is equal to a maximum load of 7,917 pounds to be met in this cylinder. The total maximum resistance in both high- and low-pressure cylinders, is therefore, 9,424 pounds plus 7,917 pounds, or 17,341 pounds, which is only about 55 per cent. of that in the single stage compressor.

CARE AND USE OF AIR DRILLS AND HAMMERS

BY JAMES H. MAGUIRE.

Since the introduction of air tools much has been said for their economy in some cases and their expense in others. But although they may be expensive to buy, and in some cases expensive to maintain, in large erecting establishments they have become indispensable.

As to their use, you can have one hundred men on a floor and under certain conditions get along with five drills and nobody will ever be waiting, and on the other hand, you can have eight or ten drills on the same job and still have a lot of hand drilling to do.

Just put your head to work and look around. You see jobs that some men are doing where they use a drill about four hours a day and when finished they put it on the floor, somewhere, so that even they, when wanting it later, may not know where to find it; others desiring to use a drill and not knowing just where to get one, may lose considerable time in searching. Another class of men, when through with a drill or hammer, will hide it or lock it up so as to be able to get it when they need it again. Either way is wrong. Some common place should be selected to keep the drills and hammers; a large pan on which to lay them so that the oil will not run on the floor, and pegs of about 4 or 5 inches in diameter arranged to hang the hose on. When not in use hose should never be left lying around on the floor where trucks and castings may injure it. When a man wishes to use a drill he goes to the pan and selects the one required for his work. He will find there a key for the chucks and a hose. If there are no drills there, the noise from where they are running, or the sight of the hose, if they are piped from above, attracts him to where the drills are in use. When through using the drill he returns it, together with the key and hose to the common keeping place, so that the next man that wants it may know just where to find it. Don't let every man who uses a drill try to repair it; he loses time and frequently spoils it. Have a man who is schooled in the mechanism of the various machines to look after the repairs and forbid others to touch them.

In choosing a hammer, care must be taken to get one just right for your work, if possible. Don't get one that has too strong a blow, any more than you would get one that would not be strong enough to accomplish the work desired of it. If the hammer is used, say, for snagging castings, and the blow delivered knocks off the snags, and then has some kick beyond, you are tiring your operator unnecessarily. A very neat and handy way to help a man using a hammer is to make a sling suspended from his shoulder to help him hold the hammer; it helps wonderfully.

A word about the use of drills. As it very often happens, it takes a much shorter time to drill a hole with an air drill than it takes to fasten the drill to the desired place. So look to your tackle and see that the brackets used to hold the drills can be not only applied firmly but quickly, and train your men to handle them with the least possible outlay of energy and time. Don't install air drills, hammers, lifts, etc., and then not make it pay.

OILING PNEUMATIC TOOLS.

We now come to the most important item in the care of air tools—the oiling. As to the kind of oil, it is yet, to my mind, an open question. My best results have been with sewing-machine oil. Some of the manufacturers tell you to "use one-half pint of good oil every day in this machine." You can live up to that and still not have your machine properly oiled, and you can get along with one-quarter of that oil and have your machine oiled as it should be. Most machines have a hole or several holes marked "oil here." Oil in those places, of course. One of these holes is always in the crank case. After pouring in a quantity of oil let the drill stand in an upright position for a half a minute or so to let the oil run into the gear case, or whatever mechanism may be in the lower part of the machine, meanwhile turning the chuck so the oil may work into the gearing; then tip the machine upside down and let it stand for another half a minute to let the oil work into the upper part of the machine; now pour out nearly all the oil that will run out of oil hole in the crank case, and if you find you have to pour out too much, put less oil in next day, until you have arrived at exactly the amount required to oil your machine thoroughly and leave a little in the case for the cranks to dash into the cylinders. No need of putting in a lot more oil than you need and then blow it out through your exhaust. Don't forget the following: pour just a little oil into the hole where your air enters so as to oil the valves. Some people recommend keeping the hammers in an oil bath when not in use. I get excellent results from mine by oiling four times a day with sewing-machine oil, and soaking them in a bath of benzine once a week. Drills should also be cleaned once a week with benzine. Now, the oil you pour out from your machines which, by the way, should be but little, as good oil of the kind described is expensive, you should save and run through a filter, not to be used again in the air tools, but to be used to oil shafting, etc.

In conclusion a few rules:

Until you are sure you have some better lubricant, use sewing-machine oil.

Oil drills once a day.

Oil hammers four times a day.

Clean both once a week with benzine.

Don't let every Tom, Dick and Harry try to repair your machines.

Get the most out of your equipment by having proper brackets and rigs, and when your machines and hose are not in use have them so anyone requiring them will know where to get them, and have them brought to this keeping place every night so that the man appointed to oil them will have his work done before the machines are needed for use in the morning.

You will find yourself amply repaid for any little trouble you may be put to, to organize some method of care and use of these valuable tools.—*American Machinist.*

Another steamship has been raised by the Arbuckle compressed air method. This time the vessel was the "Soperga," an Italian ship which went ashore on Molasses Reef on her way from New York to Galveston. The apparatus was applied April 29th, and on May 6th the vessel was afloat.

STORAGE OF COMPRESSED ACETYLENE

Ever since illuminating gas came into gener use, attempts have been made to compress it into portable steel cylinders or flasks for use on vehicles, and for country residences. The results obtained, however, were unsatisfactory, for illuminating gas is generally a mixture of many different gases, some of which easily liquefy under pressure while others, like methane, hydrogen, etc., can be liquefied only at very low temperatures. When these cylinders are connected up for use, the gas fed to the burner will vary greatly as to its heating and illuminating properties. Then there is always a certain part, generally as much as ten per cent., that will not volatilize but remains as a tarry deposit in the cylinder. Theoretically, acetylene is admirably adapted for this purpose, for it is homogeneous in its composition, leaves no deposit in the cylinder, and when properly fed to a suitable burner it gives an intense brilliant white light which is superior in many ways to any other form of illuminant.

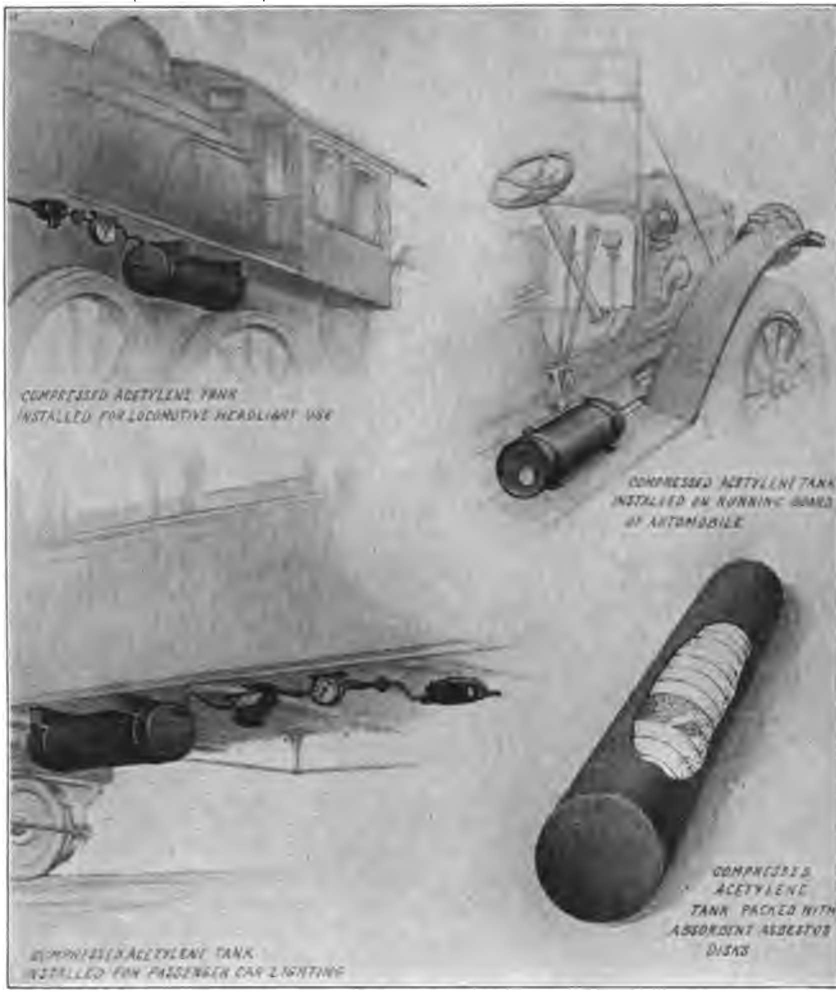
The introduction of acetylene for lighting and other industrial purposes, is of rather recent date. Prior to 1895, this gas was scarcely known outside chemical laboratories, but the discovery of calcium carbide and the process of making it, made this gas available for commercial use. Acetylene belongs to the class of unsaturated hydrocarbons and is unstable except at moderate pressures and temperatures. Its critical temperature is 37 deg. C., and pressure 68 atmospheres; however, it may be liquefied by a pressure of 21.53 atmospheres if the temperature is reduced to 0 degrees, and one cubic foot of this liquid would produce 400 cubic feet of gaseous acetylene at atmospheric pressure. If acetylene could be safely compressed and stored in steel cylinders in this cheap and simple manner, its use to-day would be much more general than it is, but liquid acetylene at normal temperatures is about as touchy as fulminate of mercury, and its disruptive power equal to that of nitroglycerine. Early attempts to handle acetylene in this form were fraught with numerous violent explosions. Usually it was impossible to discover the primary cause of the explosion, for the witnesses rarely ever survived the disaster, but it is probable that it was due to heat generated in manipulating the outlet valve or to some blow on the cylinder.

Acetylene under a pressure of less than two atmospheres or thirty pounds per square inch is practically safe against explosion. Should the gas be brought in contact with a wire at white heat or should a priming of fulminate of mercury be exploded in the cylinder of gas at this pressure, the gas in immediate contact with the wire of fulminate will be decomposed, but the explosion would not be transmitted to the whole mass. When under greater pressure, an explosion caused by heat or concussion at one point, is instantly transmitted through the whole mass, causing a violent explosion. If the gas is in the liquid form, the pressure generated is enormous amounting to 5,000 or 6,000 atmospheres.

In exploding, acetylene disintegrates and hydrogen is set free, and usually takes fire as it comes in contact with the air, while the carbon is thrown down in the form of an extremely fine impalpable powder. It is possible that carbon obtained in this manner, called "acetylene black" by Hubou, may yet replace lamp black for delicate work. It has a pure black cast or tint, is free from grease, and is especially suited for making black paint, printer's ink and for printing calico.

About 1897, Georges Claude, of liquid air fame, and another Frenchman, M. A. Hess, discovered that acetone, a combustible liquid resembling wood alcohol, would readily absorb acetylene gas. In putting this discovery in practical use, they partially filled the cylinder with acetone and then forced the gas in under a pressure of about twelve atmospheres. At this pressure and at ordinary temperature, the acetone will absorb about 300 times its own volume of the gas. When the valve is opened the pressure is reduced and the surplus gas passes off to the point of use, such as a burner, leaving the acetone unaltered and capable of taking up a fresh charge of gas. In all cases where acetone is used, the valve must be kept at the top to prevent its escape. No trouble, however, would result should it get mixed with the gas, since it itself is inflammable. The gas stored in this way is safe against explosion so long as the cylinder is full, but this process is open to one serious objection. Acetone increases in volume when it absorbs the gas. A cylinder having only forty-seven per cent. of its volume filled with acetone at the beginning will be entirely filled with liquid when fully charged with the gas, and when the gas is escaping it shrinks, so that a cylinder which has been in use for some time will have a space at the top filled with gas under a dangerous pressure. Under a pressure of ten atmospheres (150 pounds) the presence of the acetone is an element of safety, for the acetylene dissolved therein does not explode, but should the pressure be over twenty atmospheres (300 pounds) it does explode and adds its heat of combustion to that evolved by the acetylene. While this process greatly reduced the chances of explosion, still the use of acetone alone was too dangerous to make the process a commercial success.

A few years later, Edmund Fouché, of Paris, added the final element which made compressed acetylene a commercial possibility. He first placed in the cylinder a filler of some inert porous substance, such as asbestos, infusorial earth, or charcoal, etc., and then added the acetone in which the gas was absorbed as before. In this way he prevented the existence of any considerable volume of compressed gas at any one point. In the illustration is shown one form or filler now in use. It consists of disks of asbestos entirely filling the cylinder. This filler decreases the gas holding capacity about twenty per cent., but its addition renders the gas entirely safe against explosion. In practice, these cylinders charged under ten atmospheres will hold about 100 volumes of the gas measured at atmospheric pressure. A platinum wire passing through the cylinder and heated electrically to a white heat has no other effect than to decompose the gas in immediate contact with it, for the porous filler effectually prevents the further spread of the explosive wave. The porous filler alone, when composed of charcoal, forms a perfectly safe medium for the storage of the compressed gas if the pressure does not exceed seven atmospheres. At this pressure, according to Capelle, a cylinder of one liter capacity will hold eight to nine liters of acetylene measured at atmospheric pressure. This is a cheap method and may be used advantageously where a large reserve supply is not needed. When the cylinders are exhausted they are usually sent to some central charging station. Here acetylene from the generator, after being purified, is com-



COMPRESSED ACETYLENE GAS STORAGE.

pressed generally in two stages, carefully cooled and then forced into large storage tanks which also contain a porous filler and acetone. The exhausted cylinders are connected up and charged directly from these tanks.

The consumption of compressed acetylene has become enormous in recent years. Small portable generators are not practicable in winter, as the water is apt to freeze, but the solution of acetone and acetylene will not freeze during the coldest weather. To-day no automobile is considered complete without a cylinder of acetylene for lighting purposes. The cylinders are also extensively used in lighting railway cars, boats, buildings, and for oxy-acetylene flame apparatus. As yet they are used but to a limited extent on locomotives for supplying the head lights, but this field may widen in future, for the light produced by acetylene comes nearer to being the same as sunlight than any other forms of artificial illuminant, and hence does not distort or alter the colors of the various signals used in railway work.—*Scientific American.*

The loss of power in a gas engine owing to its installation at considerable elevations above sea level may be roughly estimated at about 3⅓ per cent. for each thousand feet. The decrease in barometric height is about one inch for 950 feet of altitude.

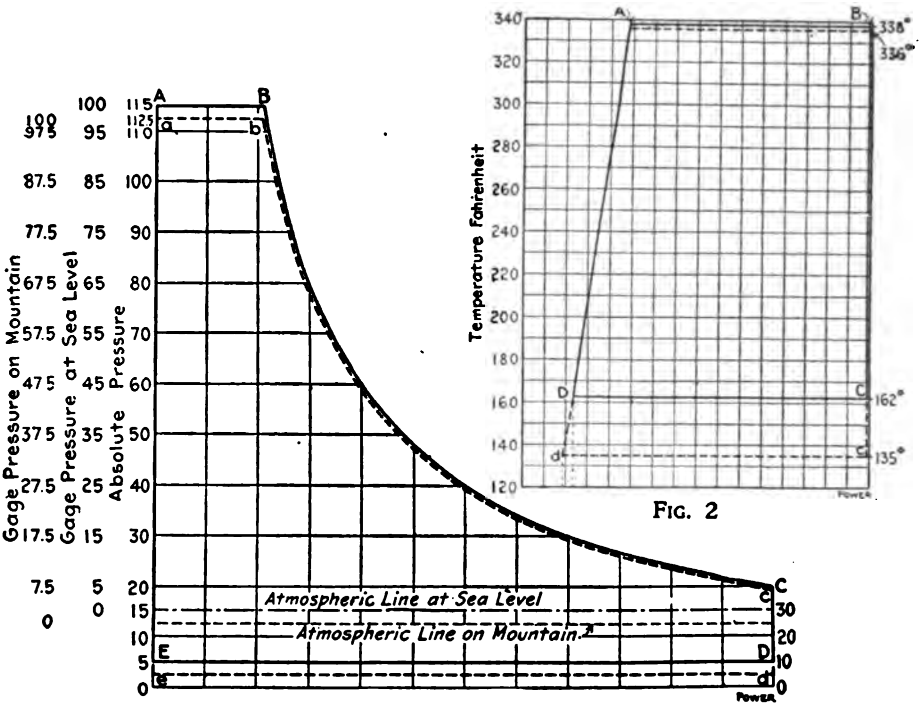


FIG. 2

FIG. 1

THE EFFECT OF VACUUM AT AN ALTITUDE

In a recent issue of *Power* the question was asked: "At a height of a mile is the vacuum in an engine cylinder as effective as at the sea level?"

And answered: "It is."

In an effort to be laconic the editor who wrote the answer failed to put himself into the mental attitude of the man who wrote the question. If the question asked no more than whether a given force is just as effective to move a piston in Colorado as in New York his answer is right, but the question is not worth answering. Adding twenty inches of vacuum will add, in round numbers, ten pounds to the mean effective pressure, and this wherever the engine may be, but this is too obvious to be taken as the point in the question. The atmospheric line from which it is reckoned has slipped downward at the higher altitude.

Suppose an engine with an initial pressure of 100 pounds gage and a vacuum of 20 inches to be run, first with a 30-inch barometer, as there might be at the sea level, and then with a 25-inch barometer, as there might be at the altitude of a mile. To simplify the matter, since we are not after absolute results, assume 2 inches of mercury to be equal to one pound pressure.

Then at the sea level with the 30-inch barometer the atmospheric pressure would be 15 pounds and the absolute initial pressure 115 pounds per square inch.

With a 20-inch vacuum the absolute back pressure in the cylinder would be 30 — 20 = 10 inches of mercury, or 5 pounds.

The ideal diagram would be *A B C D E* of Fig. 1, which, with a ratio of expansion of 6, gives a theoretical mean effective pressure of 48.5 pounds.

On the mountain, with the 25-inch barometer the atmospheric pressure would be 12.5 and the absolute initial pressure 112.5 pounds. With a 20-inch vacuum the back pressure in the cylinder would be 25 — 20 = 5 inches of mercury, or 2.5 pounds absolute.

The ideal diagram would be *a b c d e,* represented by the dotted lines, and, with six expansions as before, would give a mean effective pressure of 49.8 pounds; 2.7 per cent. more than in the case of the same engine with the same initial pressure (gage) and the same vacuum at the sea level.

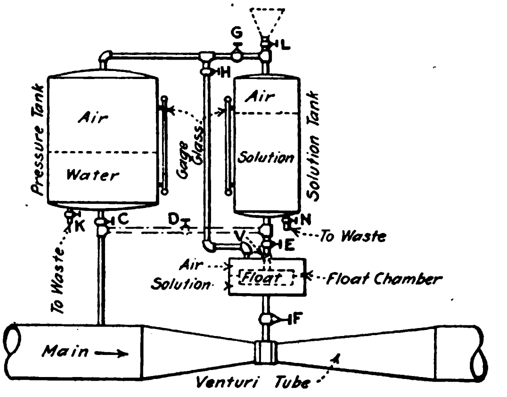
The effect of the condenser is to reduce the lower temperature level, to increase the head or fall of the heat between the temperatures of entry and rejection. A 20-inch vacuum on a mountain means a lower absolute pressure and a lower temperature of rejection than does the same vacuum at the sea level.

In the diagram, Fig. 2, heights represent temperatures instead of pressures, as they do in Fig. 1, but the area represents energy just as does the area of the other diagram. The diagram should be plotted with absolute temperatures, so that its real base is $460 + 338 = 798$ units below the level *A B* and the area of the whole diagram would represent the energy in the form of heat which must be put into a pound of water to make it into a pound of dry saturated steam at the given pressure. The area *A B C D* shows how much of this heat a perfect engine, working in a Rankine cycle between the limits 338 and 162 degrees (100 pounds initial and 20 inches vacuum at 30-inch barometer), could convert into mechanical energy as against that convertible by a similar engine working between the limits 336 and 135 degrees (100 pounds initial and 20 inches vacuum with 25-inch barometer), as shown by the area bounded by the dotted lines.—*Power.*

APPLYING CHEMICALS TO WATER IN PIPES UNDER PRESSURE

The modern tendency toward the use of hypochlorite and other disinfectants in the purification of water-supplies for drinking purposes has brought up the question of the most suitable means of applying these chemicals to the water.

To avoid contact with the pump valves, the solution can be added after the water has left the pumps; but the introduction of a definite proportion of some chemical solution into water flowing in a pipe under pressure is not an easy matter. The solution can be fed into the main readily enough by subjecting it to a pressure slightly exceeding the water pressure at the point where the feed pipe is attached, and the amount of solution introduced during any interval of time will depend on the difference between the feed pressure and the pressure in the main. The trouble is that the rate of flow through the main continually changes, so that the requirements are not met by simply maintaining the feed pressure at a definite amount above that in the main. The pressure difference could be adjusted to give the right mixture at the average rate of flow; but with diminishing flow through the main the water would be over-dosed, and under-dosed when the flow increased above the average.



A Device for Adding Hypochlorite or Other Disinfectants to Water in Pipes Under Pressure.

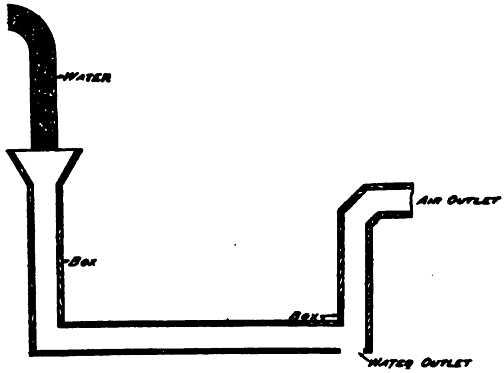
The problem has been met by the Simplex Valve & Meter Co., of 112 North Broad St., Philadelphia, Pa., by utilizing the well-known relationship between pressure drop and rate of flow in a Venturi tube.

The ingenious arrangement of the apparatus is shown diagrammatically in the accompanying illustration. The chief elements are the pressure tank, the solution tank and the float chamber. Solution is admitted to the float chamber from the solution tank through a needle valve V. This valve is controlled by a float which keeps the solution in the chamber at a constant level. The pipes shown by solid lines in the diagram are the only ones in use when the apparatus is feeding solution into the main. A pipe from the main just above the Venturi tube opens into the bottom of the pressure tank. Water rises in this pipe and compresses the air above it in the pressure tank until the pressure in the main is balanced. A pipe from the top of the pressure tank communicates with the upper end of the solution tank, and a branch from this same pipe opens into the float chamber. In this way, the same air pressure as exists in the pressure tank is made to act on the contents of the solution tank and the float chamber.

The proportion of solution fed into the water in the main is regulated by adjusting the gate valve F. By observing the rate at which the solution level drops in the gage glass on the solution tank and comparing it with the volume of water flowing in a given time through the Venturi tube, the proportion of solution being added can be definitely determined. When the valve F is once set at the correct opening, the solution will continue to flow at the desired ratio of grains per gallon regardless of variations in the amount of water flowing. This is because the pressure drop through the valve F is always practically the same as the difference in head at the full and contracted sections of the Venturi tube, which varies in direct proportion to the volume of water passing through.

The pressure on the solution in the float chamber will be slightly less than that in the main, due to the head of water in the pressure tank. This pressure difference would be of no consequence so long as it were constant, since it would be compensated in the adjustment of the feed valve F. As a matter of fact, however, the water in the pressure tank will rise while the solution is being drawn off from the solution tank. The amount of this rise will depend on the ration between the diameter of the pressure tank and the capacity of the solution tank. If the capacity of the solution tank be made, say, 130 gals., the rise of water can ordinarily be reduced to a fraction of one per cent. of the total head on the main by making the pressure tank 4 or 5 ft. in diameter. The effect on the solution feed will then be negligible.

As the solution is drawn off from the solution tank, the water rises in the pressure tank until finally when all the solution has been drawn off an equivalent volume of water will have been admitted to the pressure tank. The solution tank will meantime have received the same volume of compressed air. This air can be returned to the pressure tank by closing valves C and E and opening valves D and K. This causes water from the main to pass into the bottom of the solution tank and drive the air before it back into the pressure tank. The water in the pressure tank is driven out by the air and escapes through the drain valve K. The solution tank is next cut off from the main and from the pressure tank by closing valves G and D, and can then be emptied of water through the drain valve N. A fresh charge of solution is then poured in through the funnel shown by dotted lines, and everything is ready to begin feeding again as soon as the valves G, E and C are reopened.—*Engineering News.*



EARLY IRON MANUFACTURE AND A PRIMITIVE BLOWER

At a recent meeting of the Engineer's Society of Western Pennsylvania, when methods of iron and steel manufacture were under discussion, Mr. Jas. H. Baker said: In the matter of iron making it may interest my young friends to have a description of what I saw in this line 53 years ago in the mountains of Virginia. I would take my father's team and go to an iron works and wait all day while the forge made for us probably a ton of wrought iron from the pig. I am not an illustrator, but the accompanying rough sketch will show you how we obtained the blast to blow the open hearth fire in which the pig iron was melted down, refined, forged into a bloom, reheated and forged into bar iron. A fall of water of say 15 ft. was secured, and after falling some four or five feet to acquire velocity it entered an upright box or hollow log, the lower end of which was inserted in a horizontal box, and at the opposite end of this last and on the lower side was a hole to let the water out, while the air carried in all the falling water escaped from the top of the box through another vertical log or box and was carried to the forge. The hammer was run by tups fastened in the wooden shaft of an overshot water wheel, while the spring to give the hammer force was made of dry hickory wood. There were only two sizes of iron given out to iron wagons with, and from these we made all the small forgings as well as the large ones.

It takes 4.221 pounds of ore, 2,310 pounds of coke, which means about three thousand pounds of coal, and 1,147 pounds of limestone, a total of over four tons of ore, coal, and limestone, to make a ton of pig iron.

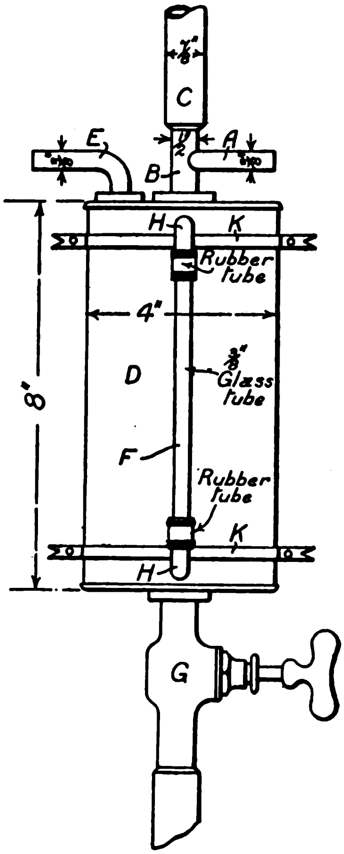


FIG. 1.

FIG. 2.

A WATER OPERATED LABORATORY BLOWER

By R. J. England.

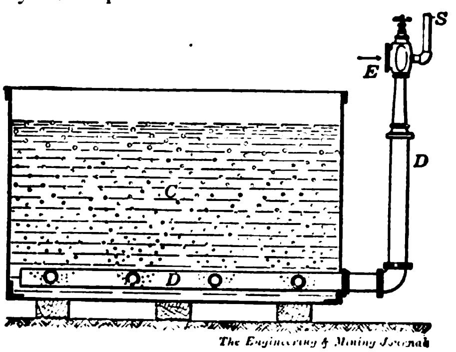
A very simple substitute for the usual bellows in connection with a blowlamp, etc., is shown in Fig. 1. Where a water main at fairly high pressure is available, this apparatus supplies a constant blast of air to the lamp at a pressure equal to that given by a good foot bellows, and the advantage of being able to give all one's attention to the work in hand is obviously very great.

The arrangement consists of a closed cylindrical vessel D of dimensions shown in Fig. 1, which is preferably made of brass, having a T piece fixed at the top. One end of limb B of the T piece is connected to the supply pipe C, while the other end communicates with the vessel D, the limb A being left open. A pipe E, also connected with the interior of D, is led from the top, and connected to the blowlamp, etc., by rubber tube. A water gauge F is fitted to D to enable the level of the water to be read, while G is the exhaust pipe, which must have a stop cock, as shown.

The action of the above apparatus is very simple. When connection is made with the main, water at a high pressure in the pipe C enters the T piece with a large velocity, the pressure energy of the water being here almost altogether changed to kinetic energy, the pressure in B falls below that of the atmosphere, and hence air rushes in through A, and mixing with the water, is carried into D. Now the stop cock on the exhaust pipe is so regulated that there is always a few inches of water in the lower part of D. It will be seen that the air which has been carried into D has now no way of escape except by the pipe E, so if this is closed the pressure in D must rise. Hence we can get a constant supply of air from the pipe E. A blower of the dimensions shown is in daily use in a large physics laboratory for sealing tubes and for glass work generally.

The vessel D is made of sheet brass with soldered joints, while the water gage is simply made by soldering in two ⅜ in. right-angle gas bends, as shown, and connecting the free ends to a piece of straight glass tube by means of rubber tube. The whole apparatus is fixed to the wall by two strips of metal KK, and is permanently connected up to the water main through a stop cock.

The above apparatus may be used also for drawing air through tubes, etc. Thus, suppose we wish to fill an optical instrument with dry air, to prevent condensation of moisture on the glasses in cold weather, all that is necessary is to connect one end of the instrument to be desiccated to drying tubes, etc., and the other end to limb A of the T piece on the blower. When the water is turned on a steady stream of air will be drawn through the drying tubes into the instrument. For this purpose the tube E and the stop cock G should be left full open. Of course, if it is only required for the latter purpose the T piece A B is alone required, and the rest of the blower may be dispensed with.



AIR-JET AGITATOR

DIRECT STEAM-COMPRESSED AIR FOR SLIME AGITATION

By Oskar Nagel.

Air compressors are generally used in the cyanide process for supplying the aëration necessary according to the equation:

$$2Au+4KCN+O+H_2O=2KAu(CN)_2+2KOH$$

If, without any extra expense the air for this reaction could be furnished by means of an appliance in which direct steam is the acting medium, it would mean a great advantage as compared to the present process, since the aëration would be coupled with a simultaneous costless heating of the solution. The effect of heating is important in the cyanide process, as it means an acceleration of the reaction and more rapid solution (Nernst has shown that in nearly all reactions the speed is doubled by a 10-deg. C. increase in temperature).

An apparatus suited for sucking or pressing air by means of steam through liquids is the steam-jet exhauster, shown in the accompanying illustration. *D* is the discharge, *E* the gas and *S* the steam entrance.

Compared with air pumps, these instruments have advantages which give them the preference wherever they are applicable, viz: (1) They have no moving parts and need practically no repairs; (2) the cost of the jet apparatus is only a fifth that of air pumps; (3) the jet apparatus may be simply inserted in the pipe line, while air pumps, as a rule, require foundations, and often separate buildings. These steam-jet exhausters are constructed for a mean steam pressure of 45 lb., and are built with capacities from 100 to 60,000 cu. ft. per hour.—*Engineering and Mining Journal.*

MARBLE

The word "marble" is not an exact scientific term, but merely a popular or trade designation for certain kinds of limestones. No definition can be made broad enough to include all of the marbles, or restricted enough to exclude certain limestones. The accepted definition is: "A crystalline limestone, capable of taking a high polish, and suitable for use in building or decoration." But some structural marbles are highly crystalline and yet take only a dull polish. There are limestones, on the contrary, that will take a polish and yet cannot be called marbles because of their lack of a crystalline texture. Lithographic limestone can be polished, but no one would think of calling it a marble because of its dullness and lack of distinction. Most of the foreign limestones that we are now using for interior decoration partake far more in their structure and texture of the nature of lithographic stone than of genuine marble. But because of their beauty in coloring and the soft polish they take, they are now very largely classified as marble by the trade.

The longest word found in the Imperial edition of Webster's dictionary contains 13 syllables and 27 letters—one more than the alphabet numbers—"perineocalporectomyomectomy," which names a delicate and complex operation in surgery.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

FOR HIGH PRESSURE GAS

Compressed air and compressed gas, whether natural gas compressed by the forces of nature, or manufactured illuminating gas artificially compressed, are so closely related that it would seem not to be going out of the way to speak of the latter in a journal ostensibly devoted to the interests of the former, as is done in our present issue. The air compressor is of course quite as readily a gas compressor also, and for it to be offering, and indeed urging the acceptance of, its services for gas as well as for air should be natural enough. Indeed the compressor has a right to feel slighted while its proffered services are so ignored and the gas interests give it so little employment.

Experience has completely demonstrated, especially in European practice, that gas served at higher pressures is more economical and satisfactory for the consumer, and many miles of high pressure distributing pipes have been laid and are in satisfactory use in cities both in England and in Germany. The pressures now desirable where the gas is to be used are of course impossible at the gas holders of the present type, and such holders when required for the storage of inert gas, to compensate for the varying rates of consumption, should be permissible to any capacity that may be required at or near the point of gas manufacture, but there can be no necessity for locating such gas holders in valuable sections of crowded cities, entailing such enormous depreciations of neighborhood properties. Natural gas practice everywhere would seem to completely upset any claim that the gas holder is a nuisance which is unavoidable.

QUARRYING BY AIR AND BY ELECTRICITY

The work of the rock channeler is simple enough in the essential idea of it—just cutting slits in bed-rock normally vertically downward and extending considerable lengths horizontally, but also working at all angles, from the vertical to the horizontal. The facility with which it does this special line of work has made the machine of the greatest importance, and now it is indispensable to the quarryman for getting out stone according to requirements, and to the engineer for securing smooth sides to rock-cut canals and aqueducts.

Few of our industrial operations can enumerate so many important collateral advantages resulting without some offsetting considerations. Not only is the element of chance eliminated in the size and shape of stones produced, so that they require a minimum of work for the ultimate dressing and finishing, but at the quarry the waste to be disposed of is reduced to the smallest possible amount, and the condition of the bed is as good as, or better than, before for subsequent operations.

The channeler being accepted as a necessary detail of the equipment of the up-to-date quarry, the most important consideration in connection with it is as to the drive of it. In this the channeler is not to be considered alone, but in connection with the entire power equipment and the requirements of all the apparatus employed, to which it should be able to accommodate itself without sacrifice of efficiency.

The first channelers were steam-operated, generally having their own boilers and enabling the machines to be located and operated in locations otherwise not practicable. This, however, could not long satisfy the developing conditions. The pushing habit of electricity has brought it to the quarry also, and it has become very desirable in many cases, on account of the out-of-the-way location of the work or the large water-power available at a convenient distance, to employ the electric current for all power requirements.

This has hitherto been impossible on account of the rock drills and the channelers, which have insistently required either steam or air. The most persistent experimenting and the most ingenious inventing and designing have not brought a successful electrically driven rock drill in sight, and, the operating conditions of the channeler as to power application being identical, it has been in the same category.

Following only tradition and habit, without any persistent attempt at simplification, it might easily have happened, and in some cases it did happen, that steam and air and electricity were all used in the same plant for different details of the work. If one medium could have been employed for all of the power transmitted instead of the three, the presumptive economy and convenience should be self-evident. Of the three, the one which now most strenuously refuses to be dispensed with is electricity, and in many cases the sooner it is adopted the better.

So far as the rock drill and the channeler are concerned, they have entirely ceased to embarrass one in the employment of electricity for driving. If electric current is the most available, the most economical, or in any way the most desirable power to be used in any given case, and if all the other apparatus can properly be electrically driven, then the electric drive is the best also for the drills and channelers. The electric-air principle as employed in both of these adapts them perfectly to the electric drive, not only without the slightest sacrifice of efficiency or convenience, but with a very appreciable and demonstrable saving of power for every unit employed. The electric-air drive, so far as the essential operating principle of it is concerned, was not a gradual or step-by-step development. It is one of those inventions which *came all at once*, bringing all its advantages with it, some of them only revealed by actual experience after the event. The saving of power was certainly not the first thing thought of in the first installations of the electric-air drill and channeler, but none of their advantages are more pronounced and indisputable.

NEW BOOK

Power, by Charles E. Lucke, Ph.D. New York Columbia University Press, 324 pages 7¾ by 5¼ inches, 223 illustrations, $1.50 *net.*

Although this is a series of "Hewitt" lectures delivered at Columbia University, it does not pose as a learned book and it would seem to be better adapted for the general public than for the student. It gives a very complete and an easily readable account of all the sources of mechanical power and of the means employed to make these available for industrial purposes, and it is not cumbered with mathematics or too minute details which are already sufficiently accessible.

ELECTRIC ROCK DRILL EXPERIENCE

The following occurs in a paper on "The Tietton Canal" by E. G. Hopson, Transactious of American Society of Civil Engineers, March, 1911.

The third long tunnel, the Trail Creek Tunnel, was driven for almost its entire length through an unusually hard blue basalt. The driving was effected at first by electric drills operated by three-phase, 60-cycle, 220-volt alternating current. As the work progressed, continual trouble was caused by breakage of parts of these drills, the springs operating the rebound being particularly susceptible to injury. Duplicate parts could only be obtained after much delay. In addition, there was much difficulty on account of labor, it being found practically impossible to obtain drillmen skilled in the use of electric drills. Ordinary drillmen would generally refuse to use the apparatus, or, if persuaded to make a trial, would obviously use it in an unsympathetic and ineffective way. Careful study, however, of the effectiveness of the electric drills, even when skillfully handled, showed that in very hard rock they were uneconomical, their penetrative power being low. Eventually, Temple-Ingersoll Electric-Air drills were substituted, and the work was completed with them. These drills are practically air drills driven by an electrically-operated air pump on a small truck. This apparatus was found to be much more effective than the electric drills for which they had been substituted, the blows being much more forcible and the penetration correspondingly more economical. This apparatus, moreover, was found to be far less subject to injury than the electric drills.

AUTOMATIC CONTROL OF ATMOSPHERIC HUMIDITY

By Charles Mandeville.

Allied to the thermostatic system is that of the humidistat, or the controlling of the moisture, which has been widely applied in connection with our most modern systems for heating and ventilating.

When indirect heating is used, where air is drawn over tempering coils and forced through ducts to delivery points, the air delivered is often very dry, so dry as to be injurious to our lungs.

Air at any ordinary temperature contains moisture in the form of vapor, the amount depending upon the temperature of the air, not in direct proportion but in increased proportion. Water in the air is necessary both for the growth of animal and of vegetable life. The human body is constantly giving off moisture from the skin and lungs and this process is very important to the preservation of a healthy bodily condition.

Now that we have settled that air which is very dry or that contains a low percentage of moisture will produce bodily discomfort and eventually ill health, it has remained for our scientists to settle for us that a relative humidity of 60 or 70 per cent. is about the most comfortable for our living rooms. The humidity or dampness of the air does not depend alone upon the quantity of aqueous vapor present but upon the nearness to the saturation point. The moisture necessary to cause saturation increases rapidly with the temperature. Therefore the quantity of water that would saturate the air at a low temperature would only partly saturate it at a higher temperature. We say that the air is damp when it is nearly saturated with vapor.

Heating air, while the quantity of vapor remains unaltered, removes it farther from the saturation point and diminishes its dampness. When damp air from out doors passes through tempering coils it becomes dry air; not because it has lost any of its moisture, but because its capacity to take up water vapor has increased with the rise in temperature. The requisite amount of moisture is then much greater and it is necessary to add more water vapor to bring the rooms nearer to the saturation point. Humidity is therefore expressed relatively as the proportion of the water vapor present to the total amount required to saturate air at that temperature and pressure. If air containing water vapor be gradually cooled, a temperature will at length be reached at which the vapor will begin to condense. This point is called the dew point.

HUMIDISTAT SYSTEM.

Ventilating experts have put an extra coil of pipe in the heating chamber where our regular tempering coils are, just at the beginning of the ducts or passages leading to the rooms to be heated. This extra coil of pipe is put into a sheet iron pan. The pressure of the steam used in this extra coil is usually somewhat higher than that used in the tempering coils proper; it has been found good practice to carry about 20 lb. pressure in order to get the benefit of the additional heat units in the steam at higher pressure.

There is placed beside the pan holding the heating coil an ordinary plumber's cistern fitted as usual with a float valve or ball cock and piped to some water supply source. This cistern is set at such a height as to maintain a constant level of water, enough to cover the steam coil in the humidistat pan, into which it discharges its water.

SIMILARITIES OF HUMIDISTAT AND THERMOSTAT.

In the room or duct where it is desired to maintain a uniform humidity of the air the humiditat is placed. This instrument is in construction and action identical with that of the thermostat except that while the small expansion strip of the thermostat is made of brass and steel, in the humidistat it is a piece of wood of a kind which is highly sensitive to the action of the moisture contained in the air surrounding it; sugar maple is commonly used.

HYGROMETER.

In order that we may know what the humidity of the air is, there must be provided an indicator or measuring instrument called a hygrometer. It consists of 2 thermometers arranged on a board with a scale or table of figures and lines between them. The bulb of one of the thermometers dips into a small trough which is kept filled with water. If the surrounding air is not saturated, evaporation will occur from the wet bulb and the constant abstraction of heat will lower the temperature below that of the surroundings. After a little time the wet bulb will indicate a temperature constantly below that of the dry bulb by an amount depending upon the humidity, since the rate of evaporation is determined by the amount of water vapor present in the air. The scale on the board is made to show by means of a traveling pointer or movable arm just what humidity the thermometer readings show to be existing at the place where the instrument is set.

There is one feature to be noted in connection with this system: as heated air will hold more water than cooled air, if we heat the air supply and load it up with 75 or 80 per cent. of all the water it will take, we must be careful to avoid lowering its temperature, either on the way to the point of delivery or at the delivery point itself, otherwise excessive condensation will occur.

In operating this system it is necessary to arrange so that the steam supply to the humidistat coil is not controlled by the automatic valve until the heated air has been circulated for some little time, say 15 min., and that the steam supply is shut off from the automatic valve before the tempered air supply is shut off. This regulation of steam delivery is done by a hand-controlled valve placed on the reduced pressure steam pipe behind the automatic air-controlled valve controlled by the humidistat. Notice here that this is an essential feature in the operation of this system and must especially be attended to where the heated air is forced through ducts or passages by mechanical blowers or fans.

In connection with the compressed air supply there has been an arrangement made to guard against this danger of excessive humidity. In the ordinary action of the compressed air controlling valve in both thermostatic and humidistatic systems, when the air goes on the diaphragm valve the valve shuts. In case a pipe should break in this system or should the compressor fail to keep up the required pressure, the entire system of control valves should remain wide open. Now while in a system of thermostatic control of heating alone this condition can be tolerated in such an emergency, in the case of the humididistatic system there is a difference. Should the automatically-actuated steam supply valve to the coil in the moistening pan remain open the water supply to the pan is automatically maintained and the steam coil would get all the water it could boil and would boil all it could get. In a short time there would be clouds of steam going through the air passages and condensing in the rooms supplied.

In order to prevent such an accident there has been arranged for this system the scheme of putting 2 air-controlled valves in the reduced-pressure steam line supplying the coils in the humidistat pan, one valve being immediately behind the other. One valve is so connected that the steam pressure is underneath the valve seat, so that when the air supply is cut off from the diaphagm valve the pressure of the steam forces the valve open. This is the ordinary action of these valves. The other valve is piped so that the pressure comes on top of the disk, when the air pressure acts to hold it constantly open against the steam pressure. The air line to this second or emergency valve is taken directly from the main air coming from the receiver and is not controlled by an instrument, hence in case the main line pressure fails the valve will be shut by the steam pressure, aided by the spring around the valve stem.

NOTES

The only two foods which contain all the substances necessary to human life are said to be milk and the yolk of eggs. A man can live in health on these two foods.

The highest waves ever met with in the ocean are said to be those off the Cape of Good Hope. Under the influence of a northwesterly gale they have been known to exceed 40 feet in height.

Demonstrations that gasoline can be profitably extracted from natural gas have been made in Ohio, West Virginia and Pennsylvania, where a number of plants have been installed. It is reported that a large plant is soon to be established in Kern county, California, where it is expected to handle 4,000,000 cu. ft. of gas daily, and make a yield of 8,000 gallons of gasoline per day.

A plant for extracting nitrogen from the air electrically for use as fertilizer is in course of construction near Great Falls, S. D. The first installation will have a capacity of 5,000 horsepower at a pressure of 6,600 volts. If the first installation proves a success additional equipment will be added to the plant later to bring the capacity up to 25,000 horsepower. No details of the process are available at present, but it is reported that the nitrogen is extracted by means of large electrical furnaces and absorbed by means of crushed limestone.

It is said that a height of 7.5 miles is the highest point at which a recorded temperature was ever secured. This height was reached by a balloon sent up from the meteorological laboratory of Toronto, Feb. 3. When the instruments sent up with the balloon were recovered, it was shown that the balloon burst at 7.5 miles and that the temperature was 90 degrees below zero.

In a new form of milking machine just invented by a Swedish engineer, pressure instead of suction is employed, so that the act of milking is similar to that of the hand operation. The device consists of a set of rubber-covered plates which are made to press the teats by means of suitable mechanism driven by a small electric motor. The current required to drive the machine is less than half an ampere.

Discovery of oil at Carlyle, Illinois, has increased the respect in which oil-men have held the work of the State Geological Survey. Leases were taken and wells drilled on the strength of the structure as shown in Bulletin 16, and a new field brought in. Mr. F. W. DeWolf, Mr. R. S. Blatchley, and their associates, are to be congratulated on this quick proof of their good work.

A cement for making tight joints in pumps, pipes, etc., is made of a mixture of 15 parts slaked lime, 20 parts graphite, and 30 parts barium sulphate. The ingredients are powdered, well mixed together, and stirred up with 15 parts of boiled oil. A stiffer preparation can be made by increasing the proportions of graphite and barium sulphate to 30 and 40 parts respectively, and omitting the lime.

A borehole 7,347 ft. deep was put down at Czuchow in Silesia recently. Temperatue measurements at different depths showed an average temperature gradient of about 55 ft. per degree F., but near the middle this increased to 31 ft. per degree, while in the lower third the gradient was only 91 ft. per degree. The temperature near the bottom was 182 degrees F.

In modern industries peculiar conditions occur involving liability to fire where water is not only ineffective, but dangerous as an extinguisher, and the use of sand is among the substitutes. The new fire apparatus of a London electric lighting station is a truck holding 600 pounds of sand and carrying a fiber bucket and a couple of spades. This equipment is specially adapted for the purpose, and is advised for motor garages, oil stoves, electric theatres, etc.

On May 2 compressed air was for the first time turned on to the main hoist of the Mountain View Mine, Butte, Montana, formerly driven by steam. The engine has been reconstructed, with cylinders of increased capacity and other changes of details, and of course, as reported, "responded quickly and easily to its power." It is practically assured that the Anaconda mines will soon be operated at a great saving by the new power arrangements.

The Trafalgar, British battleship, which cost $4,095,840 to build and equip in 1887 was sold at auction recently for $125,000, about 3 per cent. The Pique, a second-class cruiser went to a Dutch shipbreaking company for $57,500, and another, the Tribune, brought $52,500.

Meteorological reports from European Russia show that an anti-cyclone of unprecedented intensity prevailed over the eastern portion of that country on November 26th and 27th, 1910. At several stations the barometric pressure (reduced to sea level and standard gravity) exceeded 800 millimeters (31.50 inches). At Katharineburg, at 7 a. m., November 26th, the barometer (corrected and reduced as stated above) read 800.7 millimeters (31.524 inches), the highest pressure ever recorded at a European station.

The final ripening process in the preparation of California oranges for the market is the exposure of the fruit to steam vapor, which imparts the golden yellow color described on the labels by "sun-kissed" and other appetizing terms. In fact, however, electric heat is employed to a large extent in producing this steam vapor, electric immersion coils in open tanks of water in the ripening rooms producing the warm humidity required to give the final tint to the orange of commerce.

The president of a manufacturing company in the Middle West says he is not satisfied with the atmospheric conditions in which we are living, that we need more ozone for its directly beneficial results as well as for its purifying and disinfecting actions, and suggests the desirability of producing a commercial form of ozone generating apparatus that can be placed on the desk or bench of a worker and be coupled up and operated by the electrical current of an ordinary light or power supply.

President Kuhn, of the Pittsburg-Westmoreland Coal Co., has devised a simple method for lessening the dangers of explosions, particularly dust explosions, on cold winter days, when the danger from this source is greatest. When the temperature is low the moisture in a mine is quickly absorbed by the ventilating current on account of the dryness of the air, and to overcome this feature Mr. Kuhn has exhaust steam turned into the fan houses at all his mines following a sudden drop of temperature. This keeps the air-currents moist and prevents the mines from becoming filled with dry dust. Other companies in Western Pennsylvania have adopted the plan.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 2.

990,830. AIR-LIFT. MIKE P. BISCHOFF and JOHN W. REYNOLDS, Oilfields, Cal.

990,886. PUMP. WILLIAM J. LAPWORTH, Pittsburg, Kans.

1. In a pneumatic pump including a pump-cylinder having a water inlet port, a water discharge pipe, an air supply pipe and a relief port, the combination of a valve for said water inlet port, a valve for said air supply pipe and a valve for said relief port, and means operatively connecting the valve in the air supply pipe with the relief port valve, said means comprising a cylinder communicating with said discharge pipe, a float in said cylinder and connections between said float and said valves, whereby the movements of said float will close one of said valves and open the other, and automatically operative means connected with said air-supply pipe for admitting air directly to said discharge pipe.

990,897. FLYING-MACHINE. ABEL T. NEWBURY, Vermilion, Alberta, Canada.

990,944. THROTTLE CONTROL FOR FLUID-OPERATED HAMMERS. JACOB F. ZWIKER, Toledo, Ohio.

990,948. AIR-FORCING APPARATUS. CHARLES F. BAKER, Newton, Mass.

990,953. AUTOMATIC AIR-BRAKE APPLIANCE. JOSEPH SEWELL BAXTER, Millsap, Tex.

990,976. ENGINEER'S VALVE. ERNEST GONZENBACH, Greensboro, N. C.

991,040. PRESSURE-CONTROLLED OPERATING MEANS FOR TROLLEY-POLES. AYERS A. STRANGE and WILLIAM ANDERSON, Memphis, Tenn.

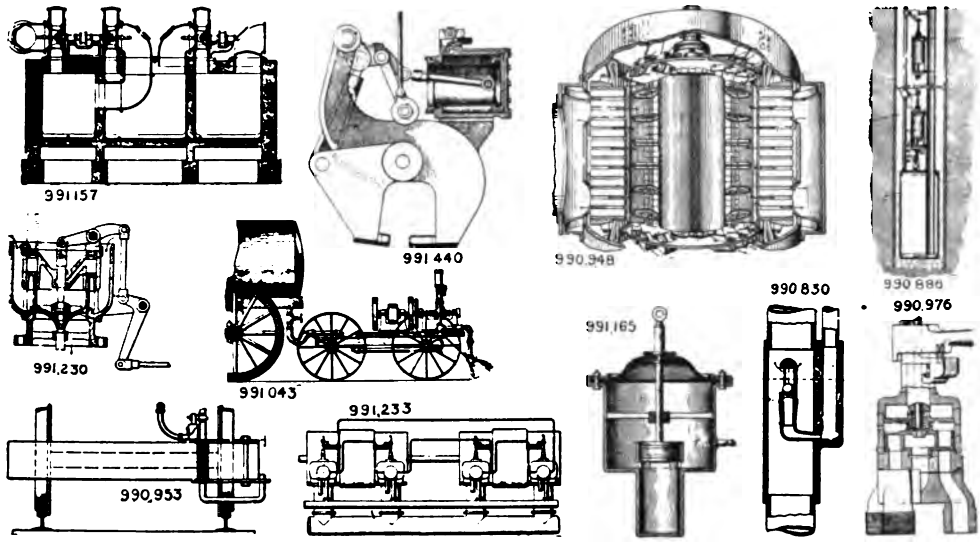
991,043. PROCESS OF MAKING ROADWAYS. JOSEPH E. WARD, Longbeach, Cal.

1. The process of making a roadway which consists in atomizing oil in contact with air, in such manner that the oil tends to remain suspended in the air for an appreciable time, bringing the atomized oil and air into contact with a porous road surface, causing the oil to permeate the the porous road surface while still in atomized condition, and causing the atomized oil to be deposited on the material of the road surface while said material is agitated and partly suspended.

991,115. FLYING-MACHINE. GEORGE S. UDSTAD, Aurora, Ill.

991,157. PROCESS OF WASHING GASES FOR RAPIDLY FREEING THEM FROM DUST OR SMOKE HELD IN SUSPENSION THEREIN. PAUL KESTNER, Lille, France.

991,165. PNEUMATIC VEHICLE-SPRING. FRANK W. MILLS, Chicago, Ill.



PNEUMATIC PATENTS MAY 2.

991,223. COMPOSITION OF MATTER. FRANK MLEKUSH, Rankin, Pa.

991,230. OVERBALANCED FLUID-PRESSURE VALVE. EDWARD P. NOYES, Winchester, Mass.

991,233. STARTING DEVICE FOR GAS-ENGINES. GUSTAV BERNHARD PETSCHE, Philadelphia, Pa.

991,440. FLUID-PRESSURE RIVETING-MACHINE. ELMER ELSWORTH HANA, Evanston, Ill.; Philetus W. Gates, conservator.

991,459. GAS-ENVELOP FOR AIRSHIPS. JOHN C. SCHLEICHER, Mount Vernon, N. Y.

MAY 9.

991,493. MERCURY VACUUM-PUMP. HENRY ALBERT FLEUSS, Thatcham, England.

991,500. AIR-BRAKE SYSTEM. FRANK GOFF, Camden, N. J.

991,504. SHIP'S-TELEGRAPH RECORDER. EDWARD A. HENKLE, Philadelphia, Pa.

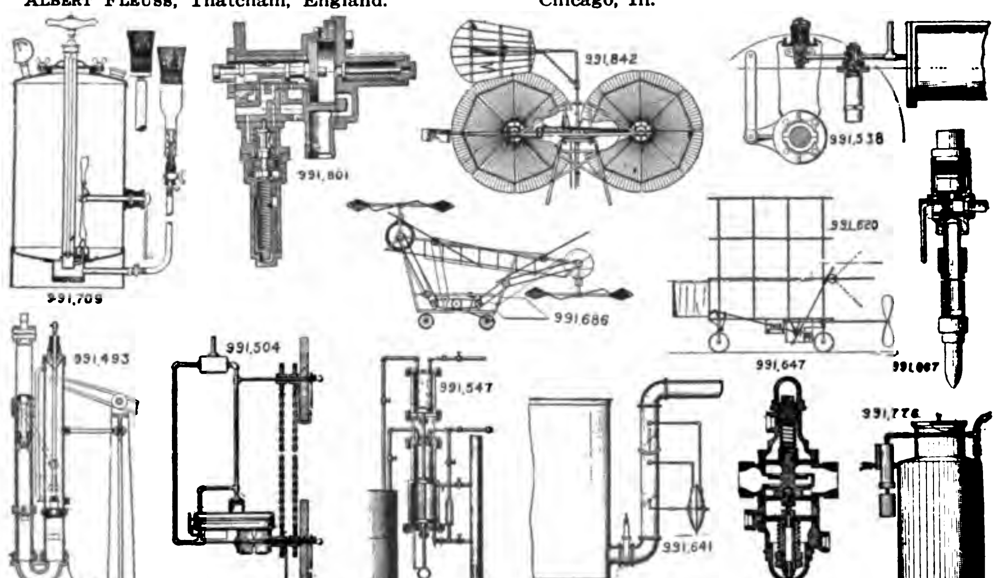
991,528. AERIAL NAVIGATION. JACK LLOYD NICHOLS, Belton, Tex.

991,530. AIR-VALVE. CHARLES E. NORMAN, Chicago, Ill.

991,538. FLUID-PRESSURE BRAKE. WALTER PHILLIPS, London, England.

991,547. DUPLEX FORCE-FEED LUBRICATOR. ALBERT E. SCHAD, Bellefonte, Pa.

991,568. APPARATUS FOR COOLING AND DISPENSING LIQUIDS. WILLIAM H. WALTER, Chicago, Ill.



PNEUMATIC PATENTS MAY 9.

991,572. AIR-FILTER. SIMON P. WEISENSTEIN, Sharpsburg, Pa.
991,620. AEROPLANE. JOHN HUGHES, Baker, Mont.
991,641. DEVICE FOR CONTROLLING FLUIDS. PIERCE PLANTINGA, Cleveland, Ohio.
991,647. AIR-PUMP GOVERNOR. DANIEL W. RIDINGER, Defiance, Ohio.
991,667. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.
991,686. APPARATUS FOR AERIAL NAVIGATION. JEAN M. ALLEAS, Boston, Mass.
991,699. FLUID-PRESSURE ENGINE. GEORGE CASSADY, New Westminster, British, Columbia, Canada.
991,709. PAINTING APPARATUS. GEORG HEINRICH FISCHER, Neustadt-on-the-Hardt, Germany.
991,718. PNEUMATIC PIANO-ACTION. AXEL G. GULBRANSEN, Chicago, Ill.
991,776. MILK-CAN ATTACHMENT FOR MILKING APPARATUS. EZRA E. GOOD, Waterloo, Iowa.

1. In a milking apparatus, the combination with a can, of a milk conduit leading into said can, an air suction conduit leading from said can, a by-passage connecting said air suction conduit to said milk conduit independently of said can, and a suction controlled valve mechanism arranged to open and close said milk conduit and by-passage in alternate order and to hold said milk conduit closed at all times when said by-passage is open, substantially as described.

991,801. FLUID-PRESSURE BRAKE APPARATUS. JOSEPH REICHMANN, Chicago, Ill.
991,842. WINDMILL. ALBERT F. GEORGE, Enid, Okla.
991,851. CONTROLLING - BELLOWS FOR PNEUMATIC MUSICAL INSTRUMENTS. JOSEPH P. HULDER, New York, N. Y.
991,902. AIR-PUMP. JOHN SCHLOSSER, Wilmington, Del., and ANDREW W. CHRISTIAN, Philadelphia, Pa.
991,932. AIR PURIFIER AND SEPARATOR. DAVID BASHORE and JOHN E. SHAVELAND, Walla, Walla, Wash.
991,989. ATMOSPHERIC ENGINE. ANTON HOLM, Passaic, N. J.

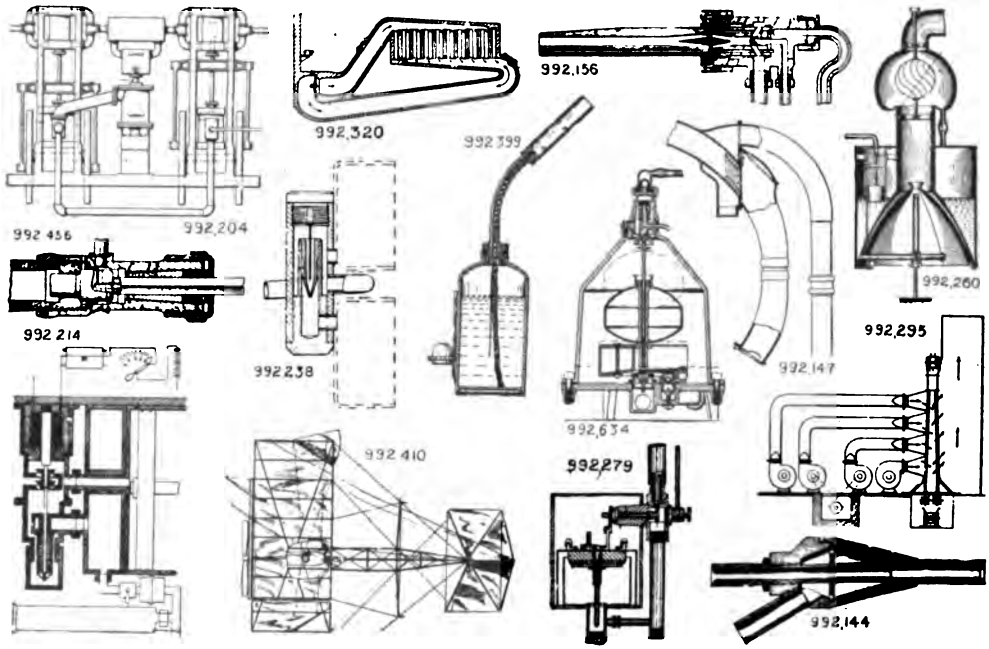
992,039. RADIATOR AIR-VALVE. ARTHUR O'BRIEN, Butte, Mont.

MAY 16.

992,144. BLAST-NOZZLE. FRED A. BABCOCK, Wyndmoor, Pa.
992,147. TERMINAL FOR PNEUMATIC-TUBE APPARATUS. LOUIS G. BARTLETT, Somerville, Mass.
992,156. WELDING-TORCH. HARRY BROUSSEAU, New York, N. Y.
992,204. AIR BLOWING OR COMPRESSING APPARATUS. JOSEPH E. JOHNSON, Jr., Ashland, Wis.

1. In combination, a steam engine actuating a positive compressor, a turbine driven by the engine's exhaust and actuating a centrifugal blower, and a connection from the blower's discharge to the compressor's intake.

992,214. ELECTROPNEUMATIC BRAKE. LOUIS ALFRED LARIVIERE, Paris, France.
992,223. PNEUMATIC-DESPATCH-TUBE APPARATUS. JAMES G. MACLAREN, Harrison, N. Y.



PNEUMATIC PATENTS MAY 16.

992,238. AIR-DISTRIBUTER FOR PNEUMATIC MILKING-MACHINES. ERIK ARVID NILSSON, Hornsberg, Stockholm, Sweden.
992,260. VAPORIZER AND SEPARATOR. CHARLES A. RUSH, San Francisco, Cal.
992,279. PRESSURE-OPERATED GAS LIGHTING AND EXTINGUISHING APPARATUS. ERNEST SPARKS, London, England.
992,295. DRYING OF NON-PULVERULENT MATERIALS. FRITZ TIEMANN, Berlin, Germany.
992,320. APPARATUS FOR DRYING DOUGH AND PASTRY GOODS. OTTO WIRZ, Cannstatt, Germany.
992,364. VACUUM CLEANING APPARATUS. JAMES W. LEASURE, Bradford, Pa.
992,399. AUTOMATIC PRESSURE-TORCH. OTTO BERNZ, Newark, N. J.
992,410. AERODROME. EDWARD J. ELSAS, Kansas City, Mo.
992,456. HAMMER-DRILL. ALBERT H. TAYLOR Easton, Pa.
992,483. PNEUMATIC VIBRATION-DIFFUSER. CHARLES H. COX, Los Angeles, Cal.

992,564. AIR-BRAKE SYSTEM. George L. Ickes, Newport, Pa.
992,634. AIR-COMPRESSOR. Harry E. Bailey, Albany, N. Y.
992,726. FLYING-MACHINE. Edwin Lyman Madden, Ingersoll, Okla.

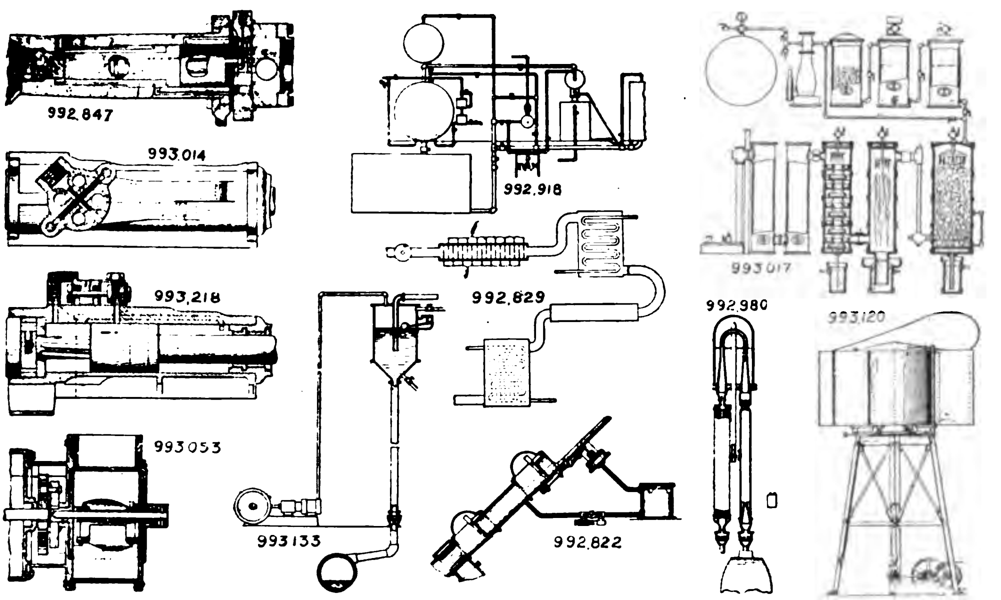
MAY 23.

992,784. VALE FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Isaac W. Litchfield, Boston, Mass.
992,822. PNEUMATIC-DESPATCH-TUBE-APPARATUS. Charles F. Stoddard, Boston, Mass.
992,824. VENTILATING MECHANISM. Bernard A. Stowe, Cleveland, Ohio.
992,829. PROCESS OF DESICCATING AIR. Herbert T. Weston, Cleveland, Ohio.
992,847. DRILL. Walter E. Carr, Telluride, Colo.
992,849. FRESH-AIR-INLET-DEVICE. Joseph Chalke, New York, N. Y.
992,918. PROCESS OF IMPREGNATING WOOD. Charles Stowell Smith, Berkeley, Cal.

within the inner tube, and a second electrode formed of a coil of wire, said coil being wound spirally upon the outer tube.
993,014. VALVE-MOTION FOR ROCK-DRILLS. Lewis C. Bayles, Johannesburg.
993,017. APPARATUS FOR OBTAINING NITROGEN FROM AIR. Charles Blagburn, San Francisco, Cal.

1. An apparatus for obtaining nitrogen from atmospheric air consisting of a furnace of considerable area in proportion to its height to expose a large body of sulfur to oxidation and so concentrated as to compel the whole of the air supplied to said sulfur to flow into contact with the sulfur in the furnace, means for supplying sulfur and air at one end of said furnace, a conduit at the other end of said furnace for the resulting gases, means for removing from said gases the sublimated sulfur, means for washing from said gases the sulfurous acid, and means for confining the residual nitrogen, substantially as described.

993,038. CONTROLLING DEVICE FOR PNEUMATICALLY-OPERATED MOTORS. Thomas Danquard and William J. Keeley, New York, N. Y.



Pneumatic Patents May 23.

2. The herein described process of preserving wood which consists in introducing the wood into an air tight cylinder, subjecting the wood in said cylinder to the action of the bath of oil at approximately 220 degrees F. for a length of time sufficient to heat up the wood and thereby vaporize most of the water contained in the wood, then drawing off the oil and applying an air pressure of about 50 pounds per square inch, introducing a preservative oil at approximately 120 degrees F. and raising the pressure to about 157 pounds per square inch, for a length of time sufficient to insure the desired impregnation, then relieving the pressure and simultaneously drawing off the unabsorbed oil and then subjecting the wood to a vacuum for the purpose of drawing out a portion of the oil from the cell cavities.

992,932. ENGINE-DRIVEN COMPRESSOR. George L. Badger, Quincy, Mass.
992,980. OZONE-PRODUCING APPARATUS. Octave Patin, Paris, France.

1. An ozone apparatus comprising two concentrically positioned tubes having an annular space space therebetween, an electrode positioned

993,053. SUCTION-PRODUCING DEVICE. John H. Goehst and John A. Dunlap, Chicago, Ill.
993,063. AERODROME. Robert Ernest Heath, Yorkville, S. C.
993,108. AIRSHIP. Thomas Rhoades, Hanna, Utah.
993,120. WINDMILL. Clement A. Sterner, Allentown, Pa.
993,133. DUST-COLLECTOR FOR PNEUMATIC CLEANING SYSTEMS. David T. Williams, Paterson, N. J.
993,202. VACUUM-CLEANER FOR CARPETS AND THE LIKE. John H. Russell and Albert A. Carson, Ashland, Ohio.
993,218. VALVE-MOTION FOR ROCK-DRILLS. Lewis C. Bayles, Johannesburg, Transvaal.

MAY 30.

993,343. DUST-COLLECTOR. Percy D. Brewster, East Orange, N. J.

1. A dust collector having a pipe adapted to carry the air and dust, means for introducing

water into the air and dust while under the partial vacuum, means for producing the vacuum and separate means adapted to remove the water from under the partial vacuum.

993,356. AIR-COMPRESSOR FOR USE WITH ENGINES. FRANK E. FOLLETT, Otterbein, Ind.

3. The combination of an engine cylinder, a hollow stud projecting from the end wall thereof, an air pump adapted to be moved longitudinally into position on said stud, means for locking said cylinder in position on the stud, a reciprocatory plunger disposed within said cylinder and plunger rod secured to said plunger and extending through said stud into the interior of the engine cylinder in position to be engaged and actuated by the engine piston located therein, substantially as described.

993,415. PNEUMATIC APPARATUS. JOSEPH SCHWERTNER, New York, N. Y.

993,424. THROTTLE-VALVE FOR ROCK-DRILLS. DANIEL S. WAUGH, Denver, Colo.

993,628. FEED-WATER REGULATOR. ORBERT E. WILLIAMS, Scranton, Pa.

3. The combination with the main feed line of a boiler, and an inlet valve therein, of a fluid pump communicating with the tank above the liquid therein for inducing a current of air to flow from the reflector into the tank.

993,648. ROTARY FLUID OPERATED AND OPERATING DEVICE. ALMON B. CALKINS, Passaic, N. J.

993,655. MEANS FOR INFLATING PNEUMATIC TIRES. HARRY L. CORSON, Dayton, Ohio.

993,659. PNEUMATIC WHEEL. OTTO P. DOWNING, Pecos, Tex.

993,694. VACUUM CLEANING APPARATUS. FRANCIS D. LARSON, Salt Lake City, Utah.

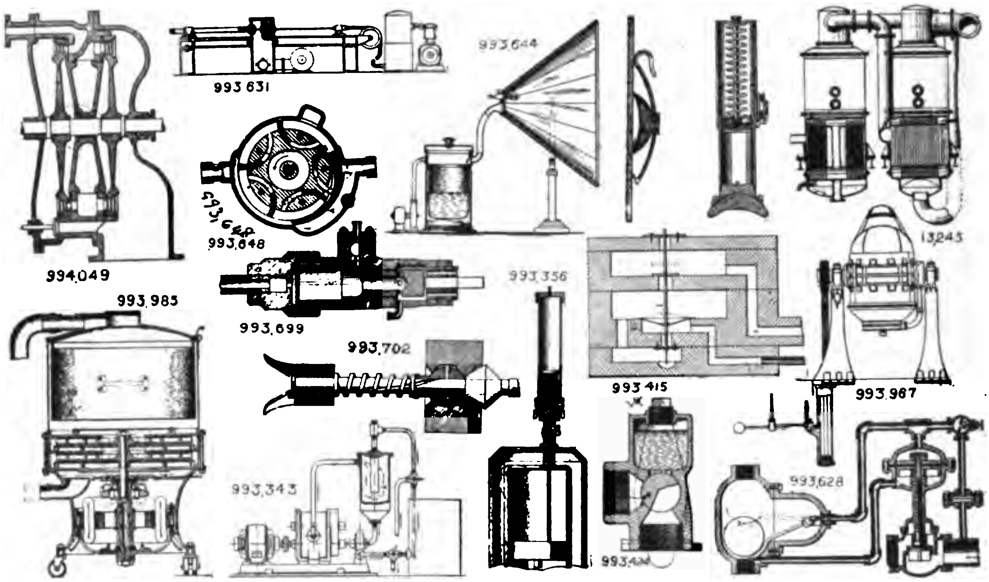
993,699. POWER-DRILL. DUNCAN LAREN MCFARLANE, Victor, Colo.

993,702. AUTOMATIC AIR-COUPLING. H. STANLEY MILLER, Johnson City, Tenn.

993,724. AEROPLANE. OLIVER G. SIMMONS, Washington, D. C.

993,928. APPARATUS FOR FEEDING PULVERIZED FUEL. JOHN A. WELTON, Canal Dover, Ohio.

1. The combination with a fire box, of means for feeding comminuted fuel thereinto, comprising a fuel receptacle, a trough mounted in the



PNEUMATIC PATENTS MAY 30.

pressure device to operate said valve, acted on by fluid from a constantly flowing stream, and means operated by changes of water level in the boiler to restrict such stream of fluid to varying degrees.

993,631. METHOD OF MANUFACTURING HOLLOW METAL RODS, BARS, AND THE LIKE. ARTHUR YOUNG and THOMAS ROWLANDS, Sheffield, England.

1. The method of removing a refractory core from a hollow rod or bar which consists in discharging a jet of a gaseous fluid under pressure directly against the end of said core, and progressing said jet through said rod or bar as rapidly as said core is disintegrated by the action of said jet.

993,644. INSECT-DESTROYING APPARATUS. ARTHUR BRISBANE, New York, N. Y.

1. In an apparatus of the character described, the combination of a tank having therein a quantity of liquid as kerosene or the like, a removable container located in the liquid, a reflector, a pipe connecting the reflector with the tank above the liquid therein, means for illuminating the reflector, a suction pump and connections from the discharge end thereof, and spaced at its opposite edges from the walls thereof, a screw conveyer working in the trough, a cylindrical casing mounted beneath the trough and the discharge end of the receptacle, a grinder and conveyer mounted in said casing, a pipe into which the casing discharges, and a fluid pressure pipe leading to and discharging into the fire box, the said pipe being entered by the fuel pipe.

993,967. SAFETY OR BRAKING DEVICE FOR APPARATUS DRIVEN BY FLUIDS UNDER PRESSURE. JOSEPH HUBERT DEBAUCHE, Gilly, Belgium.

993,985. PNEUMATIC PUMPING-MACHINE. CHARLES EDWARD HARKER, Parnassus, Pa.

993,989. VACUUM SUPPORTING DEVICE. ROSS HAZELRIGG, Oakland, Cal.

994,049. FLUID-PRESSURE TURBINE. KARL ALQUIST, Rugby, England.

994,104. AIRSHIP. WILLIAM CHARLES HURST, New York, N. Y.

13,245. (Reissue). VACUMM EVAPORATOR OR HEATER. JOSEPH E. DUNN, Philadelphia, Pa.

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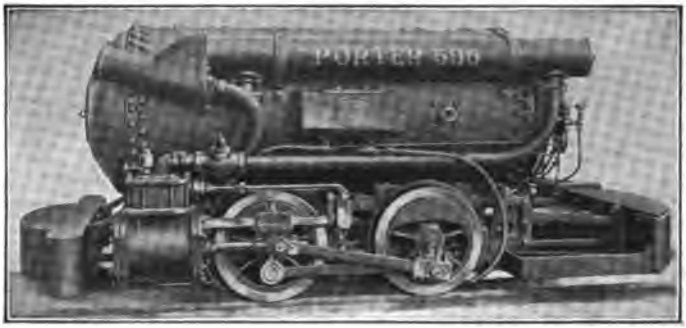

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Vol. XVI | AUGUST, 1911 | No. 8

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INDEX TO ADVERTISERS.

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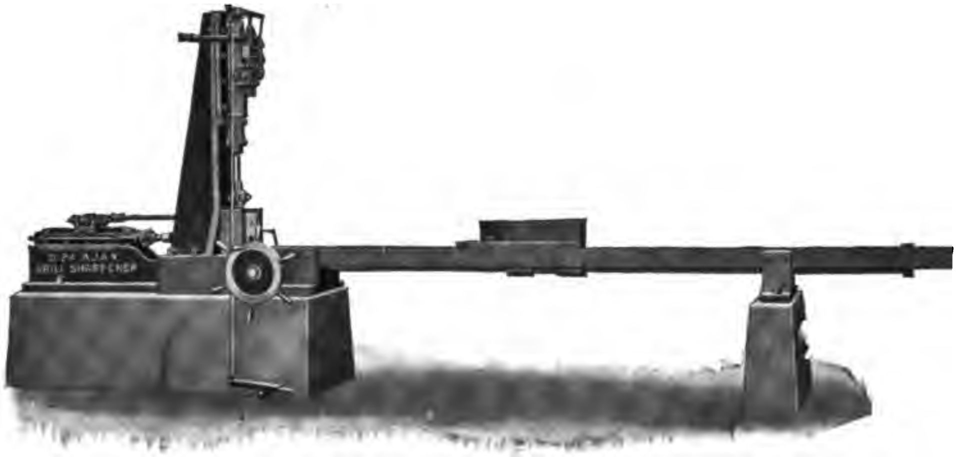

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EVERYTHING PNEUMATIC.

Vol. xv AUGUST, 1911 No. 8

PNEUMATIC HAMMERS ELECTRIFY HOOSAC TUNNEL

The Hoosac Tunnel is the longest tunnel in the United States, and only within the present year have trains been run through it by any other motive power than steam. It is now completely equipped with and operated by electricity, and an account of its electrification forms the *piece de resistance* in a recent issue of the *Electric Railway Journal.* The most strenuous part of the work was, of course, the drilling of the holes and the securing of the hangers and wires through the tunnel. The following account is reproduced from the source indicated.

The erection of the hanger brackets and stringing of wires in the tunnel was carried on under the most difficult working conditions. Only one track at a time was given up to the contractors and trains were operated constantly on the other track at intervals as frequent as safety permitted. At all times when work was being done in the tunnel the air was very bad, because of the smoke and gases from oil and coal-burning locomotives passing through on the single track in use. After the passage of a train, all work had to be suspended for ten to twenty minutes, sometimes longer, to allow the worst of the smoke to clear out. It was found necessary to construct air compartments on the train supplied with cleaned air from the compressor car to serve as refuges for the men during such periods. Owing to atmospheric and traffic conditions, the construction force was able to utilize less than one-half the time in actual work. These factors more than doubled the time that would otherwise have been necessary for the construction work in the tunnel. The tunnel is ventilated from a central shaft 1,100 feet deep, at the top of which is a large suction fan which draws fresh air into the tunnel from both portals and exhausts the smoke and gases up through the shaft. With a strong wind from the east or west the far end of the tunnel is sometimes very poorly ventilated.

CONSTRUCTION TRAINS.

The railroad furnished and equipped for the contractor two special tunnel work trains, each consisting of an oil-burning locomotive, two locomotive tenders, a boxcar containing an engine-driven generator, a box car containing three blacksmiths' forges and anvils, an air compressor car, thirteen platform cars, a coach fitted up as a dining car and a freight caboose. The platform cars were ordinary flat cars on which were built working platforms 11 ft. above the rail with low sides to prevent the workmen from falling off. Posts 6 in. x 4 in. were set in each stake pocket and cross beams of the same size were framed across to support the 2-in. plank floor. The car floors and the working platforms were made continuous throughout the train by steel aprons at the ends. Trap doors were built in each working platform so that the men could reach the car floor by ladders. A 1½-in. air pipe for the compressed air supply was run along each side of the working platforms and globe valves were inserted at frequent intervals for attaching the drills. On the floor of every third platform car a wooden air lock 14 ft. x 5 ft. x 4 ft. was built, into which the men could retreat during and after the passage of a train. An air valve was provided inside these locks which when partially opened created sufficient pressure to keep out the surrounding smoke and gases and provided fresh air for the men in the lock.

The equipment on each train for drilling the roof holes for the hanger bolts consisted of seven H.C.-12 Ingersoll-Rand hammer drills and several pneumatic hammers which were used for drilling holes in the side walls for the attachment of signal cable brackets. In the compressor car, which was placed next to the locomotive, was mounted a steam-driven class A-1 compressor with a capacity of 285 cu. ft. of free air per minute. It received steam from the locomotive at 90 lb. pressure and delivered the air at 90 lb. pressure into a receiving tank of 77 cu. ft. capacity. A small steam pump was used for pumping cooling water from the tenders through the compressor jacket and back to the tenders. The compressor intake was carried down close to the rails, where the air was purest, and was covered with a fine-mesh wire screen to keep out as much dust and dirt as posible.

The generator was a 28-kw direct-current machine, and was driven by a marine engine supplied with steam from the locomotive. In spite of the moisture and dirt in the tunnel at all times neither of the generators on the two trains failed in any way during the time they were in use. The trains were wired throughout and six sockets for attaching five-light reflector clusters were placed along the railings of the working platform on each car. Strings of incandescent lights were also run along the sides of the cars for general illumination of the tunnel walls. Each train was also equipped with a system of signal lights in the caboose, locomotive cab and compressor car by means of which the conductor could signal the engineman to move the train forward or back and signal the compressor attendant to start or stop the compressor.

The coach, which was fitted up as a dining car, was used to supply the men with hot coffee and sandwiches and to heat any other food the men brought with them. In order to stand the effects of the smoke and gases it was found necessary to keep the men well supplied with food, and they were allowed to go back to the dining car at frequent intervals to get food or coffee. The dining car was fitted with an air valve the same as the locks on the platform cars so that the air was kept fresh at all times. A complete outfit of surgical and first-aid-to-the-injured supplies was kept in the dining car, as also were an oxygen tank and air helmet for rescuing any one overcome by gas out in the tunnel. These helmets were never needed, however, although a number of men were overcome during the construction work.

About forty men were employed on each train. These included a foreman in charge, four sub-foremen, one steam engineer, one electrician, one carpenter, one cook, one blacksmith and helper and thirty laborers, in addition to the locomotive engineer and fireman, brakeman and conductor. In spite of the trying conditions under which the men worked not a single man employed on the tunnel trains quit work while the construction was in progress. The construction forces of the contractor were directed by M. J. Daly, general foreman in charge of the work.

CONSTRUCTION WORK IN THE TUNNEL.

The construction work in the tunnel included the drilling of 1,000 holes 2½ in. in diameter and 18 in. deep in the roof of the tunnel for the catenary hangers; 1,500 holes 1¾ in. in diameter and 6 in. deep in the sied walls for telephone and signal cable hangers; drilling and blasting down the rock roof of the tunnel in many places to obtain the necessary clearances and erecting the catenary and trolley wires. A preliminary survey of the tunnel was made to determine the height of the roof at the hanger locations so as to prepare in advance the hanger rods of proper length. This survey also showed that the roof would have to be blasted down in many places to obtain the necessary clearance.

The first work train was run into the tunnel on November 6, 1910, and the second was equipped and put in use on November 29. Both trains were stored in the North Adams yard when not in the tunnel. The work of drilling the roof and side wall holes was carried on from both ends of the tunnel, with the two trains progressing toward the central shaft. It was necessary to keep the two trains on opposite sides of the central ventilating shaft with the locomotives always coupled to the ends of the trains nearest the shaft, so that the men on the platform cars would not be bothered by the gas of either locomotive. One track was given over to the work trains for periods of from nine to twelve hours, beginning at 8.30 a. m.

The drilling of holes for roof bolts was carried on simultaneously at five locations 100 ft. apart above each train. The train was spotted by manipulating the conductor's valve on the caboose and was moved only as required by the progress of the drilling. The time required to drill each hole varied from twenty minutes to four hours. Some of the rock was very hard, and at one location 65 drills were required to drill three holes, each 18 in. deep. A large stock of drills was carried on each train and one or two blacksmiths and helpers worked continuously in the forge car sharpening the drills as they were removed from the machines. All holes required for blasting down the roof were drilled from the work trains, but the blasting and cleaning up was done by the force of miners regularly employed in the tunnel by the railroad company.

A NEW SUBWAY AIR-CLEANING SYSTEM

The Central London Railway is planning to install a new air cleaning system in its tubes, and each of the 14 stations will be equipped with an air purifying plant. Horace Field Parshall, chairman of the Central London Railway, speaking on the subject, is reported as follows: "Our present system of ventilation is an exhaust one and we have large exhaust fans at certain points. These do not give the best results, since they concentrate the foul air at various places through which the public have to pass. Our intention is to put in approximately 8,000,000 cu. ft. of filtered and purified air at each of our stations —4,000,000 cu. ft. for the station itself and 4,000,000 cu. ft. for the tunnels, so that the train in passing from the station to the tunnel will enter a current of purified air and carry it along. To obtain the ozone we shall have recourse to apparatus used in connection with our electrial plant. We shall take down 20-in. air pipes from the surface above each station. Before the air enters these pipes it will pass through filters which will retain all the smuts and absorb the deleterious elements which are present in the atmosphere of London. It will then pass into a mixing chamber, where it will be sterilized by means of the ozone electrically generated in a small chamber situated just above. Before the air is distributed in the station it will be recharged with ozone at the platform level in a special electrical apparatus so that the air contains about one part in a million of pure ozone.

HOELVER LIQUID FUEL BURNER

This liquid fuel burning apparatus, manufactured by the Tandem Smelting Syndicate, Limited, Merton Abbey, London, S. W., recently received a highly commendatory notice in the *Engineer,* London. The description then given is here reproduced in a somewhat condensed form.

This appliance, unlike most other devices purporting to fulfil similar duties, is, in the strict sense of the word, a burner. The liquid fuel is not only atomised, but is raised up to a temperature such that the application of a light is sufficient to ignite it. In this it will be understood it differs radically from many so-called "burners." These are more properly "sprayers," which, while emitting the

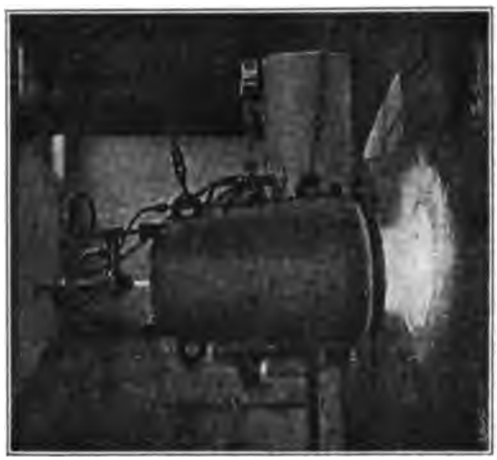


FIG. 1.

fuel in a finely divided state, require some further device to raise its temperature up to the ignition point.

The adoption of liquid fuel for firing steam raising boilers, while possessing undoubted advantages in many directions as compared with the use of coal, has been considerably retarded by the one great drawback—the unpleasant results produced by imperfect combustion. With badly designed oil burning appliances a thick deposit of caked carbon soon begins to collect in the tubes, etc., and the trouble experienced in the removal of this deposit frequently nullifies all the benefits otherwise derivable from the use of oil fuel as a heating agent in steam boilers. In the devices which we refer to the mixture of atomised fuel and atmospheric oxygen is sprayed directly into the interior of the boiler furnace, where, coming in contact with the already heated fire-bricks, it is raised to its flash-point and ignited. Satisfactory running can hardly be expected in this case. The interior of the boiler furnace is not always in the same condition, and its exact temperature is a variable quantity from minute to minute, so that while complete combustion may be attained at one instant, the next sees the conditions changed, the temperature of the fire-brick altered, and the fuel may burn either with the production of smoke or with an oxidising flame which quickly attacks the tubes and other metal work with which it comes in contact. The Höveler burner, on the other hand, does not project a stream of combustible mixture into the furnace. The actual combustion takes place outside the furnace in a separate ignition chamber, and the products of combustion, at a temperature pratically that corresponding to the initial temperature produced by ignition, are played into the furnace. Very little heat is lost, and as the external ignition chamber can be kept in any desired condition and at a constant temperature, uniformly complete combustion is ensured.

In Fig. 1 we show the appliance at work firing a metallurgical furnace. It may be described as consisting of two parts—a spraying device and an ignition chamber. The spraying device or atomiser is shown in section in Fig. 2 and will be described first. The oil supply is introduced into the apparatus through the inlet A. To this it flows under gravity from a central tank raised a few feet in level above the furnace orifice. This tank in the case of the installation which we inspected at Merton Abbey supplies in common all the burners throughout the works, and is situated in the outside yard. In cases where a heavy viscous oil is to be used the fuel supply pipe leading to the inlet A is brought within reach of the heat of the furnace, so that its viscosity is reduced and its flow through the burner rendered easy. Compressed air under a pressure of from 10 lb. to 20 lb. is introduced at B, and this flowing along the passage C produces an ejector action at the mouth of the fuel tube D. A needle valve operated from the milled nut E controls the flow of fuel from the tube D, the tip of which is of nickel, to reduce erosion. The ejector action produced at this orific, in addition to sucking in the fuel, draws atmospheric air through the series of holes F in the external casing. At G a second compressed air inlet is provided. This is the main air inlet, and, as a result of the construction adopted for the various orifices, the fuel leaves the sprayer in a very finely atomised stream, and mixed with the correct amount of air to secure its complete combustion.

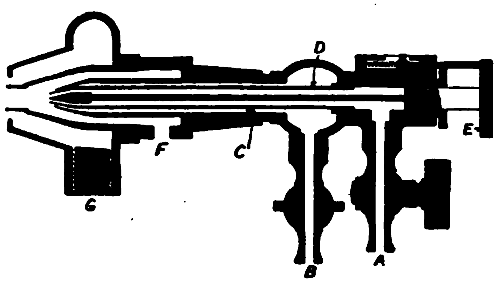


FIG. 2.

Passing from the sprayer the mixture enters in an expanding conical stream into the combustion chamber. This consists of a conical iron casting lined with fire-brick. The interior diameter of the fire-brick lining is arranged to be just sufficient to envelope the conical jet of mixture, leaving a margin of about an inch all round. At the exit end of the combustion chamber the orifice is contracted down on to the jet of mixture, so as to reduce this in diameter. The exact amount of contraction which the jet should undergo at this point is a matter of great importance in the working of the apparatus, and has been experimentally determined by Mr. H. F. Höveler, the inventor. From this orifice the now ignited mixture passes in a steady stream through a circular hole in the wall of the furnace, the interior of which has to be heated. It will be seen from Fig. 1 that the whole apparatus is very simple. The sprayer is carried on a square rod projecting from a boss on the ignition chamber casing. Behind the ignition chamber will be seen the compressed air reservoir with its pressure gauge. Flexible pipes connect this and the oil supply with the sprayer, so that the latter can be readily removed for inspection. The whole appliance is merely hung by chains or supported in any other suitable manner at the proper level.

In addition to the simplicity of the apparatus, the fact that practically any quality of flame—oxidising, reducing, or neutral—can be obtained with it is a point claimed by the makers as worthy of close attention. The apparatus is very quickly prepared for work, and from turning on the oil and air supply to the production of the working flame is a matter only of a few seconds. The quality of oil is not of much moment. From creosote to heavy German tar oil, almost a solid, the appliance can be readily adjusted to burn with equal satisfaction. There is no waste at starting and stopping, and, of course, a separate workman to attend to the firing becomes unnecessary. The makers inform us that they find that one ton of oil used in the Höveler burner produces the same results as two tons of coal. The appliance is made in different sizes so as to burn from one to five tons of oil in twenty-four hours. The applications of this apparatus, it is anticipated, will be numerous in view of the fact that any quantity of flame and a very wide range of temperature can be obtained with it.

TUNNEL VENTILATION

The Saccardo system of tunnel ventilation in use on the St. Gothard Tunnel under the Alps has recently been applied to the Tauern Tunnel in Austria with good results. The system includes the use of a blower fan connecting with a conduit outside one of the entrances. This conduit feeds an air chamber that completely encircles the tunnel just inside the entrance. This chamber opens into the tunnel through a ring of 17 nozzles, above, below and on both sides of the track. The chamber and conduits are of reinforced concrete with smooth surfaces; the nozzles are of wrought iron. Forcing the air through the conduits and air chamber into the tunnel produces a current of air through the tunnel entrance, and to take advantage of that fact blowers were installed that gave a range of velocity from 9 feet 10 inches to 19 feet 8 inches per second, equivalent to about 282,530 cubic feet per minute. The results were successful not only in supplying pure air to trainmen and trackmen within the tunnel, but also in reducing the wear or rust on the tracks caused by the sulphurous fumes of coal or oil fuel, and lessening the danger of accident.

BENEFICENT BEANS

At the Cornell University Agricultural Experiment Station it has been shown by T. L. Lyon and James A. Bizzell, who have conducted tests extending over a number of years and now publish a summary of results, that in addition to restoring to the soil a quantity of nitrogen compounds, which are later available for other crops, the growth of legumes (beans, peas, alfalfa, lucerne, etc.) may also furnish nitrogenous food to other plants while growing with them, and then influence the nitrification of the soil besides.

In earlier experiments the yield of the soil that had borne one or more crops of legumes was compared with soil upon which plants of this family had never been grown before. In the present experiments the two kinds of plants were sown together. A comparison of the total yield is shown in the next table, wherein are compared the pounds of hay per acre when oats was grown alone with the yield of hay when oats was grown with peas, on two different soils:

POUNDS OF HAY PER ACRE.

Oats alone.	Oats and Peas.
3,750	4,850
2,900	3,900

Other tables in the original paper show the total proteins per ton of yield to be likewise in favor of the grain raised in combination with the legume. The increased protein content of the hay makes it of greater food value.

On certain plots alfalfa was grown for five years; on others with the same kinds of soils, timothy was grown for five years. At the end of this time there was found a larger percentage of nitrates in the alfalfa soil than in the timothy soil, as was to have been expected. But on similar plots which were kept bare for a season after the removal of the plants the same differences were observed. This suggested that nitrification continues after the removal of the alfalfa, and actual experiments with samples of soils in flasks showed that such is really the case. The rate of nitrification, or of converting ammonia into nitrates, is of great importance in agriculture, since it determines the amount of nitrate that will be available for the crop. Samples of soil were tested for the nitrates present; weighed quantities of ammonium sulphate were added and the nitrate test repeated after ten days. In every case the soil that had borne alfalfa showed greater nitrification than soil that had not borne a leguminous crop. At the end of twenty days all of the ammonia had been nitrified in all of the soils. In other words, the rate of nitrification is decidedly influenced by the fact that alfalfa had been grown on the soil.

MOVING PICTURES OF INDUSTRIAL OPERATIONS

The Scientific Management exploiters, who now are so buttom-holing the public with their schemes, would seem to be in need of a little scientific management themselves to bring them up-to-date. Better than all the talk would be series of moving pictures showing the old, familiar ways of handling pig iron or of laying bricks and then the "scientifically" managed ways of doing the same. The idea has been taken advantage of to show the Thermit process in operation. One of the most interesting and instructive exhibits at the Atlantic City Conventions of the Railway. Master Mechanics and Master Car Builders Associations was a set of moving pictures thrown on a daylight screen and showing all the different steps in welding a locomotive frame by the Thermit process.

A great advantage of showing the welding operations in this way lies in the fact that only a small portion of each operation need be thrown on the screen, so that the entire welding operation can be shown in from ten to fifteen minutes, while if the observer were required to witness the welding itself, he would have to spend two days to see exactly the same things that are shown by moving pictures in fifteen mintues. This advantage would also apply to many other industrial operations which might be shown by the moving pictures.

In taking the pictures an operator and machine were sent to one of the railroad shops in the vicinity of New York where Thermit is used very extensively and where excellent results have always been obtained. A picture of the locomotive previous to welding was taken outside of the shops and a man is seen pointing to the location of the fracture. The next scene is inside the shops with men at work drilling the fracture open. Successive steps show the wax pattern being formed, mold box placed in position, sand rammed around pattern, preheating torch started, charging the crucible with Thermit, withdrawing the torch, plugging the preheating gate, igniting Thermit in crucible, tapping the Thermit steel into the mold, dismantling the mold, trimming up the weld, and finally the weld is shown completed with engine ready for service.

Of course, in making these pictures all the steps up to pouring the weld were taken in one day. The weld was then allowed to cool over night and in the morning pictures were taken showing the mold being dismantled and welds being trimmed up.

SAFETY OF PINTSCH GAS

No man can say that any combustible gas released in unconfined space *cannot* under some conditions be ignited. But we can say that in the case of this particular gas the chances are overwhelmingly against it. The pressure under which it is stored in the tanks and connecting pipe lines is such that, at a break, it escapes with sufficient velocity to blow out a torch. This has been proved by test. At such a break it is possible to ignite it only by some such means as a piece of incandescent metal. Furthermore, the combustible mixture of air and this gas is within unusually close limits. The small amount of this illuminant necessarily carried in the tanks of cars will, in case of a break, escape and expand in the atmosphere in two or three minutes; and of that time there is but a narrow zone, only a few seconds, in which even a high temperature will ignite it. There is no evidence of the explosion of Pintsch gas tanks in a wreck; and it is obviously impossible to have conclusive evidence of the behavior of escaping gas in a wreck. It would require an expert standing alongside of the track watching the train continuously from the moment of the derailment or collision. We have investigated, to the best of our ability, many of the alleged cases of Pintsch gas burning in a wreck, and have never found evidence to support the allegations. In the Martin's Creek wreck the piping was broken in many places. The tanks being under the car, and there being breaks in the piping near the tank, it is not possible to conceive of the gas escaping into a confined space; so there is every reason for believing that the gas was dissipated in the atmosphere so quickly that it had no part in the conflagration.—*Railway Age Gazette.*

HORSEPOWER OF A FAN BLOWER

By Albert E. Guy.

A problem frequently met with is that of finding the horsepower of a fan blower when the diameter of the rotor, width of vanes at the tip, etc., are known. This typical problem may be solved only when the necessary data embodied in the "etc." are known; otherwise it may be readily shown that two fans, having the same inlet and outlet diameters, the same width of blades, revolving at the same rate of speed and delivering the same volume of fre air per unit of time, may produce widely differing pressures. Thus, with the lower pressure, the air horsepower would be almost negligible, while with the higher pressure, which might be an extreme for the class of fan considered the air horsepower, and consequently the shaft horsepower would be matters of prime importance. This discrepancy is due simply to the fact that in either case the vanes, although of the same width, must be designed to suit the required conditions of pressure.

About two years ago in order to show the direct applicability of centrifugal-pump formulas to the design of fan blowers and to prove that a complete line of standard apparatus could be designed without making preliminary and special experiments for obtaining so called coefficients of correction, I chose two extreme sets of conditions and designed special apparatus to meet them.

It was proposed in one case to furnish 7,000 cubic feet of free air per minute at a static pressure of 22 inches of water, and in the other, 5,250 cubic feet of air per minute at a pressure of 5 inches of water, the speed being 3,600 revolutions per minute in both instances. A spiral form of casing was designed, and an impeller fitted into it, each set of conditions being met by a special impeller; but to add to the difficulties and to render the proofs more conclusive, the inlet and outlet diameters, and the width of the vanes, were kept the same for the two impellers. Fig. 1 shows the principal dimensions and forms of the impellers.

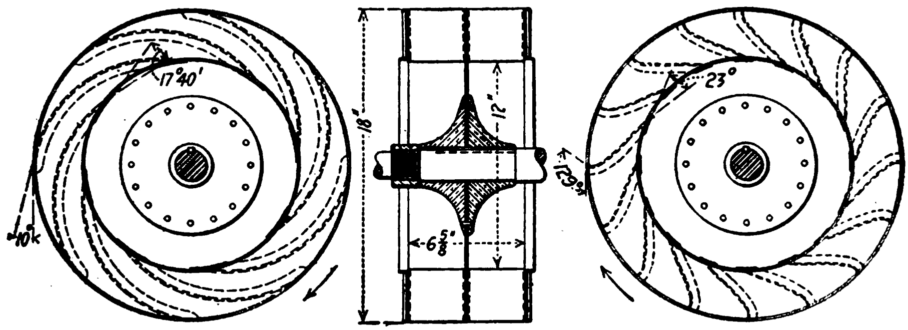


Fig. 1. Impellers Used Showing Curvature of Vanes

When completed, the apparatus was connected directly to a steam turbine and the high-pressure impeller driven at the specified speed. To determine the capacity of the fan and to obtain the curve showing the relation of volume to head, the speed was kept constant while the volume delivered was progressively increased by changing the nozzle areas at the end of the discharge pipe. The head was recorded simultaneously with the volume to which it corresponded. Various speeds above and below that specified were tried in the same way, the results being shown by the series of curves given in Fig. 2.

The steam and exhaust pressures at the turbine were recorded for each point of the curve, not for the purpose of ascertaining the steam consumption, but in order that later on, the blower being disconnected and replaced by a prony brake, the same steam and exhaust conditions could be reproduced at the proper speed and the corresponding brake horsepower recorded. With the latter data the efficiency of the apparatus was obtained and is represented by curves covering the useful range of the impeller.

The low-pressure impeller was tried next, but on account of the small amount of power required to drive it and the unsuitability of the turbine for the purpose of measuring that power, it was not possible to ascertain the efficiency with sufficient accuracy to permit representation by curves, as was done with the

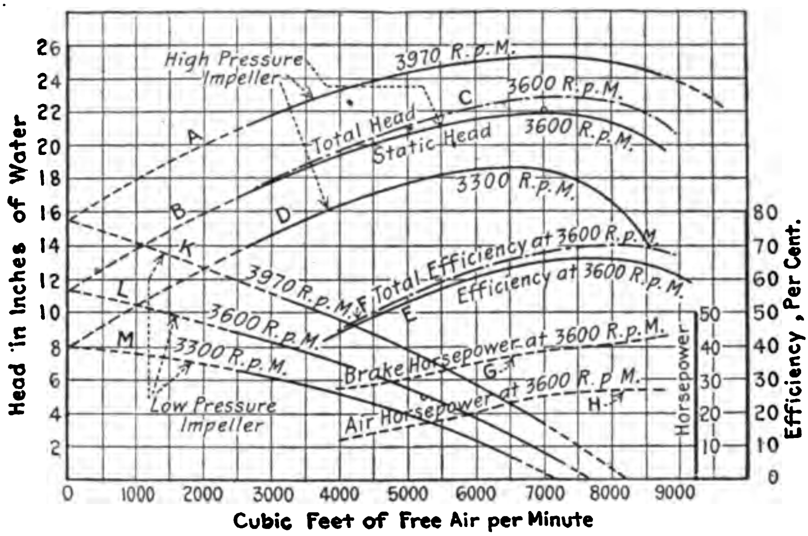


FIG. 2. CHARACTERISTICS OF THE TWO IMPELLERS TESTED

first impeller. However, it was observed that for the point aimed at in the design, the efficiency was not less than 60 per cent.

The curves *A* to *H* in Fig 2 are for the high-pressure impeller and curves, *K, L, M* are for the low-pressure impeller. It is apparent that neither impeller was suitable for the requirements of ordinary work. The usual requirements are that a practically constant head

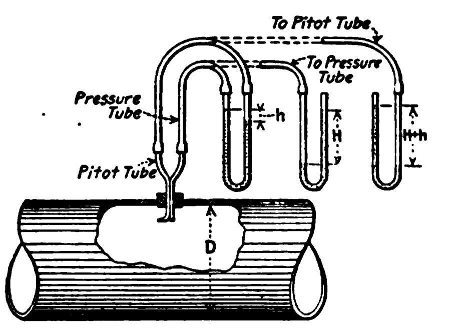


FIG. 3. DEVICE FOR MEASURING PRESSURE IN PIPE

be maintained for a wide range of volume variation. In the present case such a condition could have been met only by varying the speed, and the turbine was not well adapted for such a speed variation.

However, a comparison of the capacities of these two fans is interesting. At 3,600 revolutions per minute 7,000 cubic feet of free air were delivered against a head of 21.8 inches of water by the high-pressure fan, while the same quantity was delivered against a head of 1.6 inches of water by the low-pressure fan. The air horsepowers were nearly proportional to the heads. or in the ratio of 13.6 to 1. At the same speed and for a volume of 5,250 cubic feet of free air per minute, the brake-horsepower ratio would be about 4.5 to 1.

The impellers illustrated by Fig. 1 are not recommended for practical work. The speed of 3,600 revolutions per minute is too low for the high-pressure impeller, or, the la'ter's diameter is too small for the speed. Moreover, the reversed form of vane is not desirable, as it entails a great frictional loss, and while it is theoretically correct for turbine work, it is not so for pumping purposes. The speed of 3,600 revolutions per minute is far too high for the low-pressure impeller; the vanes are consequently too long and entail a frictional loss out of proportion to the head worked against.

These two impellers, however, served to demonstrate the proposition as intended and further illustrate the fact that it is not possible to determine the horsepower required for a given blower, when only the diameter, width and blades and the number of revolutions per minute are known. It is necessary to know also the inlet and outlet angles of the vanes, the equation of their form, and the equation of the areas of passage from the inlet to the outlet of the impeller.

It is true that for a certain line of standard machines it is possible for the manufacturer to establish a set of approximate horsepower curves which are very useful for estimating; but such information is never given to the user of the machines.

When the fan takes the air from the atmosphere and delivers into a duct, and particularly when that duct or pipe is circular, it is comparatively easy to measure the approximate capacity of the apparatus when the air handled is at a moderate temperature. The instrument needed for the operation is very simple and can be easily made. Fig. 3 represents a combination of Pitot and pressure tubes connected to a glass U-tube containing water. The end of the assembled tubes should be inserted into the delivery pipe as shown. A straight part of the pipe should be selected where the flow is not likely to be disturbed by the influence of bends, valves, etc. The gage should be inserted into the pipe for about one-sixth the diameter and turned so that the open end of the Pitot tube is against the surrent. If the tube is not so placed the readings will not be correct.

With the two rubber tubes in place the difference in the hights of the columns of water in the U-tube shows the velocity head causing the flow in the duct. Disconnecting the Pitot tube from the glass gage and measuring the hight between the two levels, will indicate the pressure head against which the air is delivered. Again connecting the Pitot tube and disconnecting the pressure tube, will show, by the difference in the hights of the water columns, the total head produced by the fan. This total head is composed of the static head measured by the pressure tube, plus the velocity head shown when the two tubes are used together.

Calling the velocity of flow v feet per second, the velocity head h inches of water, and the static pressure head H inches of water,

$$v = \sqrt{2g\frac{p}{d}} = \sqrt{\frac{1{,}746{,}700 \times h}{406.7 + H}} = 1321\sqrt{\frac{h}{(406.7 + H)}}$$

where,

p=Pressure in pounds per square foot;

d=Weight, in pounds, of one cubic foot of free air at 50 degrees Fahrenheit =0.077884;

406.7=Inches of water corresponding to atmospheric pressure.

Knowing the inside diameter D, in inches, of the delivery pipe, the volume discharged in cubic feet per second is

$$\frac{\pi D^2}{4 \times 144} \times v$$

But this air is at a pressure H and the corresponding volume of free air per minute would be

$$\frac{\pi D^2 \times v \times 60 \times (406.7 + H)}{4 \times 144 \times 406.7} = \frac{D^2 \times v \times (406.7 + H)}{1242}$$

cubic feet per minute

The horsepower in air delivered would be

$$\frac{\textit{Volume per minute} \times \textit{pressure per square foot}}{33{,}000}$$

One cubic foot of water weighs 62.35 pounds; one inch of water equals

$$\frac{62.35}{12} = 5.196 \textit{ pounds per square foot}$$

Hence,

$$\frac{\textit{Volume per minute} \times 5.196 \times H}{33{,}000} = \textit{Air horsepower}$$

or

$$\textit{Air horsepower} = \frac{\textit{Cubic feet per minute} \times H}{6350}$$

Substituting for the volume and velocity their respective values:

$$\textit{Air horsepower} = \frac{D^2 \times v \times H \times (406.7 + H)}{6350 \times 1242} =$$

$$D^2 \times H \times \left(1321\sqrt{\frac{h}{406.7 + H}}\right) \times (406.7 + H)$$

$$= \frac{D^2 H \sqrt{h \times (406.7 + H)}}{5970}$$

As the efficiency of ordinary blowers is about 50 per cent., multiplying the air horsepower as just obtained by 2 gives approximately the shaft horsepower necessary to run the blower. While reading the gages the speed should be kept constant, and the time selected when the flow of air is uniform.

The gage readings and particularly that of the velocity head should be very close, for which reason it is preferable to use a U-tube of rather small diameter.

The formulas herein given are intended for approximate work only. The density of the air depends so much upon the temperature that the method would not apply to hot-blast work, for instance. Corrections should also be made for altitude and humidity. However, if the proper constants were determined to suit a given installation, the formula as modified would be found very useful.—*American Machinist.*

COAL DUST EXPLOSIONS

The following, by C. M. Young, Asso. Prof. of Mining Engineering, University of Kansas, controverts certain statements and deductions of an article which had previously appeared in *Mines and Minerals,* and incidentally conveys imformation upon the general topic which should be of interest to many of our readers.

The article here criticized begins with a quotation from a report published by a British commission on coal dust in 1894, which states that "coal dust alone without the presence of any gas at all may cause a dangerous explosion if ignited by a blownout shot or violent inflammation. To produce such a result, however, the conditions must be exceptional and are only likely to be produced on rare occasions." It will be noticed first that this report was published 17 years ago, before any widespread attention had been devoted to the subject of dust explosions and that the conclusions there stated must of necessity have been founded upon a comparatively small number of observations. The opinion here stated is undoubtedly in the main correct, as is shown by the fact that dust explosions occur as rarely as they do. But the writer of the article referred to bases on this report and on certain other data the opinion that the principal factor to be considered in an investigation of dust explosions is not the coal dust, but apparently the air with which it burns.

After a discussion of the air-currents produced by blasting, the author advances the statement that a dust explosion can occur only in case the air in which the dust is suspended is subjected to more or less compression, using the following language: "It is the presence and influence of this dynamic force (*sic*) that produces high explosive effects and in its absence the mere contact of flame and coal dust has proved comparatively harmless. The results of experiments and laboratory tests clearly and convincingly show that explosive effects and the propagation of an explosion can only be produced by the forcible injection of air and dust into the flame. Peckman and Peck could only produce explosive effects by blowing the dust into a flame by means of a bellows, etc." The work of other experimenters is cited as showing that dust must be suspended by compressed air, and the paragraph closes with a reference to an experiment by Holtzwart and Meyer, in which an explosion was obtained when the dust was puffed between the terminals of an electric circuit, but not when the dust was shaken in the tube.

The data given here are not sufficient for a conclusion that the dust must be suspended by compressed air in order to be explosive. In the first place, as far as I can learn, the reason for using compressed air in all cases except the last was the simple fact that it offered the most convenient means of getting the dust into suspension. That it is not necessary has been abundantly demonstrated.

A large number of experiments along this line at the University of Kansas do not suggest any such conclusion. In the earlier experiments compressed air was used simply because it was convenient, but in later experiments, comprising by far the larger number, the dust was placed in a box and thrown into the air by an agitator. In most cases ignition was obtained by moving aside the cover of the box and holding a naked flame at the opening. The air was under no pressure whatever, the only object sought being to suspend the dust in the air in the form of a cloud. It was found that the result of the experiment depended more upon the quantity and condition of the dust than upon any other factors. Some dusts were inexplosive in any quantities, and others were explosive in small quantities, others in large quantities, others only in the presence of gas. The following examples will illustrate:

No. 1. Drill dust from W. C. & C. Co., No. 16. Explosive limit 2.9 grams.

No. 2. Dust from haulageway W. C. & C. Co., No. 15. Inexplosive alone; 3 per cent. natural gas required to make it explosive.

No. 33. Dust from Monongah mine No. 8. Explosive limits 2.1 grams and 2.8 grams, depending on the method of selecting the dust.

These experiments are selected from a considerable number for the purpose of showing that the explosive limit depends upon the quality and quantity of the dust, other things being the same. The statement quoted by the author that "Unless there is an exceptionally large amount of dust in the air, experience shows that ignition does not take place from a naked flame," is undoubtedly correct. The reason, however, is that unless the dust exists in large quantities the mixture with the air is not explosive, but the quantity required depends upon the character of the dust. If the dust contains large quantities of combustible volatile matter, relatively small quantities suspended in the air will be explosive, but if it contains little combustible volatile matter our experiments tend to indicate that no quantity will be explosive. I wish to emphasize the statement that the conditions necessary for an explosion are first, an explosive dust; second, the suspension of a sufficient quantity of it in the air. The author quotes experiments of the Chesterfield and Derbyshire Institute of Engineers in which out of 134 tests ignition was obtained in 36 cases, and no violent explosion was obtained even with 6 per cent. of gas. A horse pistol was used to ignite the mixture. The conclusion is drawn that failure to produce more explosions was due to the fact that the firing of the pistol did not produce sufficient compression of the air. I do not believe that this conclusion is justified. The data are not sufficient. In the first place we have no knowledge whatever of the quantity of dust suspended, and second, we know nothing of its quality. Either it must have been very small in quantity or almost inexplosive, to show absence of violent explosion in the presence of 6 per cent. of gas, because this much gas alone is explosive under favorable conditions. I assume here that gas means methane. This statement that 6 per cent. of gas alone can be exploded is based upon a large number of experiments and our experiments have also demonstrated that gas and coal dust can replace each other in explosive mixtures. The fact that so few explosions were obtained in these experiments is very good proof that the dust was nearly inexplosive, or was present in small quantities, or else that the flame from the horse pistol was insufficient to ignite even an explosive gas mixture.

Farther on in the article the author advances the idea that increase in the density of the air due to decrease in temperature is likely to be a determining factor in the occurrence of explosions. I think it probable that increase in density of air may make a dust mixture somewhat more explosive, but that the effect due to a natural change in temperature would be very slight indeed. But the author's reason for this increased explosiveness is at least not well stated. He refers it to an increase in oxygen and a little later says: "The quantity of air rather than the quality of dust is really the measure of the magnitude of an explosion." I wish to take issue with this conclusion, and I can best give my reasons for doing so by making some statements concerning dust explosions in general.

An explosion of dust is not a detonation but a burning so rapid that a violent expansion of air and gases occurs. This expansion is due partly to the formation of gases and vapors during the burning of the coal, and partly to the expansion of gases and vapors because of the increase of temperature. Coal dust can burn with explosive rapidity only when it is suspended in the air. Otherwise the supply of oxygen will be too small.

The propagation of the combustion through the mixture depends upon the quality and quantity of the dust. In other words, some dusts will burn only in the immediate neighborhood of the igniting flame, others will burn throughout the mixture, and this burnings constitutes a dust explosion. In order that a flame may be propagated through any mixture of a combustible substance with air, it is necessary that the combustion at the point of ignition furnish sufficient heat to raise the surrounding particles to the ignition temperature. If the dust furnishes a large amount of heat, the combustion will be propagated. If it does not, burning will take place only in the immediate neighborhood of the ignition agent.

The quantity of heat furnished depends upon the quality and quantity of the dust.

The dust must also be readily ignitable, and it will be so if it contains large quantities of combustible volatile matter. This volatile matter will be distilled by heat and will be intimately mixed with the air. The difficulty of igniting anthracite dust is due to the fact that it contains very little volatile combustible matter. Therefore, it does not readily explode. I do not know whether it is possible to explode it or not. Experiments at the university lead to the conclusion that it is not possible, but I do not wish to say positively that its explosion is impossible.

The error in the author's conclusion that explosiveness depends largely upon the quantity of air present, lies in the fact that in most cases there is too little dust present to be explosive. In other words, the air is greatly in excess of the required amount. The dust present does not furnish sufficient heat for sustained combustion; therefore, there is no explosion. It is only when considerable quantities of dust are suspended in the air and when this dust is of readily combustible character that an explosion occurs.

One of the gravest sources of danger lies in the fact that a deficiency of volatile combustible matter in the coal may be made up by the presence of gas in the mine air. For example, in the case of one sample of dust, whose limit in our apparatus was 2.3 grams, it was found that .7 gram of dust would explode in an atmosphere containing 3 per cent. of gas, .8 gram in an atmosphere containing 2 per cent. gas and 1.2 grams in an atmosphere containing 1 per cent. of gas. The presence of so little as 1 per cent. of gas cut in two the quantity required for explosion, and 2 per cent. of gas practically divided the quantity by three. The ordinary means of detecting fire-damp will hardly show 2 per cent. of gas and probably most fire bosses will not detect less than 3 per cent. It is readily seen then that dust may be a very great source of danger even when it is supposed to be harmless. I wish to emphasize in conclusion my beliefs, founded upon a large number of experiments, that the conditions necessary for a coal-dust explosion are that the dust shall be of such quality as to be explosive, and that it shall be suspended in the air. Also that gas and dust are completely interchangeable in explosive mixtures. In other words, there may be a pure gas explosion or a pure dust explosion, but I believe that in most cases the explosion is due to both dust and gas, because I greatly doubt whether any coal mine is entirely free from gas. The experiments referred to, and a large number of others, will be given in detail in the forthcoming Volume X of the University Geological Survey of Kansas.

I wish in conclusion to very heartily commend what is said by the author concerning the training and education of all persons connected with the coal-mining industry. I believe that the only way to prevent coal mine explosions and other accidents in mines is to thoroughly educate all persons concerned with the industry to a real appreciation of all of its conditions.

SCIENTIFIC CONBINATION OF KINEMATOGRAPH, GYROSCOPE AND PNEUNATIC MOTOR

In a paper published in the *Comptes Rendus,* M. G. de Proszynski remarks that the scope of the kinematograph for non-artificial view—in other words, its scientific utility—is at present very limited, owing to the necessity for posing the instrument on a very steady bases. The tremblings which injure definition if the instrument is not sufficiently steady fall under four headings: (1) Movements of translation. (2) Oscillations around the optic axis. (3 and 4) Oscillations around axes perpendicular to the optic axis. The effect of 1 and 2 is negligible. To obtain a sharp impression it is sufficient to annul or reduce oscillations 3 and 4. This Proszynski does by employing a gyroscope with its axis parallel to the optic axis of the apparatus. The requisite dimensions and velocity of the gyroscope may be calculated from consideration of the admissible maximum displacement of the impression on the plate in a given time, and of the forces due to shaking of the hand and weight of the apparatus. The gyroscope, however, only annuls short, rapid movements, and does little to counteract slow movements, such, for example, as are imparted to the apparatus by turning the handle. To avoid this inconvenience de Proszynski has constructed an automatic apparatus comprising a pneumatic motor, which is at once light, powerful, and very small.

NEW REFRIGERATING PROCESS

A new chemical refrigeration process due to Doctor Repin, a French chemist, is claimed to be free from the defects of the ammonia process, and to be specially adapted for economical results in small plants. As is well known, in one of the methods of refrigeration at present in use, the cooling is effected by the evaporation of liquefied ammonia. The ammonia gas is recovered in water, which absorbs large volumes, and when the solution so formed is heated the ammonia is expelled into a cooled receiver and liquefied by its own pressure. A serious difficulty is that about 25 per cent. of water is carried with the ammonia from the solution. The new process, which is said to be free from this trouble, uses sulphur dioxide as a refrigerant and camphor as an absorbent, 20 per cent. of naphthol being added to the latter to prevent excessive foaming and melting of the camphor on heating. The sulphor dioxide is easily liquefied and absorbs much heat in evaporating, while it is entirely disengaged in gaseous form from the camphor solution at a temperature below the boiling point of water.—*The Engineer.*

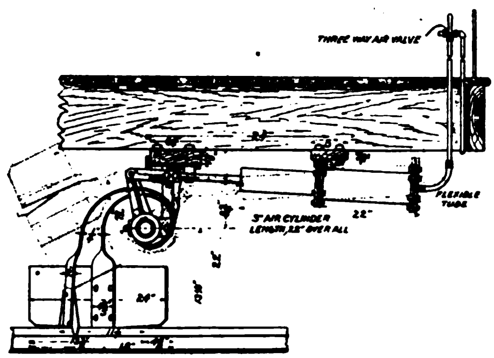
The air receivers usually provided with compressed air installations are not of much account so far as air storage is concerned. Where much larger receiver or storage capacity can be provided at little expense it is well to do so. Old boilers and tanks not otherwise used can be connected into the system with advantage. At the Eagle-Shawmut mine a whole battery of boilers is now put to this use. At the Utica mine the manager, F. J. Martin, has an unusually large amount of air stored in the mine. This he accomplished by the simple means of bulkheading an old drift with concrete stoppings, and storing the air in it. The drift is 125 ft. long and of the usual cross-section. Being in solid rock, there has been no trouble from leakage.

PNEUMATIC TRAOK SCRAPERS

The Boston Elevated Railway has recently applied to 100 cars the Root pneumatic track scraper shown in the accompanying halftone and drawing. The two most important features of this air-operated scraper are that it eliminates an extra wheel and staff from the platform and that it cannot fall at either end

UNDER THE CAR.

of the car when it is not in service. The scraper can be adjusted for any desirable pressure. It operates instantly when the motorman turns on the three-way air valve which is located on the platform. When the air is released, the spring inside the air cylinder pulls the scraper out of the way. This type



SCRAPER LIFTER.

of scraper was especially designed for the new Boston cars in order to avoid the use of windlass rods. With the exception of the pipe from the air cylinder to the three-way valve, the complete scraper equipment was furnished by the Root Spring Scraper Company, Kalamazoo, Mich.—*Electric Railway Journal.*

According to a press report the nitrogen works at Trostberg, Bavaria, were recently destroyed by an explosion. At this plant, in which American capital was invested, nitrogen was recovered from the atmosphere by the electric arc.

AVIATION AIR SICKNESS

Not only are the workers in air under increased pressure subject to special physical derangements, but it seems that those also who get to great altitudes, either by climbing mountains or in flying machines, have also their troubles sufficiently serious to call the aid of the physician. In the case of the aviator other conditions besides the levity of the air combine to produce "air sickness." In this connection two physicians of France, Dr. René Cruchet and Dr. Moulineir, have recently presented to the Académie des Sciences an interesting report of experiments and inquiries conducted by them.

Air-sickness does not seriously affect those who fly at moderate heights, but reserves its terrors for the daring aviator who seeks to reach exceptionally high altitudes, and while the mountain climber and the high-flying aviator would seem to work under similar conditions there are two specific additional factors which apply only to the latter.

In the first place, flight in a heavier-than-air machine necessitates a continuous, concntrated, physical and mental effort, and this under conditions which render the slightest relaxation of grave peril to life and limb, thus producing an exalted state of nervous tension. Then there is the extreme rapidity with which physical conditions are changed, and the corresponding inability of physiological conditions to adjust themselves in time to avoid violent disturbances, this factor being considered the most significant in the production of the specific symptoms of air-sickness.

In general, high flights have a duration of 45 minutes at most. An altitude of from 7,000 to 10,000 feet is reached in from 30 to 40 minutes, and the descent is of course even more rapid, occupying usually from 5 to 7 minutes. Biplanes are somewhat slower of ascent than monoplanes, but, on the other hand, they require more labor from the pilot. Thus we have conditions in all altitude flights of rather rapid ascent and vertiginous descent, these conditions affecting the character of the biological action.

During ascent the respiration becomes quicker at about 5,000 feet, and the heart beats faster, but usually without palpitation. Nausea and the sense of inflation of the stomach experienced by mountain climbers are usually absent, but there is a slight feeling of "malaise" or discomfort, which Morane attributed partly to the overpowering sense of intense solitude. The buzzing of the ears was not noted by Morane until nearly 6,000 feet of elevation, but novices observed it at about 1,200 feet, and even the former is considerably lower than the height at which mountain climbers are affected.

Morane states that the sight is always clear. "What makes it seem not so," he says, "is the great rapidity with which objects diminish and recede." He remarks, moreover, that when the day is fine but with a slight mist, the sun is reflected from the surface of the fog as in a mirror, so as to dazzle the aviator. This phenomenon is especially annoying where there are eddies of air, and may seriously interfere with steering the machine.

Even skill aviators suffer from a slight headache encircling the temples at about 5,000 feet, while novices feel it sooner. Cold becomes painful at about 7,000 feet. Above 5,000 feet, or even lower, the volumtary motions tend to become more nervous and jerky and the reflex motions have more amplitude. These motor modifications are easily explained by the combined effect of the cold, the quicker heart beat, the slight shortness of breath, the ear troubles, the reflection of the sun, and the nervous tension and fatigue.

In descent the heart beats more strongly, but the palpitations which are soon felt augment according to the precipitousness of the descent. The rapid fall—over a thousand feet per minute—causes that peculiar feeling of emptiness experienced in a too swiftly descending elevator. There is a buzzing of the ears toward the end, and this may increase in intensity at the end of the flight.

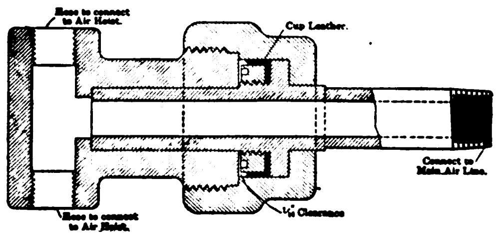
But the phenomena which are dominant and augmented as the ground draws near are the redness of the face with a sensation of heat and pain, the smarting of the eyes, moisture of the nostrils, headache, and overwhelming fatigue, with actual drowiness. This sleepiness is a very marked feature, and in itself indicates the enormous strain to which the aeroplanist has been subjected, and the resultant fatigue of nerve-centers. It is so great that the eyes close of themselves from moment to moment, in spite of the strongest desire to keep them open. In one case a searching party was sent out for a young aviator who had failed to return, and found him seated in his machine in the open country sound asleep! When waked he found it impossible to remember how he had arrived at the place where found.

On landing the motions are slow, lazy and awkward, in contrast to the native subject. Respiration tends to become normal very soon, but the headache and sleepiness may last several hours, as does the disturbance of the circulation. The latter is marked by hypertension of the arteries, with cyanosis of the extremities, and blueness of the fingers. This augmentation of pressure in the arteries is confined to those who descend from great heights; it is somewhat less marked when there is excessive fatigue, but in this case palpitation of the heart and rapid pulse are noted. This condition might be dangerous when the subject had heavy brain work to do.

Besides the changes from the normal adjustments of the body which can be recognized and described the aviator also experiences curious intellectual and mental affections. Morane spoke of a sort of "anguish" caused in part by the feeling of intense solitude. Another man, noted for his *sang-froid* and his virile energy, said that in the downward flight feelings of wretchedness and momentary fear assail one, and the thought of a dreadful death presents itself, which is the more terrible because of the semi-torpor of mind and body.

This mental and physical lethargy is spoken of by various aviators as preventing their performing as rapidly as is necessary the required mechanical acts, and many accidents may be due to the mental state. Renaux confessed that he was haunted by the thought of Chavez achieving an immortal victory with a frightful death. In crossing the Alps Chavez rose very swiftly to a great altitude, from which he descended in a long, rapid glide. The quick checking of this glide by a sudden pull on the control wheel is thought to have thrown such a strain on the wings that one of them broke off, and it is highly probable, says the *Scientific American*, that his mistake was due to the condition he was in. There may even have been some mental confusion or hallucination. One aviator has, in fact, made the remarkable statement that he constantly had a vision of the towers of the cathedral of Notre Dame, as if they were close at hand, though he knew them to be hundreds of miles away.

We thus learn and are warned by the fact that there are limits to the adapability, and especially to the possible speed of adjustment of the human machine as well as to those of the aeroplane itself.



SWIVEL JOINT FOR AIR PIPE

The sketch here reproduced from the *American Machinist* shows a revolving joint designed by a correspondent for connecting to one or more air hoists on a continuous circular track. Though here shown horizontal it will be understood that its normal position is vertical; otherwise the sketch seems to be fully and clearly self-explanatory. Several of these joints were made, this one for two hoists and others for four. The air pressure used was 80 lb., gage.

THE STORY OF A GRAIN OF IRON

James Gayley, the inventor of the Gayley process of air refrigeration and dehydration for blast furnaces, has recently published a unique booklet with the above title.

Little Grain and Oxygen, who are the hero and heroine, "lived deep down in the darkness of the earth surrounded by rich, warm Jasper between two immense strata of Rock." The reader is told how they were separated by the machinations of the Earth Gods, who used Coal to accomplish that end. The transportation of ore and coal and the operations of the blast furnace and the converter are dealt with in the language of fancy, Little Grain finally coming to rest in a steel rail. The denouement is the reuniting of Little Grain and Oxygen by the help of Water, in accord with the inexorable law of the iron people. The conceit is most ingeniously worked out in a way that gives a new light on the imaginative possibilities of metallurgical science.

THE COMPLEX PROBLEM OF THE FLYING MACHINE

[We present here the most essential portions of a paper by Mr. James S. Stephens, presented at the meeting, April 5, 1911, of the Western Society of Engineers. The reading of the paper provoked an unusually extended discussion, some of the speakers refusing to accept the assumptions of the writer. It must be conceded that the day is not yet for the fixing of absolute principles as to anything pertaining to aviation practice.]

Each of the aviation accidents which have occurred has had some specific cause, and numerous explanations and theories have been offered to account for them. Unfortunately the man who would have best been able to offer a satisfactory solution has in practically every case lost his life.

Theories have been advanced by some of the aviators blaming the so-called *Swiss cheese* sky and *holes in the air* for many of these accidents.

It is generally admitted that there are many varying currents in the air, and that these changes of speed and direction in the motion of the air are undoubtedly greater near the surface of the earth than they are higher up, and while some of the difficulties of flying are chargeable to this cause, it has, the writer believes, been blamed for a great deal more than it is accountable for. Such variations as do occur in the trend of the wind or air current are not sufficiently abrupt to make flying extra hazardous from that cause alone.

Once a machine is off the ground, it would be immaterial whether the wind was blowing steadily in one direction one mile or one hundred miles an hour, if it were not for the fact that it is necessary to give due consideration to the laws of inertia, acceleration, retardation, momentum, centrifugal force and gravity in their proper relation to the speed of the machine, both relative to the air and relative to the earth.

In still air a flying machine, in maneuvering in a horizontal plane, would have to accommodate itself to practically the same conditions as a vehicle on the ground. In starting up, increasing or decreasing the speed, the inertia of the weight of the machine must be overcome, thus introducing the elements of time and power. In turning, some positive resistance, such as banking the machine, must be depended upon to counteract the centrifugal or tangential forces.

All of the men who have flown these machines have learned to do so in comparatively still air, and have been thoroughly familiar with the conditional requirements just referred to, as a result of their experience with vehicles running on the ground.

Flying in a wind, the writer believes, introduces the effect of some of Nature's laws in a way that up to the present time has not been fully appreciated, and therefore has not had the consideration which is due.

To illustrate, imagine a machine flying at the rate of 40 miles an hour, which is in round numbers 60 ft. per second, directly against a wind blowing at the same speed. While such a machine would maintain itself in the air just as surely and safely as if it were flying on a calm day and covering a distance of 40 miles an hour as measured on the earth's surface, it would in fact actually be standing still, in so far as its relative position to the earth is concerned, and the entire output of its engine would be expended in supporting it against the action of gravity and in preventing it from drifting backward in the wind.

Now consider what would happen if the 40-mile wind could be suddenly stopped. The machine, having no initial velocity or momentum, could get no support from the air until it could acquire a sufficiently high relative velocity. This, on account of inertia, and the limited power available, requires time, and during such time-interval, the machine must fall. While the abrupt stopping of a 40-mile wind is not possible, a somewhat analogous condition may be brought about by an abrupt turning of the machine when it is stationary relative to the earth through flying against a high wind as above mentioned.

Under the most favorable conditions, it would take considerable time to bring a machine weighing about 1,200 lb. from a standing position up to a speed of 60 ft. per second, or double this speed, as the writer will endeavor to show may be necessary under certain practical conditions.

The following is quoted from *Aircraft*, the December, 1910, issue, describing the flight of Johnstone and Hoxsey at the Belmont Park International Aviation Meet, both of whom have since lost their lives as martyrs to the cause of progress. "They faced the wind coming in from the ocean, and as they went higher their speed in relation to the ground rapidly diminished as that of the air they were meeting became greater. Soon they appeared to be standing still, the velocity of the wind being just even to theirs (about 38 miles), and then, as they went higher, they started to lose ground and the higher they went the faster they went backwards. Close together they appeared like two great kites on a string—a string being slowly paid out."

How great a wind Johnstone faced at his maximum altitude of 8,500 ft. no one can say, but with his machine going close on to 40 miles an hour, he was blown backwards some 40 miles in the course of less than two hours, and 75 miles an hour is not an exaggerated estimate of the maximum velocity of the wind met by him.

Brookins, Johnstone and Hoxsey, on Wright machines, have made complete circles in the air in about six seconds. Let us suppose one of them had undertaken to make such a turn when flying against a head wind; a quarter of a turn would be made in less than two seconds with the result that, whereas the machine before the turn had the necessary supporting power to maintain it in the air, in less than two seconds of time it would have turned around a quarter of a turn in the air, and with respect to its relative position to the earth, would have practically turned upon its own center, and have begun to drift sideways, having practically lost all of its sustaining power; it had no initial forward motion when commencing to make the turn, the time allowed not being sufficient to acquire the necessary acceleration, and the power available not being great enough.

Should he be able to get his machine around a full half turn, which he might be able to do in three seconds, the machine, even though assisted by all the power of its engine, and the effect of the wind in the direction it had turned, could not in that limited time have gotten up sufficient headway against its own inertia so as to be moving as fast as the wind itself, and the wind would actually be blowing from behind and aiding gravity in forcing the machine downward. It seems hardly probable that under such conditions it would be possible for the operator to again right the machine, even though it were falling head first, especially if he was not aware of the actual cause of the trouble.

As a matter of fact, a machine under such conditions as above outlined would, in so far as the forces of gravity and inertia are concerned, have to start from a standstill and acquire a velocity of 80 miles per hour relative to the earth before again obtaining its normal supporting power of 40 miles per hour relative to the air in which it would be flying.

A further complication would be the fact that once commencing a turn under the conditions above stated, the machine would have a tendency to turn practically on its own center, and having thus acquired an initial rotary motion with little forward motion in the same plane, it would be much harder to check or reverse the turn. Any effort which might be made by the operator would probably be such as would result in just the reverse to that intended, as the conditions of support would for the time be reversed.

The support of a flying machine in the air depends upon a nice adjustment of speed relative to the air, its surface and power, as opposed to the action of gravity. The power may be so applied when flying as to store up within the machine dynamic force, which would be the product of its speed relative to the earth and its weight, or simply to overcome the static force caused by gravity, if the machine were flying against a wind blowing at the same speed required for sustention. In fact, if the machine were flying against a wind blowing relative to the earth at greater speed than the speed of the machine through the air, it would then have stored up within itself dynamic force acting in the opposite direction to which the machine would be actually moving through the air.

It seems evident that a flying machine may be turned very quickly and may, on account of the small frictional hold it has upon the air, and due to momentum, or centrifugal force, skid a considerable distance in making a turn, unless the resistance available by banking the machine is adjusted very nicely to the relative forces brought about by the speed of the machine. It is the writer's belief that such quick turns, if made in a wind, are extremely dangerous and are responsible for at least some of the fatal accidents which have occurred.

Professor Langley, the writer believes, was the first to compare the flight of an aeroplane to a skater passing rapidly over thin ice, which would sustain him safely so long as he maintained sufficient speed to distribute his weight over a sufficient area. Let us go a little further with this illustration. We know that the skater might turn his body around while passing swiftly over such thin ice, and still continue on in safety, but should he check his speed and endeavor to reverse the direction of motion, he would surely break through. So with a flying machine: if turned too quickly, its momentum would tend to carry it along in the direction in which it had been flying until it reached a critical position without sufficient support from speed in the direction it had been turned.

Safety in either case could be assured only by making a long turn that would meet the requirements of time, weight, and surface; and, while the skater might turn on his own center, skating either face forward or backward, without affecting his safety so long as he maintained his speed, the flying machine must of necessity at all times present its front directly toward its direction of motion, and at the same time maintain its proper angle of incidence and forward speed relative to the air to prevent its falling.

This essential condition that the machine must be moving at its full speed relative to the air and in the direction it has turned irrespective of the speed of the wind or the relative speed of the machine to the earth, and the fact that such changes in direction when flying in a wind may bring about or require rapid changes in the actual velocity of the machine itself, so that at all times it may have a normal speed relative to the wind, is, the writer believes, responsible for conditions which we have not had to consider in other methods of transportation prior to the advent of the flying machine.

It is believed that a greater power is required to get a machine off the ground than that necessary to maintain it in the air in horizontal flight. If making a flight in still air, the machine might start in any direction on level ground. The power required would be that which would be necessary to overcome the head resistance of the air, the frictional resistance of the air, the action of gravity, and the inertia of the weight of the machine in bringing it up to the speed necessary for sustention, in a given time. After attaining this speed, that portion of the power required for overcoming inertia would remain in the machine as kinetic energy, and when flying in still air would remain constant irrespective of the direction in which the machine might be flying.

If a machine were started from a stationary position on the ground against a head wind blowing at a speed equal to that necessary for the support of the machine, no power would be required to overcome the inertia of the machine in a horizontal plane; it would maintain its relative position to the earth; and if it were possible for the wind to instantly stop blowing, the machine would fall during the time necessary to accelerate the machine up to a speed necessary for support.

If a machine were started from a stationary position on the ground, moving in the same direction with a wind blowing at a speed equal to that necessary for the support of the machine, it may be assumed that, if sufficient time is allowed, the force of the wind will accelerate the speed of the machine up to the speed of the wind, but from this time until the machine obtains a speed necessary for support greater than the speed of the wind, the same elements of resistance will have to be overcome as in starting from the ground in still air, including the power and time necessary to overcome the inertia of the machine.

The above statements, the writer believes, demonstrate the fact that in flying in a wind and making a turn, the necessity for quick changes in the actual velocity of the machine, required to accommodate the speed of the machine to the speed of the wind when the direction of the machine is changed, may be such as to cause the machine to fall for want of sufficient surplus power to meet such variable conditions, or on account of not allowing sufficient time for the small amount of power available to meet the requirements of changes in the actual velocity of the machine.

In flying in a wind it would seem as if there must always be a variable resistance or momentum to be considered when making a turn; that this variable will be proportionate to the speed of the wind, and must be provided for, when turning, by the allowance of ample time for increase or decrease of the actual speed of the machine so that it may at all times maintain its normal speed relative to the air. Also that, in making such adjustments of time and speed, the weight of the machine, the normal speed, the amount of surface, and the surplus power available will all have to receive due consideration—in the hands of an expert operator who has become thoroughly familiar with these conditions and their relative values—if safety in flight is to be attained.

A flying machine cannot, without risk of falling, be turned in its course through the air without allowing the necessary time relative to the power and weight to overcome its inertia and maintain its speed in the direction it has turned.

For the sake of argument, consider what would actually happen to a flying machine weighing 1,000 lb. moving through the are at the rate of 60 ft. per second, or 40 miles per hour, and making a complete turn in the air in six seconds, while the wind was blowing at a speed of 40 miles per hour, the turn to commence when the machine was flying against the wind and practically standing relative to the earth. In making such a turn in still air, the machine would traverse a true circle about 360 ft. in circumference, both iu the air and relative to the earth, commencing and completing the turn with the normal speed necessary for sustention, 60 ft. per second in the air and relative to the earth's surface at all points of the turn.

In making a turn in the air with the wind blowing 40 miles per hour, the machine would, if it were not for the effect of inertia, traverse a true circle relative to the air, just as when turning in still air; but relative to the earth it would move in the direction in which the wind was blowing 60 ft. per second. But on account of inertia, in making such a complete turn the weight of the machine, 1000 lb., would have to be accelerated from a standing position to a speed of 120 ft. per second in the first three seconds of the turn, and retarded from this speed to a full stop in the last three seconds of the turn.

As a matter of fact, a flying machine may be turned around in about six seconds and with comparative safety in still air, but to make such a turn and at the same increase the speed of 1,000 lb. weight to 120 ft. per second, and again retard it the same amount in six seconds, is beyond the power available for acceleration, or the strength of the machine to act in retardation, especially if we consider the fact that the power available for acceleration would be very small, practically all of the power being actually necessary to support the machine in the air. The amount of power available over and above that required for sustention may be approximated by the ability of the machine to rise. For instance, if a machine weighing 1,000 lb. were capable of rising 100 ft. per minute, this would indicate that it had 3 h. p., or 100,000 foot pounds per minute, of surplus power above that required to maintain speed of sustention. Three seconds is one-twentieth of a minute, so that we would have 5,000 foot pounds available for three seconds to increase the velocity of 1,000 lb. weight to 120 ft. per second. It would take about 140,000 foot pounds to do this in three seconds, or about a minute and a half to accelerate 1,000 lb. weight with the energy available, 5,000 foot pounds. These figures are merely approximations made to illustrate the conditions involved.

The wind would assist in acceleration on the first half of the turn, and the resistance of the air to forward motion would help decrease the time necessary on the last half of the turn. This would materially decrease the time required for the complete turn. The arbitrary conditions mentioned herein are used for illustration only. The actual time in which a safe turn may be made in the air may be closely estimated, if we have the weight of the machine, know how much surplus power it has, know the speed of the machine relative to the air, and the speed of the wind. The product of these factors would be varied somewhat by the area of the surface of the machine, the form of the machine, and the ability of the operator to control it to the best advantage.

It is believed that some of the accidents referred to have been due to a combination of the above named causes, and to the failure of the aviator to appreciate their varying influence as compared to his speed through the air and his relative speed over the earth due to the speed of the wind. It is only when quite near the earth that the relative speed of the machine may be judged of; when higher up, the aviator's attention is given to necessary adjustments to meet the changing conditions in the air.

On apporaching the ground, he has no way of determining the direction or speed of the wind except by noting some object such as smoke or flag, or by first flying in a circle near the earth and noting the amount and direction of the side drift of the machine. And it must beadmitted that to do this even approximately must require a highly cultivated sense of speed and direction. Any speed indicator placed upon a machine can only show the speed through the air. Nevertheless, such an instrument is of the highest importance as a guide, to limit speed in gliding and to maintain necessary speed for sustention. It is quite possible that accidents have occurred on account of lack of knowledge of these relative speeds.

PNEUMATIC REMOVAL OF SEDIMENT FROM SETTLING TANKS

For the removal of sediment from the settling tanks in coal-washing plant a Silesian engineer, Herr H. Schubert, has introduced a pneumatic method which has already found application at a number of collieries in Upper Silesia. A characteristic feature of the method is that, instead of being pumped or

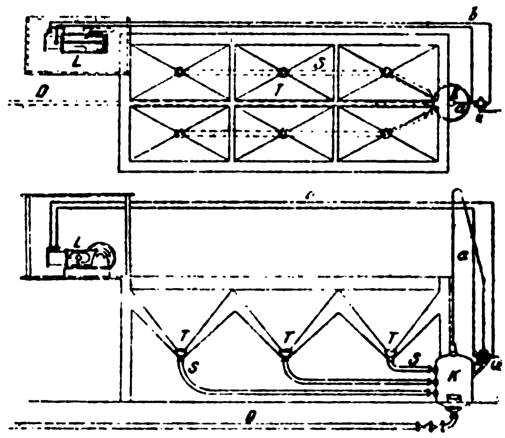


FIG. 1.

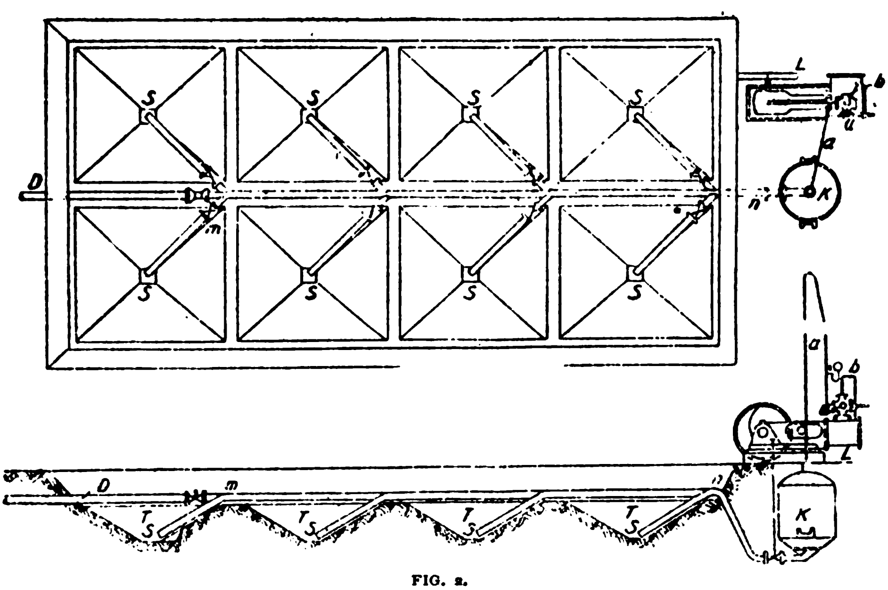


FIG. 2.

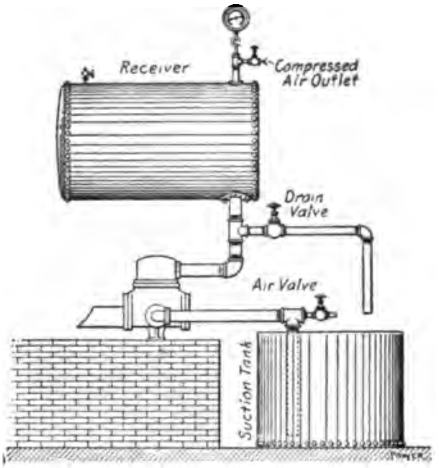
drawn off from the tanks in a semi-liquid form, the sediment is handled in a thick condition. The effluent water, laden with fine particles of coal, is run into the settling tank, which is provided with funnel-shaped recesses T (Fig. 1), which latter are connected by suction pipes S with a closed receiver K. This is provided at the top with an automatic valve, from which a pipe *a* leads to a reversing apparatus U, which in turn is connected with the suction pump L by the pipe *b*. The pipe *a* leads to a reversing apparatus U, which in turn is connected with the suction pump L by the pipe *b*. The pipe *a* is 40 to 50 ft. in height and has two limbs, in order that no sediment may be drawn into the suction pump in the event of any accident to the automatic valve. When the receiver K is connected with the suction pump by means of the reversing apparatus U, the air in the receiver is exhausted and becomes filled with sediment drawn from the recesses T through the pipes S. As soon as a float attached to K indicates that this latter is sufficiently charged, communication with the pipes S is cut off by moving a lever and the receiver K is put in communication with the delivery pipe D, so that the pump L now acts as a force pump and expels the contents of K to their destination.

Another form is illustrated in Fig. 2, the bottom of the settling tank being divided into recesses T, into which dip the suction pipes S, branching from a main, *m-n*, leading to the receiver K. This main is connected direct with the delivery pipe D, an arrangement found preferable to the use of seperate suction and delivery pipes where the former are very long. In this modification, when the receiver K is full, the reversing apparatus is operated and the sediment in the receiver is expelled through *m-n* and D. which done, the valve connecting *m-n* and D closes automatically, and the pump again begins to act by suction. Since all the sediment in *m-n* has been forced into D, the suction pump has merely to overcome the inertia of the sediment in the short branches S, so that only a low vacuum is required. If, however, the suction and delivery pipes were separate, the whole length of *m-n* would remain filled with sediment, and a high vacuum would be needed to set this quantity in motion on renewing the suction phase of the process; indeed, in certain circumstances, it would be necessary to employ compressed air for that purpose. Furthermore, combining the suction and delivery pipes in the manner indicated is equivalent to increasing the capacity of the receiver K.

GETTING AIR PRESSURE WITH A WATER PUMP

Mr. Louis T. Watry, Pueblo, Colorado, a contributor to *Power,* tells in a recent issue how he obtained a pressure of air for testing purposes from an ordinary steam pump by admitting air with water entering the suction pipe. He says:

Some time ago I was employed in a plant where iron barrels were occasionally tested, an air pressure of 10 or 12 pounds per square inch being necessary. The foreman said he had thought of using a small duplex pump, but he could not pump over 4 pounds of air pressure. I told him I could get all the pressure he needed and, to prove my argument, devised the scheme shown in the accompanying drawing.



The barrel to be tested is first connected by a hose to the open-air outlet valve on the receiver. The drain valve is closed. The pump is then slowly started and when primed the air valve on the suction line is opened just enough to prevent the pump from entirely "losing its water." By proper regulation of this air valve the pump will take in a large volume of air with each stroke and just enough water to keep the plungers and valves fairly well sealed. When a pressure of 8 or 10 pounds is reached the air valve on the suction line is closed, the pump takes water and the receiver is nearly filled. This forces the air out of the receiver into the barrel being tested and increases the pressure at the same time.

Should more pressure be desired the air-outlet valve is closed and the receiver is drained into the suction tank. The small valve shown on top of the receiver admits air when the receiver is being drained. The operation mentioned is then repeated.

Incidentally it is not the most economical way of compressing air.

In the basement of the state house, at Columbus, O., the state of Ohio is going to build a miniature mine, where its mine experts will produce mine explosions and rescue victims of black damp by use of the lastest mine rescuing devices.

AIR AND WATER FOR CLEANING TUBES

John Bailey, Milwaukee, a correspondent of *Power,* tells of the cleaning of a large vertical boiler as seen in the cut. The boiler had not been cleaned in a long time and a flue cleaner was ordered. In cleaning, the operator must stand on the upper drum and feed his cleaner down. Because the operator must be confined in the drum, a steam-driven machine was out of the question. Water was not available in sufficient quantities at the required pressure, so an air machine was used.

The machine arrived and, superintended by the engineer and several others, the work was commenced. The machine ran fine, but after several tubes had been cleaned the dust in the drum became too much for the fireman doing the job. Covering all the tubes excepting the one on which he was working helped matters some, but was not sufficient. Stopping them up tight with plugs stopped the dust all right but unfortunately the draft also, and the drum of the still warm boiler became unbearable.

The fireman finally discovered a remedy himself. He took a small hose into the drum with him and let a very small amount of water trickle into the tube on top of his cleaner. This stopped the trouble completely and as far as I can see did no harm to the machine.

CAVES OR MINES AS BAROMETERS

Large subterranean chambers, whether caves of natural formation or mines, naturally feel the pressure changes in the external atmosphere, the air flowing in or out to adjust the balance. Where there is a large shaft or other opening the ebb and flow is not generally noticeable, but if there is only a restricted air passage the rate of flow is proportionately increased. In a suburb of Seattle, Wash., a man recently bored in his back yard to a depth of 153 feet in quest of water, but not striking any he gave it up. Since then it has been noticed that a small pipe which caps the bore spouts wind with such force as to cause a whistling sound. Sometimes the air current is reversed, the pipe then sucking instead of blowing, the former action preceding a storm, while the latter gives promise of fair weather. It is assumed that the bore penetrated a cavern of some size, the contents of which thus respond to the barometric changes outside.

FORCED HOT AIR SYSTEM

General Manager M. O. Robinson, of the Port Arthur and Fort William Electric Railway system states that they have had on trial on one of their cars the forced ventilation hot-air system. Although they did not have this in operation in the coldest weather, it has been 15 below zero since it was installed, and at that temperature it proved to be superior to the electric heaters. The good features of the system are that the air in the car is continually being changed, being taken from outside, heated and forced under the car by a fan. It has the advantage over the hot water that there is no danger of frozen or leaky pipes; also it is one-half the weight and when the heater is taken out for the summer the car is not so heavy even as with the electric heaters. The cost of operation in comparison with electricity is said to be less than one-half.

The "trainometer" is the latest. If you are on a train and you are curious to know how fast you are going, you put a penny in the slot and the hand on a dial informs you. H. W. Prance, an Englishman, is the genius who thought of this idea, but it has not been adopted in this country yet.

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EVERYTHING PNEUMATIC

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CONTENTS

DANGERS FROM ELECTRICITY IN MINES

The *Electrical Review* of Chicago, in a recent issue, gives the results of tests of various fuses, looking to the reducing of the dangers so closely allied with every method of electric detonation in mines. The *Electrical Review* admits the existence of these dangers and states that the time has come not only for educating the miners to the realization of the risks they run from electrically charged wires, but it advocates the appointment of an electrician in each mine and of Government inspectors specially trained to pass upon electrical conditions and equipment.

It is fortunate that we have the recently created Bureau of Mines at Washington, because here is a scientific body with Government authority, equipped to investigate the dangers accompanying the use of electricity underground. That this subject has been neglected goes without saying. It is little less than a crime to subject human beings to the dangers that result from an electric spark simply because it may be considered a little cheaper to equip with electricity than with compressed air. This economy, if it really exists, is nothing more than a little difference in the first cost of the installation, but in the end it is doubtful that there is an economy at all. Investigations have shown that acidulous waters in mines destroy the insulation of charged wires. This takes place silently and in the dark. There is no noise resulting from it as occurs when a leak exists in an air pipe, the result being that in the case of electricity there is a short circuit and exposed switches, resulting in sparks and electric arcs which initiate coal dust explosions. Any and all explosive material is in the same danger from the same source.

It has been conclusively shown that coal dust explodes per se. It is not necessary to have the mixture of gases, for the Government testing plants at Pittsburg have repeatedly exploded coal dust when mixed with nothing but air.

How different is the case with compressed air. Not only is it free from fire dangers, but it is the very thing that is wanted in the mine for ventilation and cooling. An air pipe costs a little more than an electric wire, but its durability is greater and its usefulness in case of accidents and imprisonment of men cannot be over-estimated. Compressed air is now produced by high duty air compressors so that its cost compares very favorably with that of electricity, and so far as mining service is concerned it serves to furnish power for all the requirements of operating machinery.

THE WASTEFUL STORY OF COAL

It is a very modern story throughout. Not so very long ago was the first finding of the coal. Then it was discovered that coal would burn, and all could sit or stand around and enjoy the warmth of it. Then the fire came to be used for roasting and broiling and boiling, and the boiling brought steam and the steam engine, and through the succeeding developments, which still crowd so closely upon each other, coal has become our chief source of light, as well as of heat and of power, for all manufacturing operations and for transportation upon the land and on the sea. From the coal, as it lies inert in its native bed, to the output of the great power houses and the speeding of the ocean racers, is a long string of contrivances and of methods, which we know to be still crude and wasteful, but which our best investigators and inventors are constantly striving to simplify and to render more economical and efficient.

Most gratifying—though still not at all satisfying—results have been attained in the line of coal saving at the hither end of its employment, as is evidenced in the fourfold reduction which, in half a century, has been effected in the fuel cost per horsepower of, say, the Atlantic liners; but it is quite astonishing to realize how little has been done, comparatively, in the line of saving at the mine itself. The ultimate cost of the coal is, of course, the labor cost of getting and handling and transporting it, and the saving of coal anywhere along the line of activities involved in its employment, of course, represents a commensurate saving in the labor cost of the coal; but it would seem that the first place of all to begin the labor saving should be where the coal is first attacked and secured; and yet coal mining machines are among the most recent of our inventions practically developed and employed. Machinery and applied mechanical power save human labor everywhere. and in coal mining it would mean a considerable reduction in the number of human lives exposed to the unusual risks of a most dangerous line of employment. It is estimated that one coal machine with three attendants will do as much work as twenty men working entirely by hand, and yet as recently as 1906, in the United States, only 35.1 per cent. of the coal output was machine mined, and in Great Britain only 4 per cent.

The advantage which the machines give is shown in all the comparisons between the United States and Great Britain in recent years, these figures being generally available only a year or two after date. In 1908, in the United States, 690,438 persons employed produced 126,562,000 more tons of coal than were produced by 966,264 persons employed in the mines of Great Britain. The total of American operators with fewer men produce annually 60 per cent. more coal than is mined in Great Britain. In 1908 the production of coal per person employed was 538 tons in the United States and 271 tons in Great Britain, the average for all civilized countries being 294 tons, very few coal machines being used except by the nations mentioned.

Of the machines employed, there are a number of different types, and both electricity and air are employed to drive them. In the Newcastle district of England in 1909 there were 45 electric machines and 178 air-driven. Of all the machines of all types in use in the United States, about 60 per cent. are pick or puncher machines.

It remains a wonder that machinery has not done more to lighten, or at least to make more individually productive, the labor of the man down in the dark who gets out the coal for us. Every impulse of humanity, as well as all pecuniary considerations, urge the employment of machinery wherever possible, and especially the coal punchers, which are leading the attack.

WHAT AIR RECEIVERS HAVE TO STAND

An enquiry was held recently, at Dunfermline (Scotland), before Sheriff Umpherston and a jury, into the facts of the death of David Robertson, who was killed on May 5 at Bowhill Colliery in consequence of the receiver of a steam-driven air-compressor plant, of which he was in charge, bursting or exploding.

Robert Anstruther Muir, manager, stated

that the plant was purchased by himself and the Bowhill Company, about 1899, and it worked satisfactorily. They never, when making examination of the plant, found any indictation of defects. *The plant was not new when it was bought.* The plate of the air-compressor was 3/8 in. in thickness, and its safe working load would be about 100 lb. He did not think the accident could be due to normal working conditions. There must have been a high temperature inside. *It might have been brought from the outside.* The theory he had formed as to the accident was an internal ignition. Any oil put in the air cylinder would in the course of time find its way into the receiver and naturally accumulate. It had been his practice all along to use common engine oil for air compressors. It would be quite right to use a safer oil even where they were working at low pressures. *He thought the receiver was cleaned out about two years ago.*

Neil Anderson Wilkie, manager, Bowhill, stated that he knew that the safety valve was working on the morning of the accident, because he heard the air flowing from it. He had had no trouble with the plant since he went to the colliery eleven months ago, and it was working all right now. He thought there must have been some internal ignition inside the receiver with consequent large increase of pressure and heat. Since the accident they were using partly common engine oil and partly soapsuds for lubricating purposes. The company would not continue the arrangement for lubricating purposes employed before the accident now, in consequence of the accident.

James Sibbald, engineman, said he had been familiar with the machinery in question for about seven years. There was an outlet cock at the bottom of the receiver, and *it was used regularly three times a week.* Sometimes a little oil came out of the cock.

David Muir, head engineer at the colliery, said that *during the time he had been there there had been no examination of the plant,* which had worked quite smoothly. Witness further said that he had wrought air compressors before the Bowhill one, and at these there was a special compressor oil in use.

Mr. Robinson, H. M. inspector of mines, said that common oil was not the sort of oil to use for compressors generally. He found that it was occasionally used, and always where he knew it was used he drew attention to it because of its low flashpoint.

Mr. Colvin, representing the Scottish Mineowners' Association, said that under normal conditions the oil in use would have been quite safe, as the ordinary flashpoint of it was much above the temperature at which the compressor was working.

The jury added to their formal verdict an order that they were of opinion that a special oil should be used in connection with plant of that kind.

[We reprint the above, verbatim and entire, from the *Colliery Guardian,* London, merely adding the italics, of which we might have been more liberal.

It seems that this poor air receiver was we don't know how many years old a dozen years ago, and they went on using it just as if it was new. Of course, it had been rusting and weakening all the time, and it had to give out some time and when it did give out the jury evidently found nobody, to blame. There seems to have been no precautions taken before the "accident" and no critical examination of anything after the accident, and not a word is cited as to any visible evidence of the assumed explosion. There may have been an explosion, but not the slightest evidence of it appeared. If the receiver was to ultimately give out either through the gradual weakening by corrosion or by the sudden accession of pressure due to an explosion there had been no precautions taken in anticipation of either possible catastrophe. The shiftlessness of practice evidenced throughout this case has never been surpassed in the United States. Ed. C. A. M.]

THE LOETSCHBERG TUNNEL

The following notes on the completion of the Loetschberg tunnel, in Switzerland, are taken from the *Moniteur Industrielle.* An illustrated description of the work was published in COMPRESSED AIR MAGAZINE, Feb., 1909:

On March 31 the two headings of the Loetschberg tunnel between Kandersteg and the Loetsch valley came together. But the formal opening of the line is not expected until 1913. Work was begun in the latter part of 1906, so that something less than five years has been required for the penetration of about 47,675 ft. of rock from north to south. No enterprise of this kind has ever approached this rapidity of execution before, and it is quite proper to consider this as establishing a world's record.

The work is French in conception and execution. According to the first estimates and surveys, the tunnel was to have had a length of45,050 ft. with a single track; and it was upon this basis that the work was begun. At the start the pick was used, but with this primitive method years on years would have passed before it would have been completed. On March 1, 1907, an electric system with means of mechanical drilling was installed; and thanks to a Swiss subvention, it became possible so to enlarge the tunnel that a double track could be laid.

It was the electric installation, the first to be set up at the work, that made the completion a possibility, and the results obtained at the Loetschberg show that mountain tunneling has been robbed of most of its difficulties. Here an excavation of 1,000,000 cu. yds. of rock was required and an advance at the rate of 130 cu. yds. a week was regularly effected. At the north end the electric current was furnished by the hydraulic works at Spiez, at 15,000 volts as a three-phase alternating current. At the south end a similar current was furnished by the works at Lonza with which it was possible to supply power to the several secondary work shops. Electricity was not, however, used as a motive power in the heading. All drilling and all underground traction was done with air that had been compressed by electricity.

THE SAND BLAST ON THE PANAMA CANAL

After a test of one month, the sand blast method of cleaning steel cars, and the pneumatic painters in use at Gorgona shops have demonstrated the economy of this method over the one formerly employed, viz., removing the scale by hammering the cars and painting them by brush. The steel dump cars in use on the Pacific and Atlantic Division work are subjected to excessive oxidization from the salt air and, on all the work, the cars are continually subject to rust, consequent upon hauling wet material and being subjected to the continuous rainy weather.

The sand blast machine installed at the shops about a month ago consists of a reservoir in which dried sand is placed, and three leads to which hose may be attached. An air pressure of 50 pounds forces the sand from the reservoir into the leads, where a pressure of 80 pounds is applied to drive it forcibly against the cars. Only two leads are commonly used, and the sand is projected through a ¼-inch nozzle. At present, Chamé sand is used, but this is so fine that it is not thoroughly effective, and an order has been placed for some coarser quartz sand, which occurs in small deposits at Chorrera. Six cars san be cleaned of scale in one day. The cars are run on a switch alongside the sand blast plant, and, after cleaning, are pushed forward a few feet to the place where the pneumatic painting is done. Coal tar paint is used, and it is ordinarily applied through two nozzles, thus making it possible to work on two cars at one time. Twelve cars may be painted by this method in an 8-hour day.—*Canal Record.*

MAGNETIC RELATIONS OF PETROLEUM DEPOSITS

In Bulletin 401 of the United States Geological Survey, entitled "Relations between Local Magnetic Disturbances and the Genesis of Petroleum," by George F. Becker, the condition of knowledge of the origin of petroleum and other bituminous substances is reviewed. Some oils, says Mr. Becker, are undoubtedly organic and some are beyond question inorganic. They may have been derived from carbonaceous matter of vegetable or animal origin, and they may have been derived from carbides of iron or other metals. It is also barely possible that the hydrocarbons exist as such in the mass of the earth.

While studying the subject, Mr. Becker was led to inquire whether any relation could be detected between the behavior of the compass needle and the distribution of hydrocarbons. Not much could be expected from a comparison of these phenomena, for magnetite exerts an attraction on the needle whether this ore occurs in sold masses or is disseminated in massive rocks; moreover, many volcanic rocks possess polarity. On a map of the magnetic declination in the United States, Mr. Becker found that the irregularities of the curves of equal declination of the compass were strongly marked in the principal oil regions. The most marked agreement is found through the great Appalachian oilfield, which is the area of greatest variation in declination. In California, also, strong deflections accompany the chain of hydrocarbon deposits.

These observations are to some extent also supported by conditions in the Caucasus, where great magnetic disturbances exist. While the theory of the inorganic origin of the hydrocarbons as exploited by various scientists is not proved by this study, yet the contention that great oil deposits are generated from iron carbides is strongly born out by a study of the map of magnetic disturbances in the United States. The map shows that petroleum is intimately similar to those arising from the neighborhood of substances possessing sensible magnetic properties, such as iron, nickle, cobalt and magnetite.

"TAYLORISM"

The following appears in *The Engineer*, London:

SIR,—The industrial system, upon which modern civilisation is supposed to be founded, presents many features to which the philosophical critic may take exception; but whatever these faults may be, he is sure to find that the United States, as the more "go-ahead" nation, have gone one better (or, rather, worse). Your article on "Taylorism" in America reveals a peculiarly hideous method of dehumanisation, and it is sincerely to be hoped that no such false economy will be introduced into British workshops. We want men to be men and not machines.

IMMO S. ALLEN.

London, 22nd May.

DANGEROUS SAFETY

Patrick Eustice and John Murray, structural steel erectors, working in the Heisen building, now being erected at Chicago, starred in a somewhat remarkable episode recently. Eustice, who was working on the 20th floor, lost his balance and slipped from a girder. Murray, working on the 19th floor, saw his companion fall and, holding on to a girder with one hand, he leaned far out, and with his free arm grasped the falling man by the blouse. He was not able to hold the weight, but gave the body a descending swing inward and the latter landed on the 18th floor, practically unhurt.

NOTES

J. M. Betton, manufacturer of the Druckleib Injector Sand-Blast Apparatus, has removed from 178 Washington street to 14 Park place, New York City.

The Southern Pacific is about to commence the construction of a 6-mile tunnel under the Sierra Nevada Mountains between Cisco and Donner, Cal. There will then be a reduction in grade and distance to San Francisco and present troubles due to snow will be elminiated.

Dredge No. 86, is now pumping through the longest line of discharge pipe ever laid on the Isthmus, and one of the longest, without relay, of record. The pipe from the dredge to the fill at Colon hospital is 7,150 ft. long. The material is delivered by the 20-in. pump without a relay. The pipe is laid on level ground, and the pressure required runs up to 70 lbs.

The sand-blast has been used in Germany for testing granite, marble, the various woods, linoleum and other materials used in the construction and furnishing of buildings. The samples are subjected for about two minutes to the action of a blast of fine quartz sand under a pressure of two atmospheres, the results showing the resisting powers of the substances to the effects of wear.

A new coal-dust extractor, consisting of a combination of pressure air jets worked by electricity directed upon the surface to be cleaned in order to raise the dust, and the simultaneous withdrawal of the dust by suction, has been given a successful demonstration by a Scottish electrical engineer, following a series of experiments conducted during the past winter.

In the discussion which followed the reading of the flying machine paper which we present in this issue, the author, Mr. Stephens, stated that "the flying machine of to-day, crude as it is, is capable of carrying a heavier load in proportion to its weight a given distance at a greater speed, with less power and fuel consumption, than the perfected automobile."

A few years ago the man who owned a cotton gin was required by law to *burn* his pile of refuse seeds every week. To-day we transform those manure heaps into fifteen prime products (and any number of specialities), bringing in an annual income of $50,000,000. Fifty million dollars for a stench! And ninety per cent. of those cotton-seed products, in this enlightened age, we *eat*.

In making the borings for the proposed new dry dock at Balboa, Panama Canal, there was recently brought out a drill core of solid rock; 6 ft. 6 ins. in length, and 1 in. in diameter. The core consists of the hardest kind of trap rock, without the least change in color or grain from end to end. It is believed that this is the longest core of the kind that has ever been produced intact on the Isthmus.

In 1908 there were 1659 mechanical coal cutters in operation in 414 mines in the United Kingdom. In 1909 there were 1,691 machines working in 420 mines. About 5 per cent. of the total coal output of the United Kingdom is machine cut (13,508,510 gross tons in 1908 and 13,728,902 tons in 1909). Electrical cutters predominate in Scotland, while compressed-air machines are favored in Wales, West England and Ireland.

A resolution urging the Federal bureau of mines to take immediate steps toward conservation of natural gas, and asking that this product be placed in the mineral class was passed at the sixth annual convention of the Natural Gas Association of America, at Pittsburg, Pa. Prof. William T. Magruder, of Ohio State University, was the father of the resolution; he presented it at the close of an address on the needs of engineering.

A pneumatic concrete spraying machine for coating surfaces with concrete mortar has been sent to the Isthmus by the General Cement Products Company, and it will be tested for a period of 30 days in coating the surface of rock in Culebra Cut, for the purpose of preventing deterioration. Much of the rock in the Cut, which is hard and firm when first excavated, crumbles rapidly on exposure to the air.

The machine shops of the Caledonia Railway Company, St. Rollox, Scotland, are lighted by an installation of compressed gas, 112,000 candle-power being required. A pressure of 54 in. of water is obtained by rotary compressors. The inverted lamps vary from 60 to 1,500 candle-power per single burner, and are said to have an efficiency of 60 candle-power per cubic foot of gas, a result due not only to the high pressure, but also to a pre-heating device, by which the gas and air mixture is warmed before entering the burner.

An article of considerable interest to the world of aerial navigation for "heavier than air" as well as "lighter than air" craft is the new metal known as Liege metal. It is said to be 40 per cent. lighter than aluminum, its specific gravity being only 1.762. Its surface is grayish-white, reflecting rays analogous to those of poorly worked aluminum. The following is its composition: Aluminum, 0.04 per cent.; iron, 0.01 per cent.; zinc, 0.44 per cent.; sodium, 0.21 per cent.; magnesium, 99.3 per cent.

At a mine in Yorkshire recently a man had his foot blown off by a high explosive under peculiar circumstances. The detonator had ignited the explosive but did not raise it up to explosive detonating pressure, resulting in the explosive burning in the hole until sufficient force had been gathered to blow out the stemming. After this had been done, the deputy, noticing a glare as from fire, went to the scene and found something burning on the floor. He put his foot on it, and it blew his foot off immediately. It seemed that the explosive must have been nearly up to the proper explosive point, and the action of the man in putting his foot upon it evidently completed the necessary process.

A new method for drying humid walls, says *The Master Builder*, devised by a Belgian architect, consists of embedding inclined porous tubes in the walls, the directions of the tubes being perpendicular to the wall surfaces. By capillary action these tubes continually absorb moisture from the wall, for the air which they contain, being in the same hygrometric condition as that of the interior of the building, is relatively dry, and readily takes up moisture. The act of vaporizing ensuing therefrom reduces the temperature of the air passing from the tube and being constantly replaced by drier and warmer air. The tubes are placed sufficiently close together to leave no intervals between their zones of influence. In new buildings the places for the tubes are left, but the tubes themselves are not inserted until the mortar has set.

For extinguishing oil fires where water is both ineffective and dangerous, frothy liquids have been recommended. In a late test, near Hamburg, a mixture of one quart each of caustic soda and alum solutions yielded 15 quarts of a yellowish-white foam, having a density of 0.14, and this could be sucked up and distributed like water by a hose. A basement of 30 square feet, filled with benzine to 20in., was fired, and was extinguished in 78 seconds with 18 gallons of the frothy mixture, and a burning benzine tank, 6ft. in diameter and 9ft. high, was extinguished in 13 seconds. The benzine was little effected, burning as usual after removal of the froth.

The melting of metals in vacuum is the ideal method, because oxidation is prevented and gases present in the metal are expelled from it. While it has long been known that the method of melting metals in a vacuum gave superior results in the final product, the method has been limited to very small quantities of metal, due to the difficulty of carrying it out in practice. Metals which ordinarily are considered as brittle substances, and incapable of being rolled or drawn, can be produced, by melting them in vacuum, in a malleable or ductile condition. Examples of such metals are tungsten and tantalum, which in this way can be made in the form of wire, and are used to a great extent in the new incandescent electric metallic filament lamps.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 6.

994,106. AEROPLANE. WILLIAM BOYD ALEXANDER, Montreal, Quebec, Canada.

994,118. PNEUMATIC BULB FOR HORNS. JOHN A. BROADFIELD, Philadelphia, Pa.

994,144. MUCK SHOVELING, CATCHING, AND CONVEYING APPARATUS FOR TUNNELING-MACHINES. GEORGE A. FOWLER, Denver, Colo.

1. A pneumatically operating muck conveyer for tunneling machines, comprising a closed casing having an opening in its top near the forward end, a shoveling lip having a closed top portion extending beyond said opening, a discharge aperture at the opposite end of the casing, a perforated plate extending beneath said opening into said top portion and means for supplying compressed air beneath said plate, the perforations of said perforated plate being arranged to direct said air to move said muck from said shoveling lip through said casing and discharge it from said discharge aperture.

994,160. COAL-WASHING JIG. ALBERT CHARLES HOECKER, Collinsville, Ill.

994,167-8. FLUID-PRESSURE REGULATOR CARL G. KOPPITZ, Youngstown, Ohio.

994,197. AIRSHIP. HENRY P. RHETT, Hempstead, N. Y.

994,202. AIRSHIP CONSTRUCTION. GUSTAV SCHEEL, New York, N. Y.

994,220. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

994,255. AUTOMATIC SPRINKLER SYSTEM. ALMON M. GRANGER, Medford, Mass.

1. In an automatic sprinkler system, a distribution pipe provided with sprinkler-heads, means connected with said pipe to supply the same with water under pressure, a connection to said distribution pipe for charging the same with air under pressure, a valve in said connection, and a by-pass around the valve of less area than the outlet of the sprinkler-head.

994,294. OZONE-GENERATOR. EUGENE P. WOILLARD, Los Angeles, Cal.

994,322. CASE-HARDENING. ADOLPH W. MACHLET, Elizabeth, N. J.

1. The combination with an apparatus for compressing air and producing carbon-monoxid therefrom, of a case-hardening retort having a vent and provided with heating means and connected to said producing apparatus, and an oil tank connected between the producing means and the retort, to cause the carbon-monoxid to pass through the oil in flowing to the retort; the connection being continuous from said air compressing apparatus to said vent, to enable the former to force the carburizing gas to flow through the retort.

994,335. PUMPING SYSTEM. ELIJAH H. PERKINS, Dinuba, Cal.

1. A pumping system, comprising a main well, a number of auxiliary wells, means for siphoning water from the auxiliary wells to the main well, said mains consisting of vertically disposed pipes in each of said wells, a horizontally disposed pipe connecting the upper ends of said vertical pipes, pumping means for drawing air from the siphon through a pipe connected with said horizontally disposed pipe, a casing disposed in the main well on the lower end of the siphon, pumping means connected to said casing, and a foot valve in said casing opening to the main well.

994,339. AERIAL MACHINE. PAUL SEILER, San Francisco, Cal.

994,344. PNEUMATIC TRANSMISSION SYSTEM. JOSEPH J. STOETZEL, Chicago, Ill.

994,417. AERODROME. NATHANIEL L. MAYHEW, Beaumont, Tex.

994,422. MACHINE FOR MANUFACTURING GLASSWARE. FRANK O'NEILL, Zanesville, Ohio.

994,481. AIR-VALVE. FREDERICK H. SAUER, New York, N. Y.

994,522. COMBINED PUMP AND AERATOR. ROBERT W. KELLEY, deceased, Atchison, Kans.

994,555. PROCESS OF CONDENSING MILK. JAMES CHRISTIAN ALEXANDER, Roseburg, Oreg.

1. The herein described process of concentrating milk, which comprises the placing of the milk in a closed receptacle, creating a vacuum within the receptacle to remove the air from the milk, agitating the milk after the vacuum is created and the air removed from said milk whereby such agitation will not cause the milk to foam, and applying a freezing medium to the exterior of the receptacle to cause the water in the outer portion of the mass of the milk to freeze, the other elements

of the said outer portion of the milk becoming mixed with the unfrozen milk.

994,611. MEANS FOR RAISING SUNKEN VESSELS. JAMES SKATSCHKOFF, St. Petersburg, Russia.

2. In an apparatus for raising sunken vessels, an air- and water-proof case formed of flexible material and made of a size and shape corresponding to the vessel over whose upper portion it is to be applied, ropes having fastening devices and adapted to be passed around the vessel lengthwise thereof and over the lower edge of the case for clamping the case tightly to the hull, and water and air pipes forming an attachment of the upper portion of the case, as shown and described.

994,679. AIR-LIFT FOR AGITATORS FOR ORE OR OTHER MATERIALS. LEON PAUL HILLS, Tuolumne, Cal.

JUNE 13.

994,743. POWER-OPERATED PERCUSSIVE TOOL. CHARLES HERMAN HAESELER, Philadelphia, Pa.

995,112. WATER-LIFT AND AIR-COMPRESSOR. RANSOM Y. BOVEE, Denver, Colo.

995,121. COMPRESSOR. JAMES H. DENTON, Milwaukee, Wis.

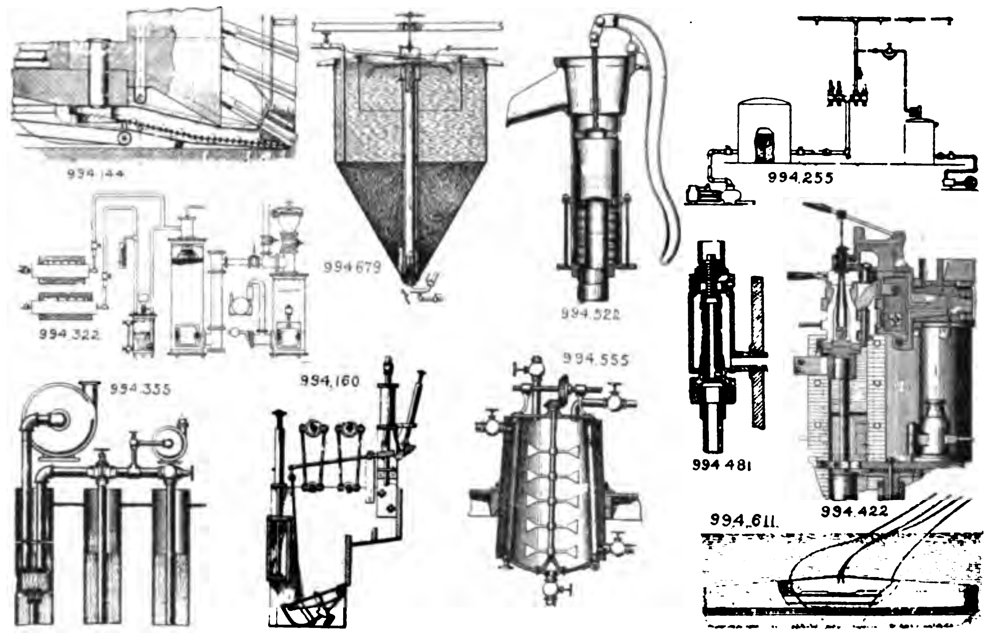
995,135. CALCULATING-MACHINE. ARTHUR WILLIAM HARRIS, Birmingham, England.

1. In calculating machines, the combination with a plurality of indicating disks, of a plurality of reciprocatory elements rotating the disks, *pneumatically operated* actuating and controlling mechanism for said elements, and manually operated controlling mechanism for said pneumatically operated mechanism, substantially as described.

995,148. ETCHING-MACHINE. FREDERICK E. JOHNSTON, Pittsburg, Pa.

3. An etching machine comprising a casing, erodent sprayers, water sprayers, *air supply means* common to the erodent and water sprayers, and a plate holder rotatable within the casing and adapted to support a plate within the range of all of said sprayers.

995,210. ROCK-DRILL. THOMAS EDGAR ADAMS, Cleveland, Ohio.



PNEUMATIC PATENTS JUNE 6.

994,757. FLYING-MACHINE. GEORGE KUNICKE, New York, N. Y.

994,782. AEROPLANE. ROBERT PATON, Carrington, N. D.

994,806. GLASS-MOLDING APPARATUS. JOHN J. WANKO, Westport, Md.

2. In a glass blowing apparatus, the combination with a blank mold, and a vertically movable forming plunger, of an air supply pipe arranged above the level of the mold, and a discharge nozzle carried by said pipe and provided with ducts for respectively discharging blasts of air at different angles therefrom and respectively against the surface of the plunger and downwardly into the forming cavity of the mold.

994,966. FLYING-MACHINE. JAMES W. WOODINGTON, Folcroft, Pa.

995,004. AERIAL MACHINE. JOHN A. HOFFMAN, San Francisco, Cal.

995,033. AIRSHIP. EARL M. RALLS, Sacramento, Cal.

995,060. AIR-LOCK FOR CAISSON-SHAFTING. CHARLES P. DOWNING, New York, N. Y.

995,248. DEEP-WELL PUMP. PETER J. GILDEA, San Francisco, Cal.

995,361. AERIAL MACHINE. EMIL LOSSE, Villeneuve-St.-Georges, France.

995,401. UNLOADING DEVICE. HERBERT W. CHENEY, Milwaukee, Wis.

JUNE 20.

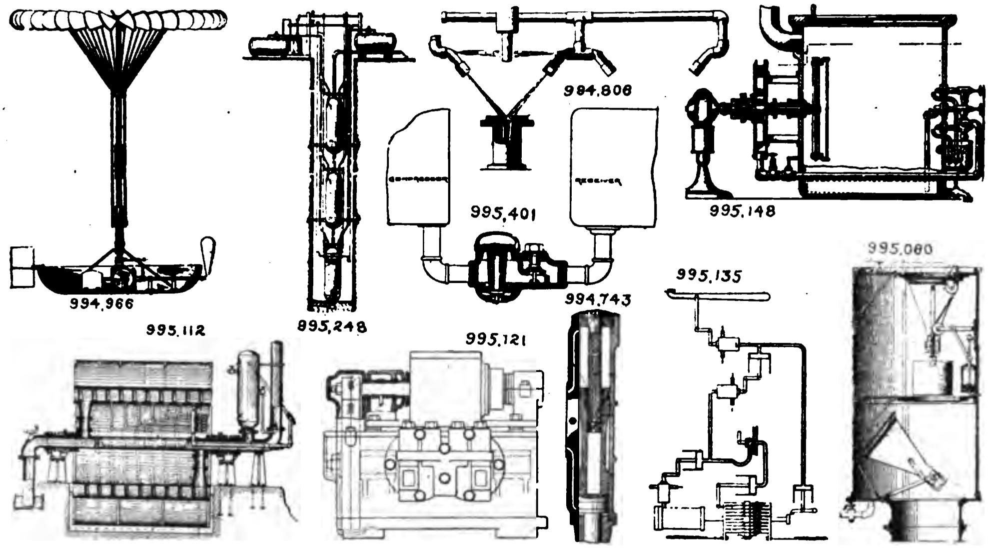
995,502. AUTOMOBILE-WHEEL WITH PNEUMATIC AND SPRING HUB. CHARLES E. WADE, Masonville, and CHARLES J. LARGERWALL, New York, N. Y.

995,510. METHOD OF PRODUCING TRANSPARENT CAMPHOR IN SHAPED PIECES. OTTO RUDOLPH DANIEL WITT, Hamburg, Germany.

Method of producing transparent camphor in any desired shape consisting in pressing the camphor in vacuum of a suitable degree.

995,513. APPARATUS FOR DRYING AIR. PAUL WURTH, Luxemburg, Luxemburg.

995,518. PNEUMATIC-DESPATCH-TUBE APPARATUS. LOUIS G. BARTLETT, Somerville, Mass.



PNEUMATIC PATENTS JUNE 21.

995,550. FLYING-MACHINE. GEORGE FRANCIS MYERS, Columbus, Ohio.

995,557. FREIGHT VESSEL. AUGUST J. PEEBLES, Molson, Wash.

995,593. PNEUMATIC TOOL. GEORGE H. GILMAN, Claremont, N. H.

995,614. VALVE MECHANISM FOR ROCK-DRILLS. FORDYCE C. LOOMIS, New Philadelphia, Ohio.

995,678. POWER-RAMMER. FRANK W. HUDSON, East St. Louis, Ill.

995,721. DRIER FOR PAPER. ALVA C. RICE, Worcester, Mas.

995,750. AIRSHIP. LINCOLN WINTERS and SAMUEL HOFSTETTER, Freeport, Ill.

995,815. AIR-COMPRESSOR. ROBERT TEMPLE, Denver, Colo.

995,819. FLYING-MACHINE. JAMES LESTER WALKER, Eagle Point, Oreg.

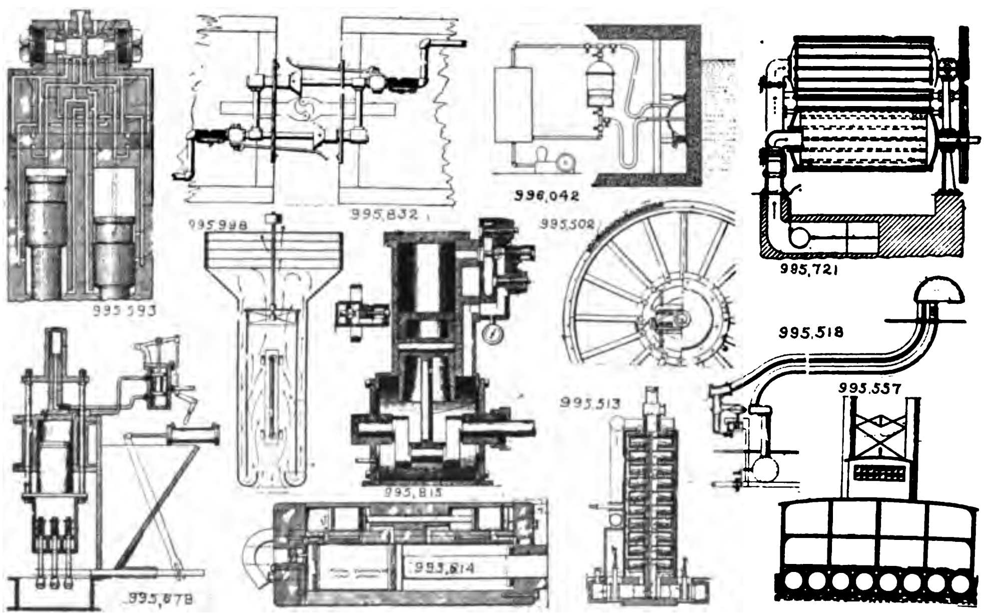
995,832. AIR-BRAKE COUPLING. ROBERT A. WINTON, Bowie, Tex.

995,861. PNEUMATIC PIPE-COUPLING. JAMES EDWARD GLEASON, Lockport, Ill.

995,969. APPARATUS FOR VACUUM-CLEANERS. BEECHER W. JUNK, Toledo, Ohio.

995,998-9. APPARATUS FOR COATING OBJECTS WITH SUBDIVIDED MATERIAL. FRANKLIN F. BRADLEY, Chicago, Ill.

1. Apparatus for coating objects with subdivided material carried by air including a re-

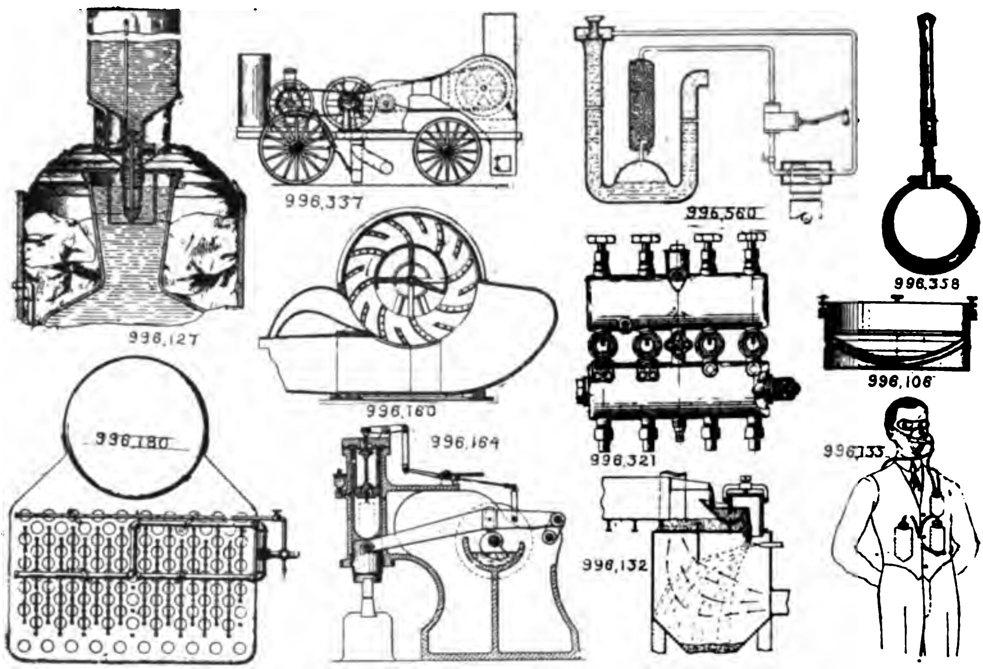


PNEUMATIC PATENTS JUNE 20.

ceptacle for the objects having an entrance opening for the objects; and mechanism for effecting the forced passage of air within the receptacle, there being present a restricted opening for the exit of air from the receptacle interior to the external air, said mechanism operating to draw air from the exterior of the receptacle in a direction from the aforesaid entrance opening toward the aforesaid exit opening, whereby the escape of material-laden air through said entrance opening is materially prevented.

996,042. TREATMENT OF POROUS STRUCTURES. JASON C. MOORE, Jonespoint, N. Y.

2. The process of treating a porous material



PNEUMATIC PATENTS JUNE 27.

as concrete subjected to the action of water which consists first driving back the incoming water by a column of air under pressure, second following the same by a column of waterproofing fluid under pressure and their preventing the escape of the fluid so introduced by a suitable counter pressure around the area of application.

JUNE 27.

996,106. AERONAUTICAL CLINOMETER. JAMES MEANS, Boston, Mass.

996,127. LIQUID-COOLER. WILLIAM E. PATNAUDE, Merrimac, Mass.

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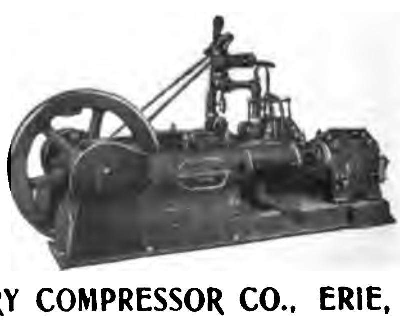

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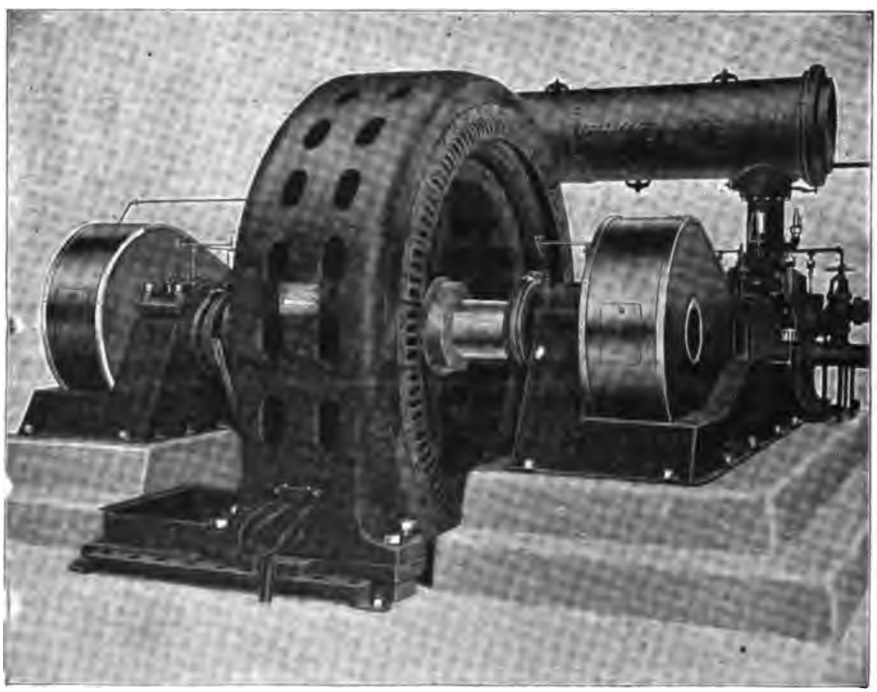

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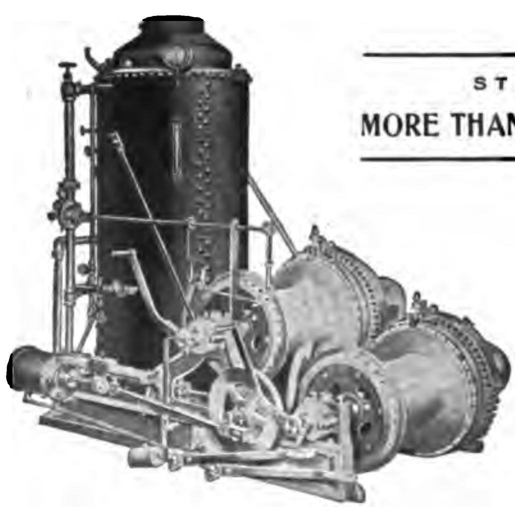

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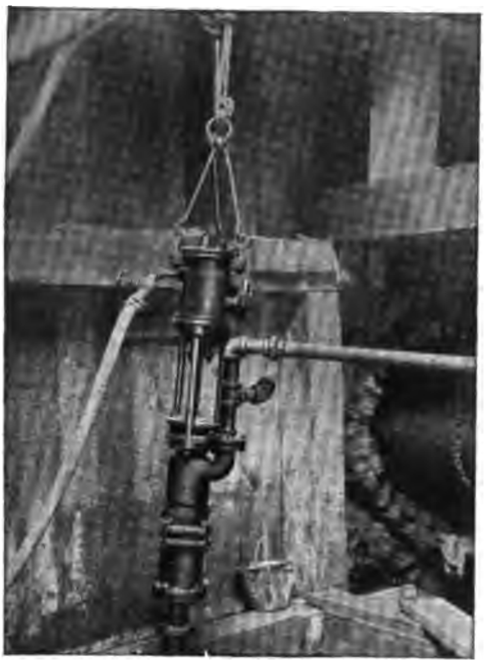

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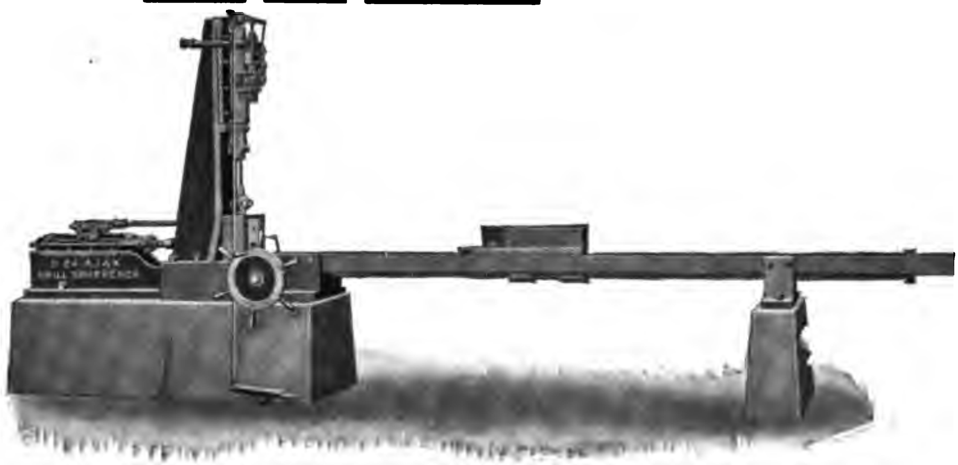

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AIR COMPRESSOR TESTING

By Frank Richards.

It happens probably more frequently than otherwise that the large manufacturers are not to any great extent the users of their own products, and they consequently labor under the disadvantage of not being able to inform themselves except at second-hand of the condition, efficiency and general satisfactoriness or otherwise of their output. Of course, under such conditions, if special precautions are not taken and means of obtaining specific and precise information are not adopted, incorrect design, unsuitable or defective material and bad workmanship may pass undetected, and improvements may not be expected to be developed.

The builders of air compressors may be said to be in the predicament here indicated, they, of course, having no use for the compressors they build, at least in the variety turned out to suit the various demands as to capacity, pressure, etc., and accordingly the experience of the larger and longer established builders has enforced the necessity of, as some might think, going out of the way to get intimately acquainted with the workings of their own machines.

I have before me a formal and elaborate report by Mr. A. Hoffman, of a test of a compound steam and two-stage air compressor made at the shops of the Ingersoll Rand Company, Phillipsburg, N. J., a report which would be welcomed as a valuable contribution to the transactions of one of the big engineering societies. Being, however, so complete and exhaustive it is necessarily in the nature of a confidential and inside communication to the company and cannot at present be given to the public.

The compressor tested was of the following dimensions: Steam cylinders, 20 and 38 inch diameter; air cylinders, 33¼ and 20¼ inch diameter, with a common stroke of 30 inches and a free air capacity at maximum speed approximating 3,000 cubic feet per minute. The report had to do entirely and exclusively with the air end of the machine.

VARIETY OF INDICATOR WORK.

The indicator cards were taken on different days and under different conditions. The report says: "On October 30, the indicating was done with our regular reducing wheel motion on the Tabor indicators, while on November 1 we used the pantograph reducing motion. In reference to the relative merits of these two motions I can say that both motions would give accurate cards, only that with the reducing wheel running at high speeds defects may occur in the cards at both ends of the stroke, that is in the re-expansion curve and in the beginning of the compression curve. This is on account of the backlash when stopping and starting the string at the ends of the stroke. With the pantograph this trouble does not exist, because the motion of the string is only about 4 inches, but even with the pantograph you have to be careful not to get any stretch in the string, because such a stretch would be such a large proportion of the total movement. We therefore found it necessary to use wire from the pantograph motion to the indicator.

"On October 3d, we took the air into the compressor simply through the regular atmosphere intake, taking the air from the shop, but on November 1 we attached about 8 feet of pipe to the atmospheric intake.

"After taking the cards from both ends of both air cyinders at different speeds, we also indicated the discharge pipe connections from both cylinders. This was done by making an opening on the low pressure side in the leg of the intercooler and piping down to the indicator. On the high pressure side an opening was tapped in the water trap between the intercooler and the inlet to the high pressure cylinder and a connection from this opening made to the indicator. By means of these pipe indicator cards the pressure loss was determined between the discharge of the low pressure cylinder and the inlet to the high pressure cylinder, and thus the pressure drop through the intercooler. The results of this are all given in the tabulation at the conclusion of this report."

This tabulation or summary of deductions from the testimony of the indicator cards, systematically arranged for the different speeds and the various delivery pressures, included some 200 items preceded by the mathematics and other particulars involved in detail, the whole being altogether too voluminous for reproduction in the ordinary technical journal and also containing information which may become the basis for reliable business guarantees of performance, but which may not yet be given unrestricted publicity. I am permitted, however, to call attention to a section of the report which presents some novel and original investigation of the operation of the water jacket and the accounting for the heat thereby abstracted in the final balance of power expended and results realized. What follows is reproduced verbatim from the report.

WATER JACKET DEDUCTIONS.

"I have given what is called the heat balance of the low pressure cylinder at 108 r. p. m., and this needs some explanation. It is well known from the principles of therodynamics that the foot pounds of work done in any compressing cylinder during any period of time, say one minute, is equal to the increase in temperature caused in compressing the air multiplied by the weight of the air and the specific heat of the air, all multiplied by Joule's equivalent to reduce the whole thing to foot pounds.

"In making up the heat balance I tried to find out if this would check out in practice, and I find that it does most excellently; in fact it checks closer than we would expect it to.

"If the above is true the work done in the cylinder must be equal to the heat given to the air cylinder water jacket plus the heat contained in the air after leaving the cylinder above the temperature of the intake air. Therefore I find that the heat given to the jacket is 2070 B. T. U. per minute, equivalent to 48.8 I. H. P. The heat contained in the air above the intake temperature of 77 degs. is 8320 B. T. U. per minute, equivalent to 196.3 H. P. The total B. T. U. is the sum of these two quantities, or 10,390 B. T. U., equal to 245 I. H. P. Theoretically, this total should be equivalent to the actual horsepower indicated in the low pressure air cylinder, and we find that this horsepower really is 243, which is also equivalent to 10,300 B. T. U. per minute. The discrepancy, therefore, is only equal to 2.1 horsepower. We would expect a greater difference than this, because we have figured the actual amount of air from the volumetric efficiency of the indicator card, which we know is not absolutely correct.

"There is also a slight discrepancy due to radiation of the outside air into the water jacket, but this is very slight because I took the temperature of the water leaving the jacket before the compressor was started, and as near as I could read the thermometer it was the same as the temperature of the cold water in the main.

WATER JACKET COOLING AFTER THE COMPRESSION.

"Our first thought would be that there was something wrong in regard to these results, because they show that about 20 per cent. of the total work indicated in the cylinder was given up to the water jacket, and according to this we should yet considerably better than isothermal compression, which of course would be an impossibility. The explanation is as follows:

"Very little heat is given to the water jacket while the air is being compressed, because the compression begins at a low temperature, and maximum temperature is not reached until the end of the compression, and while it is at its maximum temperature the piston is traveling very fast and does not have a chance to give up much heat. After the discharge valves open, however, a great deal of heat is given to the jackets because during this whole time the air is at its maximum temperature and it also comes in intimate contact with the jacket of the air cylinder head in passing out through the valves; in addition to this the piston is traveling at a comparatively slow speed toward the end of the stroke. Some heat is also given to the jacket while the air is passing out through the discharge passage.

"This explanation is sufficient to account for the large amount of heat given to the jacket, and it shows that jackets really do more good than is usually supposed. Of course heat given to the cylinder jacket while the air is discharging does not reduce the work in the cylinder, but merely lowers the temperature of the air and raises the temperature of the jacket water." From *Power,* with additions by the writer.

CONDITION OF THE GAS IN COAL

In some cases the volume of gas liberated from broken coal is greater than the volume of the coal itself—that is, of the actual solid and the cellular space combined. Several theories have been proposed to account for this fact. If the inclosed gas is mechanically imprisoned in the microscopic pores of the coal, it must be under a pressure greater than that of the atmosphere; otherwise it would occupy after its escape a volume less than that of the coal. It is possible, furthermore, that there is a continual slow formation of methane by chemical decomposition of the coal, or it may be that the gas is held in a state of occlusion—that is, either dissolved moecularly or absorbed upon the inner surfaces of the cellular spaces. The gas which escapes from coal has been very often called "occluded gas", but, as Chamberlin has made plain, the word "occluded" has been loosely used in this connection, and the radical difference between mechanical imprisonment and true occlusion or condensation has been generally overlooked.—*Bureau of Mines.*

COSTS OF UNWATERING WITH THE AIR LIFT*

An interesting experiment was made in 1910 at El Cobre Mines, Cuba, in which an air lift was used for unwatering the mines.

The water stood at the 200-ft. level, held by two Cameron station pumps. The shaft was 800 ft. deep, with one cage road, 4 × 8 ft., open to the 800-ft. level. The other compartments were blocked with platforms. The water was acid, and contained up to 400 grs. Cu. per cu. meter. A tunnel from the 50-ft. level through the mountain allowed a reduction in the head.

Tests showed the shaft to be blocked by old timber and guides, so that a cone was made to run on an old cable guide, lowered in the center of the compartment with a 2-ton weight. The wood pipe was built upon this and lowered as put together.

The wood pipe twisted around the center cable in a spiral, so that it had made a complete turn in 200 ft. without doing the slightest harm. Three columns were built up on the cone and tied together with new 1½-in. rope, which, when wet, held them together firmly. They were 750 ft. long, each, and had no support, as the guide and lowering ropes were soon eaten off by the water. With 600 ft. under water and 150 ft. above, the wood columns were nearly floating. After being water-soaked they became very heavy. The wood pipe was 10 in. inside diameter. Air pipe was 2½-in. iron pipe, which was thoroughly tarred and changed as it was eaten by the water. The high limit of the compressors was 140 lbs. pressure. Two pipes were used, the third being in reserve and operated in case of breaks in the others. The out-flow was measured hourly by weir.

The head at the start was 150 ft. submergence of air pipe 50 per cent. Head of finish was 360 ft., with 39 per cent. submergence. The water removed was 113,120,000 gallons, at a cost of 7.434 cts. per 1,000 gallons.

The pipes averaged 950 gallons per minute, each, or 105 cu. ft. of air for 100 gallons of water.

The lowest speed was with a 360 ft. head, 1,500 gallons per minute for the two pipes, or 160 cu. ft. of free air for 100 gallons of water.

Second Stage.—After reaching the 400-ft. level, a 2,000-gallon pump was installed, and the discharge of the blow pipes turned into the pump sump. Under no head, one 10-in. pipe threw 2,200 gallons per minute with air cut down. This was the pump limit on a burst of speed.

A special test was made in lowering the water for seven days. The results were as follows:

SEVEN DAYS' TEST BLOWING AND PUMPING.

Feet lowered	57 ft. 6 in.
Feet lowered per day	9 ft. 2½ ir

*From an article by E. H. Emerson in School of Mines Quarterly of Columbia University, July, 1911.

Gallons per ft. lowered	307,100
Total gallons pumped	17,659,980
Total gallons pumped per day	2,522,954
Total gallons pumped per minute	1,750
Head at start on blow pipe	21 ft. 6 in.
Head at finish on blow pipe	79 ft.
Average head	50 ft. 3 in.
Submergence at start..179 ft. =	89 per cent.
Submergence at finish..100 ft. =	50 per cent.

Air used, 100 lbs. pressure.
2½-in. air pipe inside 10-in. wooden pipe, one pipe only used.
42.3 cu. ft. of free air to 100 gallons of water.
Cost: 2.32 cts. per 1,000 gallons.

In this case the pipe was limited by the capacity of the pump. 3,500 to 4,000 cu. ft. could be blown from the one pipe with 1,000 cu. ft. of free air. The actual inflow of the mine is 213 gallons per minute.

The cost per 1,000 gallons by blowing down 60 ft. once in two months, and pumping the water to the surface, is 5.23 cts. per 1,000 gallons.

The cost of the pump alone, working under full capacity, is 2.91 cts. per 1,000 gallons (with labor proportioned to the blowing), but handling only the inflow with pumps of small size the cost was 8.3 cts. per 1,000 gallons. There is, therefore, a saving of 3.02 cts. per 1,000 gallons by the combination method of holding the water at the 400-ft. level.

It is a real saving, since in flood time the full 2,000 gallons capacity is necessary, and, therefore, there is no unnecessary investment. A great advantage is that an enormous sump is provided, which insures against drowning by the sudden floods.

ELECTRICITY IN MINES

The following we extract from a letter to the *Colliery Guardian* by an English mine owner and Member of Parliament.

I have always made it a rule at the collieries with which I am connected that no electricity shall be used in any working place or part of a mine where gas is present. There are very few men in this country who have installed more electricity in mines than I have, and for more than ten years I have been continually raising in the House of Commons the question of the use of electricity, believing that its use ought to be prohibited in all mines where cables and machines are working in an atmosphere charged with gas.

Protective devices are all very well as far as they go, but all mechanical devices are subject to accidents; especially so is this the case where the appliances are of the most delicate character.

I have never yet met a colliery manager who prefers to carry electricity into a working face where gas is present if he could have a supply of compressed air for coal-cutting or haulage purposes. It may be argued that ½ per cent. of gas is in no way dangerous, but the answer is that where ½ per cent. of gas is present more may appear at any moment.

Only last week the question of carrying electricity in-bye in a large mine in the intake airways for haulage purposes was discussed at the board meeting of one of my companies. The directors, acting under the advice of Mr. Charles Rhodes (their consulting engineer) unanimously decided not to use electricity in-bye, even though the intake airways were free of gas, owing to danger from dust, and it was therefore decided to use compressed air—naturally at a considerably increased cost—for the sake of safety.

I cannot for the life of me understand how any colliery people can claim to have the right to work coal conveyors and coal-cutting machinery in working places where lamps at times are put out owing to the presence of gas. Where electricity is used and gas is present there is always a grave element of danger. The industry requires to be protected against madmen and idiots who deliberately take this risk. Some day sooner or later—unless the law is altered to deal with these reckless people— an explosion will occur, and in view of the large number of men employed in some of the big mines of this country the death roll might be so appalling that Parliament would have no hesitation, and rightly so, in having electricity taken out of all mines.

COMPRESSED AIR CONCRETE MIXER

The Drake Standard Machine Works, 1025 West Jackson Boulevard, Chicago, have manufactured the Pneumatic Conveying Mixer, used to mix and convey concrete through pipes to place. The machine is an invention and patent of Mr. S. H. McMichael.

The mixer consists of a hopper, which is kept flush with charging platform, the bottom of which is provided with a slide, to hold the charge until it is ready to be admitted to the mixer proper. This consists of a cast iron chamber, of 6 cubic feet capacity, above which there is an air tight rocker valve, which is closed when the charge has been admitted. The capacity can be increased to 24 cubic feet by fitting on a cylindrical extension. The bottom of the chamber is connected to the pipe line by means of a reducer. When the charge has been admitted to the chamber through two pipes, one of which is connected immediately below the valve, to secure downward pressure on the material in the chamber, and the other enters the pipe in the ell below the reducer, forcing air into the straight section. The air entering the chamber at about 85 pounds pressure, producing an initial velocity in the material of about 35 feet per second. The material travels in the pipe mixed with nearly double the volume of air, reducing the frictional resistance. The frictional resistance aids in mixing the concrete, in this that the outer material is retarded by the friction against the pipe and the material in the center travels faster than that on the outside. As the materials travel with different velocities, on account of friction, and also on account of the difference in size, surface and specific gravities of the particles, a good mixture is secured.

Limestone of ¾-inch size is used for aggregate. The pressure varies with the distance of delivery of concrete. An ordinary type of compressor is used for the work. This type of mixer is being used at present in the construction of the La Salle tunnel in Chicago.

MEASUREMENTS OF SUBTERANEAN TEMPERATURE

The deepest hole in the world, up to date, is the boring begun ten years ago at Czuchow, Silesia, with the object of attaining a depth of 2,500 meters, and which has now reached a depth of 2,240 meters (7,349 feet). The bore is 44 centimeters in diameter at the top, and diminishes progressively to 5 centimeters. Measurements of temperature have been made regularly. At 2,220 meters the temperature is 83.4 deg. C. (182 deg. F.). This gives a "geothermic degree" (amount of descent corresponding to a rise of temperature of 1 deg. C.) in 31.8 meters. The change of temperature does not proceed uniformly. In fact an interesting "temperature inversion" occurs between the depths of 640 and 730 meters, where the temperature actually falls, with descent, about 2 deg.—*Scientific American.*

A GAS LIGHTER THAN HYDROGEN

The studies of Dr. A. Wegener, on the outer layers of the earth's atmosphere, lead him to the conclusion that in these outer layers there exists a hitherto unknown element (*Chem. Zeit.*, May 25, 1911). This element must be a gas lighter than hydrogen and possessed of but trifling inertia, as meteorites rush through it with scarcely diminished velocities of about 30 miles per second, and are only brought to incandescence by the friction of the denser hydrogen, which, according to Hann and others, is the principal constituent of the atmosphere at altitudes of 40 miles above the earth's surface.

PUFF FOR AN INVENTOR

Dope fiend and degenerate, his faculties befogged by the constant use of "coke," David Brown, a member of Butte's hophead community, possesses the brain of what might have been a successful inventor. In the moments when not sodden with the drug Brown has perfected a plan for a sanitary wash basin by means of which the clogging in pipes due to the present stopper can be eliminated. The plan is simple. There is a platform on the floor beneath the bowl and to this is attached a coiled spring which runs up the main pipe. By standing on this platform a person operates the spring so as to shut out the outflow from the bowl. When the weight is removed the water is given passage and allowed to flow out. A child's weight sufficies as well as that of a grown person to operate this ingenious device, for which the inventor claims he has obtained a patent.—*Anaconda Standard.*

WORLD'S RECORD IN ROCK DRILLING BY HAND

In the international contest at Hancock, Mich., July 22, the hammer and drill team of Butte, Mont., made a new world record for drilling into solid granite. The penetration was 59¼ inches in 15 minutes, winning of $1,000, offered by John R. Ryan, president of the Anaconda Copper Company.

The previous world's record was 56 inches made by the Butte team a year ago. The team is coposed of John W. McCormick, W. J. McLain and Michael Kensella.

BUILDING CONCRETE DROP SHAFTS IN SHIFTING SANDS

By P. B. McDonald.

In the past few years there have been a number of concrete drop shafts sunk in the Lake Superior iron region, notably on the Mesabi, Cuyuna, Swanzi and Marquette ranges, and in the bituminous coal region of the eastern and middle states. It seems likely that the use of compressed air for shaft sinking will gain favor, just as it has in bridge pier, tunnel and foundation work.

The favorite shape for the outside of the shaft is that of a circle. At first the inside also was made circular, and after partitions had been put in for skip and cageways, the odd spaces around the outside were utilized for pipe. Later practice makes the inside of the shaft rectangular. The Rogers shaft at Iron River, Mich., is 29 ft. outside diameter, and 16½ by 11 ft. inside at the bottom; there are three 6-in. offsets at intervals higher up, to allow leeway in aligning the guides for skips and cages. This shaft has very thick walls, but the weight is needed for forcing the cutting edge down through sand and boulders.

The principle of sinking the shaft previous to the turning on of compressed air, for holding back sand and water (and most of them are sunk some distance before the latter is necessary) can be likened to standing up a foot length of 4-in. pipe in the sand, and scooping out the material inside with a spoon, so that the pipe sinks gradually; more lengths of pipe are added at the surface as the first sinks, and the dirt and pebbles are scraped away from under the high-side, so that the tube sinks evenly. The shaft, however, is a reinforced concrete casing, with a pointed steel cutting edge, and the dredging is done with "clam shells" or by men shoveling into a bucket. The "clam shells" are used whenever possible, and the shaft is preferably allowed to fill with water, so that the dirt is washed in from under the shoe.

The steel shoe, made in sections of 90 degrees of ⅝-in. steel, and re-enforced by vertical cross partitions of steel plate, held riveted to the shoe by angle irons, may be 3 or 4 ft. high. The sections are assembled on the site of the shaft, usually in a hole or excavation dug as a starter, and the shoe is filled with concrete.

The walls are built up above the shoe, within circular steel forms on the outside and light wooden forms on the inside (if the interior is rectangular). During its gradual descent through the overburden, the shoe may become considerably bent from contact with boulders. When the solid ledge has been reached concrete is added to the pointed cutting edge, which is thus filled out flush with the rectangular interior of the shaft, and is "sealed" to the rock.

Re-enforcing rods in the concrete are of two kinds; both are of ⅞-in. square steel or iron. The vertical rods are for preventing the

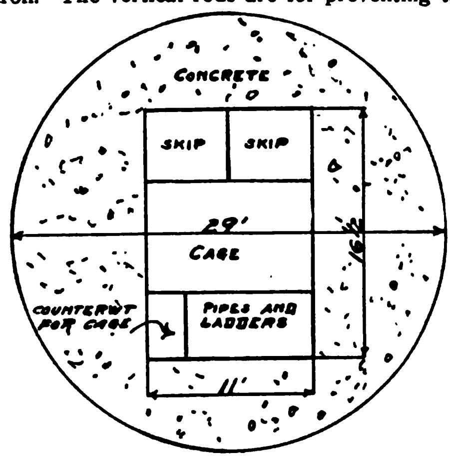


FIG. 1. SECTION OF ROGERS SHAFT.

shaft from pulling apart, in case boulders dig into the side, and hold it back while the bottom portion continues to drop away. At the start there may be two rows of the vertical rods, one a few inches from the outside forms, and one row near the interior walls; they are spaced about 18 ins. apart, and the first set is usually fastened to the shoe.

Later as the shaft nears completion, the inside row is usually left off, and the outside row is spaced at intervals of 3 or 4 ft. The horizontal re-enforcements are bent in the arc of a circle, and are laid in the concrete near the outside walls, spaced at about the same distances as the vertical rods; they are for withstanding pressure from without—that of sand and water.

The concreting mixture should contain more cement than is specified for ordinary work, because in the case of a porous wall, compressed air will leak through, and later, when the shaft is finished, water will leak in. In loose overburden, after compressed air has been turned into the shaft, bubbles of the air can be seen

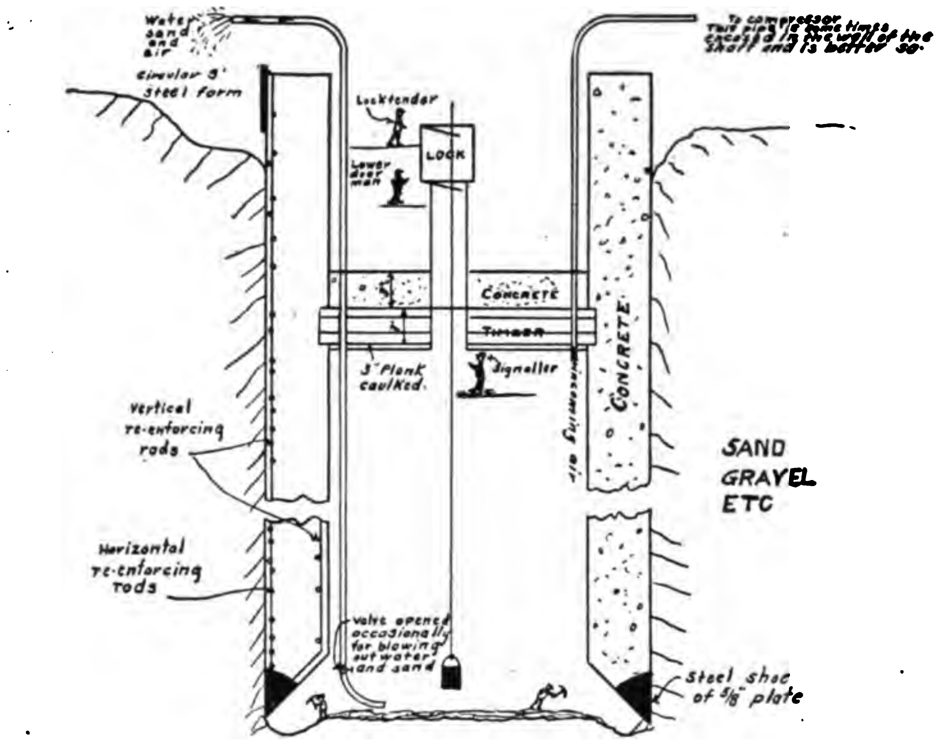


FIG. 2. SCETCH OF SHAFT SINKING OPERATION.

rising out of the ground in great quantity, close to the casing, and in some instances as far back as 100 ft from the shaft; this leaks through the walls and out under the cutting edge.

Preparatory to turning on compressed air for holding back sand and water, a timber deck is put across the shaft. Three 12-in. layers are fastened securely in a groove in the concrete; 3-in. planking underlies this, and is calked tight with oakum. Over the 12 by 12-in. timbers is put 2 or 3 ft. of concrete. In spite of this 6 ft. of caulked timber and concrete, air will leak through, and impervious clay must be kept plastered on the under side of the plank.

When air pressure is turned on, the work consists of digging a ditch around under the shoe a foot or two deep, the dirt being thrown in the center, and later hoisted. This may require a little blasting in hard ground, but usually pick and shovel work will suffice; perhaps two or three days are taken (with each man working say two 40-minute shifts in 24 hours, there being 12 or 15 shifts).

The last shift comes up, the air is let suddenly out of the shaft through two or three exhaust valves opened simultaneously (pehaps 4 minutes being taken for the air to escape), and the casing should drop down an amount equal to the depth of the ditch dug. In case it hangs up from friction on the sides, it is sometimes necessary to explode several sticks of dynamite (in the water which has run in), for shaking or jarring the casing down. Occasionally the shaft has been weighted with pig iron or wet sand for forcing the cutting edge through the loose dirt, which runs in under the shoe, when the air is allowed to escape. The air is blown out because its pressure holds the shaft up against the force of gravity. The greatest difficulty encountered in the whole process is from skin-friction on the sides of the shaft, which prevents the dropping down, and in extreme cases the casing has to be left hung up, and a concrete appendix built from the shoe down to the solid rock. The incoming air lines are often encased in the concrete walls, especially if much compressed air work is anticipated. When the pipes merely go through the timber deck, the air heated by compression makes the top of the chamber almost unbearably hot, so that not infrequently the men are overcome by the heat. This is particularly liable to happen to the man who works just under the timber deck giving signals and guiding the bucket into the hole.

[This hot air is an unnecessary hardship on the men. An aftercooler should be used. Ed. C. A. M.]

Fifty pounds of air is the limit of endurance for men to work in. With 40 lbs. pressure per square inch two 40-minute shifts are worked per man per 24 hours.—*Condensed from Mining and Engineering World.*

AIR CONDITIONING FOR FACTORIES

By C. E. A. Winslow.*

I am quite frankly and coldly treating the operative as a factor in production whose efficiency should be raised to the highest pitch, for his own sake, for that of his employer, and for the welfare of the community at large. The intimate relation between the conditions which surround the living machine and its efficiency is matter of common experience. Contrast your feelings and your effectiveness on a close, hot muggy day in August and on a cool brisk bright October morning. Many a factory operative is kept at the August level by an August atmosphere all through the winter months. He works listlessly, he half accomplishes his task, he breaks and wastes the property and the material entrusted to his care. If he works by the day the loss to the employer is direct; if he works by the piece the burden of interest on extra machinery has just as truly to be borne. At the close of the day the operative passes from an overcrowded, overheated workroom into the chill night air. His vitality lowered by the atmosphere in which he has lived, he falls a prey to minor illness, cold and grip, and the disturbing effect of absence is added to inefficiency. Back of it all lurks tuberculosis, the great social and industrial disease which lays its heavy death tax upon the whole community after the industry has borne its more direct penalty of subnormal vitality and actual illness.

The remedy for all this is not simply ventilation in the ordinary sense in which we have come to understand the term. Conditioning of the air so that the human machine may work under the most favorable conditions,—this is one of the chief elements of industrial efficiency as it is of individual health and happiness.

The chief factors in air conditioning for the living machine, the factors which in most cases far outweigh all others put together, are the temperature and humidity of the air. Heat, and particularly heat combined with excessive humidity, is the one condition in air that has been proved beyond a doubt to be universally a cause of discomfort, inefficiency and disease. Flugge and his pupils in Germany and Haldane in England have shown that when the temperature rises to 80 deg. with moderate humidity or much above 70 deg. with high humidity, depression, headache, dizziness and other symptoms associated with badly ventilated rooms begin to manifest themselves. At 78 deg. with saturated air Haldane found that the temperature of the body itself began to rise. The wonderful heat-regulating mechanism which enables us to adjust ourselves to our environment had broken down and an actual state of fever had set in. Overheating and excess of moisture is the very worst condition existing in the atmosphere and the very commonest.

The importance of the chemical impurities in the air has dwindled rapidly with the investigations of recent years. It was long believed that the carbon dioxide was an index of some subtle and mysterious "crowd poison" or "morbific matter." All attempts to prove the existence of such poisons have incontinently failed. Careful laboratory experiments have quite failed to demonstrate any unfavorable effects from rebreathed air if the surrounding temperature is kept at a proper level. In exhaustive experiment by Benedict and Milner (Bulletin 136, Office of Experiment Station, U. S. Department of Agriculture), 17 different subjects were kept for periods varying from three hours to thirteen days in a small chamber with a capacity of 197.6 cubic feet in which the air was changed only slowly while the temperature was kept down from outside. The amount of carbon dioxide was usually over 35 parts (or eight to nine times the normal) and during the day when the subject was active it was over 100

*Associate Professor of Biology, College of the City of New York.

parts, and at one time it reached 231 parts. Yet there was no perceptible injurious effect.

The main point in air conditions is then the maintenance of a low temperature and of a humidity not too excessive. For maximum efficiency the temperature should never pass 70 deg. F., and the humidity should never be above 70 per cent. of saturation. At the same time a too low humidity should also be avoided. We have little exact information upon this point, but it is a matter of common knowledge with many persons that very dry air, especially at 70 deg. or over, is excessively stimulating and produces nervousness and discomfort. It would probably be desirable to keep the relative humidity between 60 and 70 per cent.

Another point which may be emphasized in the light of current opinion is the importance of "perflation" or the flushing out of a room at intervals with vigorous drafts of fresh cool air. Where there are no air currents the hot, moist, vitiated air from the body clings round us like an "aerial blanket," as Professor Sedgwick calls it, and each of us is surrounded by a zone of concentrated discomfort. The delightful sensation of walking or riding against the wind is largely perhaps due to the dispersion of this foul envelope and it is important that a fresh blast of air should sometimes blow over the body in order to produce a similar effect. The same process will scatter the odors which have been noted as unpleasant and to some persons potentially injurious. The principal value of the carbon dioxide test to-day lies in the fact that under ordinary conditions high carbon dioxide indicates that there are no air currents changing the atmosphere about the bodies of the occupants.

Continued progress is being made in the adaptation of ozone to the purification of drinking water for the supply of towns and cities. Apart from examples in America, the ozone plants at Chartres, Florence, Hermannstadt, Nice, Paderborn, Paris, Villefranche, and Wiesbaden are sufficient to demonstrate the scientific and commercial success of the system, whose claims have been further recognized by the decision of the Paris Municipal Council to erect two additional plants each of 9,900,000 gallons output daily, and by the 11,000,000-gallon plant recently completed at St. Petersburg.—*The Engineer*, London.

PANAMA AIR COMPRESSOR LUBRICATION

The following comes from an engineer correspondent of *Power*. It is a report of the use of lubricating oils in the three air-compressor plants of the Isthmian Canal Commission for the month of February, 1911. It shows the number of revolutions, square feet covered per pint of oil, output in cubic feet of air and the cost per million square feet covered.

Oils Used:	Empire Air Compressor	Las Cascadas Air Compressor	Rio Grande Air Compressor
Valve oil ..	87¾ gal.	22 gal.	38 gal.
Stationary-engine oil.	157¾ gal.	35 gal.	60 gal.
Air-compressor cylinder oil ..	87¾ gal.	23 gal.	45 gal.
Revolutions per gallon of valve oil:	236,458	295,655	217,650
Revolution per gallon of stationary-engine oil:	131,532	185,840	137,845
Revolutions per gallon of air-compressor cylinder oil:	236,458	282,800	183,682
Square feet covered per pint of valve oil:	1,041,107	1,392,597	1,025,122
Square feet covered per pint of air-compressor cylinder oil:	1,354,971	1,837,513	1,028,152
Cost per million square feet covered (surface):			
Valve oil....	$0.0234	$0.0175	$0.0237
Air-compressor cylinder	$0.0134	$0.0098	$0.0176
Output of free air, cubic feet:	378,879,661	118,770,526	151,205,582

In the air-compressor plants at Empire, Las Cascadas and Rio Grande, there are 14 compressors, each of 425 horsepower and all operating at a steam pressure of 125 pounds. The engines are simple twin cylinder. The compressors are of the double-cylinder cross-compound type. The area of the two steam cylinders is 9.42 square feet; the area of the low-pressure air cylinders is 15.17; the area of the high-pressure cylinders is 9.42 square feet. The speed of these compressors is from 127 to 137 revolutions per minute.

D. E. Irwin.

Empire, Panama.

[This is, of course, interesting and the figures are of value for comparison of practice; but as here given the statement might be misleading. Of course one pint of cylinder oil never actually covered 1,800,000 square feet of surface, say 40 acres. There is no kind of surface upon which, spread so thinly, it would have made a visible stain, although it is probably entirely correct that this cylinder surface was swept by the piston while the pint of oil was disappearing. We learn at least that effective lubrication does not consist in keeping the surfaces wet with oil, and where so little oil was found sufficient the question is at least suggested as to whether any at all was necessary.—Ed. C. A. M.]

AVIATION MAKES SPEED RECORDS

There would seem to be really no practical value to the devices which are being developed for navigating the air, and in the prospective employment of them for getting from one point to another at a considerable distance, except as it may enable one to get there in a shorter time. The mere attainment of high speed for any portion of a given flight without any other result than the record of the speed attained, is surely a matter of momentary curiosity or a condition for gamblers to deal with. Nevertheless, high speed records are being made and we all are more or less interested in them in spite of all the suggestions of common sense. The following upon the general topic we condense from a recent editorial in the *Engineering Record.*

The record of 155 miles an hour credited to Vedrine leaves every previous exhibition of human power to make time hopelessly in the rear. It is not only a new record of speed, but almost a new conception of speed that is given the world by this extraordinary performance. True enough, the aviator had a hurricane at his back and one of the very fastest machines in the world, a Morane monoplane, beneath him, but the combined result is certainly none the less awe-inspiring. Just how fast the wind was blowing and just how fast the monoplane was scudding ahead will probably never be known.

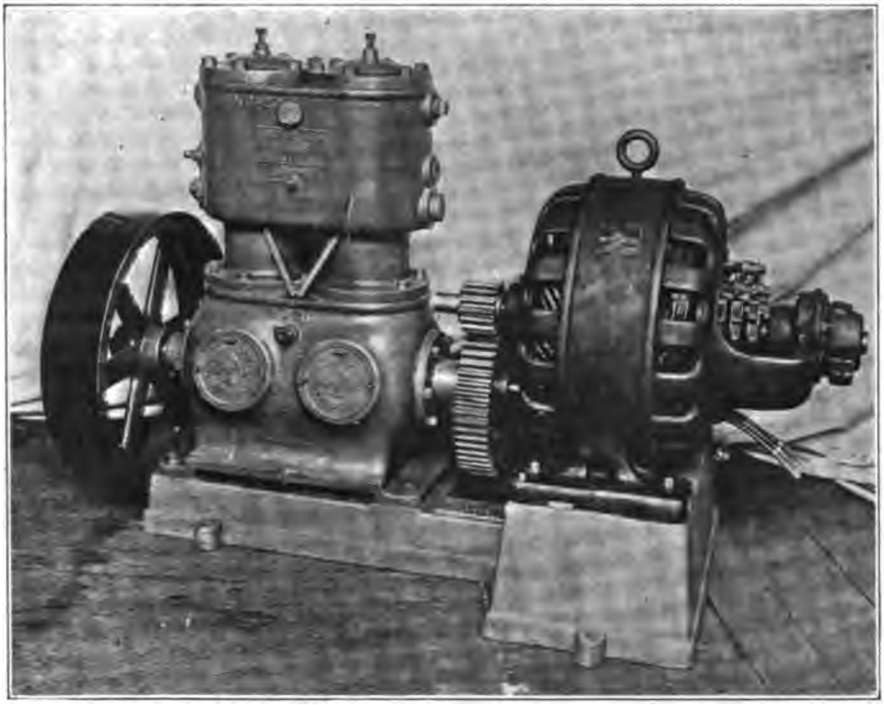
As a mere matter of mechanics the possibility of such speeds is inspiring. At the rate at which aeroplane speeds have increased for the last year or two it is going to be but a brief time before a hundred miles an hour is passed, and not much more before all records of things that travel on earth are passed. It may be long, however, before this prodigious flight of Vedrine's is beaten. At the present time there seems to be no difficulty in constructing a system of planes that will fly and fly well with sufficient power behind it. Increase over the present ordinary speeds for flying machines must come by increasing the engine power, increasing the efficiency of the propeller or greatly decreasing the resistance of the plane for a given lifting power. It would not be in the least surprising if it were possible to construct propellers with perhaps half as much again thrust in proportion to the energy wasted as the best now in use. It is quite certain that there is a great difference in the efficiency of propellers as now constructed, especially with reference to their adaptation to the high speeds employed.

The whole engine question must soon be taken up by makers all over the world. The successful aeroplane engines are very few in number. Perhaps they have been pushed already quite near to their possible limit of power per pound of weight, and yet there is a good chance for improvement in the sense that it may be possible to get continuous performance of the highest class where one now gets only occasional and uncertain performance.

As to the decrease of resistance, something may be accomplished by the construction and shaping of the planes. It already appears that in the matter of speed the simple surfaces of the monoplane have a very material advantage, much on the same principle that a racing sloop has an advantage over a schooner of similar sail area. On the other hand, the temptation to cut down resistance by reducing supporting surface is a hazardous one. The less the surface the higher the speed must be to keep up, and the slimmer the chance of alighting safely if anything happens.

Taking it altogether, one may perhaps grow hopeful that when Vedrine's speed record finally succumbs, the following gale will play a much less important part in the result. Certainly a speed of nearly 200 ft. a second higher than has ever been reached by anything, except a projectile, is enough to satisfy even one's twentieth century enthusiasm.

"A sleeper is one who sleeps. A sleeper is that in which a sleeper sleeps. A sleeper is that on which the sleeper runs while the sleeper sleeps. Therefore, while the sleeper sleeps in the sleeper, the sleeper carries the sleeper over the sleeper under the sleeper, until the sleeper which carries the sleeper jumps the sleeper and wakes the sleeper in the sleeper by striking the sleeper under the sleeper on the sleeper."



COMPRESSOR FOR TRANSFERRING ACIDS.

SULPHURIC ACID HANDLED BY COMPRESSED AIR

In the manufacture of certain chemicals considerable danger and expense is caused by the rapid deterioration of piping and other receptacles with which the acids and fumes come in contact. Sulphuric acid is particularly destructive and many serious difficulties are encountered in its manufacture. It is practically impossible to handle sulphuric acid with pumps, as they would deteriorate so rapidly that constant replacement would be necessary.

The most satisfactory method of pumping destructive acids is that used by the Nichol Syndicate in their new plant at Bay Point, California. At one stage of the process of manufacture, the acid is accumulated in a cylindrical tank which is provided with suitable inlet and outlet valves. When it is desired to pump the acid into other retainers, the inlet valve is closed and air at from 60 to 100 pounds is admitted, which forces the liquid through the outlet valve to other parts of the plant. The flow of the acid is controlled by suitable valves in the piping system.

To meet the increasing demand for apparatus that will handle destructive acids economically the United Iron Works of Oakland, California, has brought out the motor driven compressor shown in the illustration. The compressor is a 6x6 Gardner-Rix Duplex; speed 200 r.p.m., pressure 60 to 100 pounds, capacity 40 cubic feet of air per minute. The compressor is driven by a Westinghouse type HF 3 phase, 60 cycle, 550 volt motor.

This type of motor is admirably suited to this work. The secondary is phase wound and the three phases are connected to the three collector rings shown. In starting, the controller gradually cuts out the starting resistance which is connected to the secondary through the collector rings. This motor is so designed that an unusually high starting torque is developed, with comparatively low starting current.

COMPRESSED AIR IN SANITARY SERVICE.

FACTORY USE OF COMPRESSED AND EXHAUST AIR

Compressed air and suction conduits, which besides their obvious employment in modern industries possess the added advantages of producing efficient ventilation without undue drafts, have recently found a use in the manufacturing of colored paper goods.

The illustration shows a room in an up-to-date factory in Berlin, Germany, where colored calendars, postcards, boxes for candies, perfumes, etc., are made in large quantities, especially for export to the color-loving inhabitants of South America. The various colors, red, blue, green and yellow, are made from aniline compounds, dissolved in alcohol. The color is contained in the small pan of a spraying device similar to an artist's air-brush, and the operator turns on the compressed air which squirts a fine spray of color over the parts of the work exposed through the pattern.

In order to catch that part of the mist of color that escapes into the air, each operator's post is surrounded by glass walls and an air suction through a slot in the table draws away the color that might escape and be inhaled, with bad effect, by the 100 or so girls who are employed in the work.

IMPORTANCE OF AIR CIRCULATION

Dr. Langlois, of Paris, has given out some interesting facts relative to the effect on mine workers of humidity, temperature and air circulation. He found at Ronchamps at a depth of about 3280 ft., with the humidity such that the dry bulb showed 36.5 degrees C., and the wet bulb 24.8 degrees C., that work could be carried on, but that, when the humidity became greater, even with a lower temperature, work became difficult. He found that with temperatures above 25 degrees on the wet bulb, the ventilation has a marked effect on the workmen's physical condition and capacity for work. In stagnant air at the temperature of 25 degrees (wet bulb), an appreciable illness is experienced, which passes off at once when the ventilating current reaches a velocity of 3.3 ft. per second. In still air at a temperature of 30 degrees (wet bulb) marked illness is felt, but conditions become supportable when the velocity of the ventilating current reaches 6.6 ft. per second. From these data it is evident that attention to ventilation in mines is an important factor in determining the labor efficiency of the underground workmen, especially in warm moist workings. Dr. Langlois found that a workman could do more work in a temperature below 25 degrees (wet bulb) when the velocity of the ventilating current is maintained at from 3.3 to 16.5 ft. per second.

HYDRO-PNEUMATIC FEED FOR RADIAL DRILL

A radial drill of new design throughout and exhibiting many novel features has recently been put out by the Walter H. Foster Co., 50 Church street, New York.

This is an electric driven machine, differing from the standard types in the combination of the saddle on the arm with a cylinder having a gear box mounted on top containing high and low speed gears in connection with a variable speed motor. The cylinder through which the spindle passes is surrounded by an oil chamber, and a piston, sliding in the cylinder is connected with the spindle which rotates in the piston and takes its thrust on ball bearings. The vertical movement or feed of the piston and spindle is controlled by the oil which fills the cylinder solidly below the piston, the pressure above the piston being supplied by a constant air pressure of 80 pounds, usually taken from the shop supply,

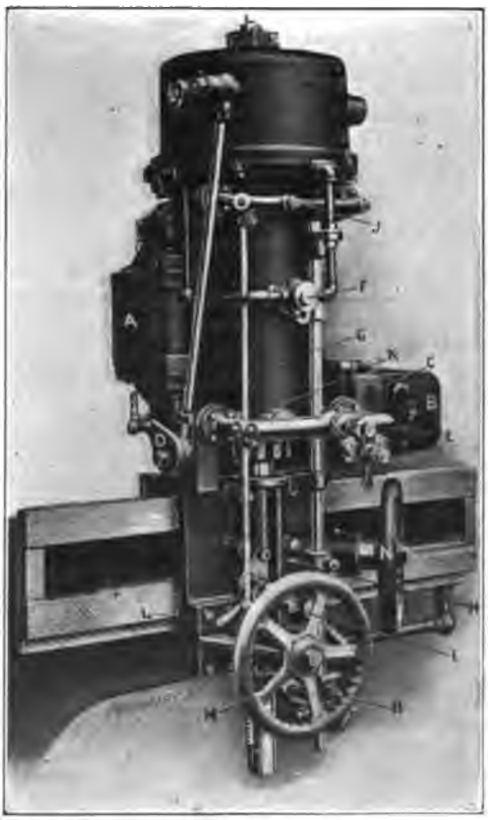


FIG. 1 PNEUMATIC DRILL FEED.

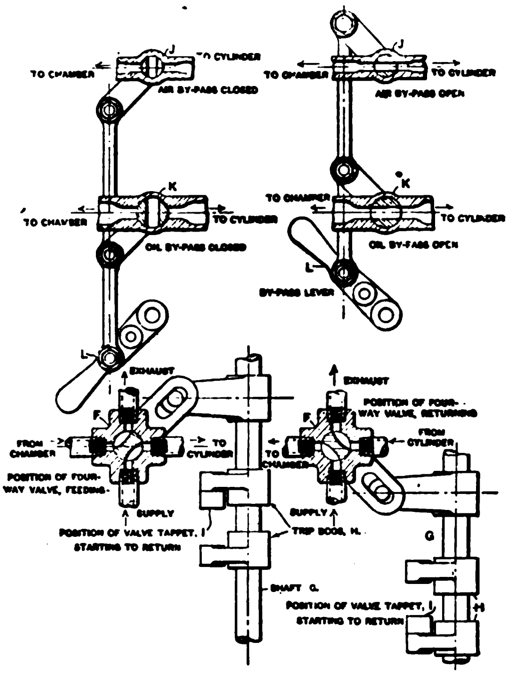


FIG. 2.

the feed movements being effected by the discharge or readmission of the oil.

Referring to Fig. 1, the motor which drives the spindle is at A. The drum type controller B is a new design, having ten points of contact, and the resistance C is attached in a neat and compact form. The feed operating valve E has a flat seat graduated to permit the passage of oil from the cylinder to the surrounding chamber, and as the air pressure on top of the piston forces it down the restricted outflow of the oil through these passages makes the feed constant. The four-way valve F controls the passage of the air, whether it is on top of the piston, forcing the spindle down (under which condition the oil is being forced into the chamber through valve E), or forcing the oil back into the cylinder under the piston, thus returning the spindle upward to its original position. The air valve is operated by the vertical shaft G which carries adjustable trip dogs H. These dogs are arranged to swing out of the way when the spindle is operated by hand, so as not to interfere with tappet I, which slides with the spindle. The by-pass valves J and K, which are operated by lever L through the connecting rod shown, allow the air and oil to pass freely in either direction while operating by hand. The hand-wheel M has a pinion engaging with a rack for hand operation of the spindle, and handwheel N has a spiral gear engaging a rack for adjustment of the head on the arm.

The line drawings, Fig. 2, show the air and oil valves in their different operating positions.

SOUND IN THE UNIVERSE

We live and move at the bottom of an ocean of air, the earth's atmosphere. One consequence of this is that every mechanical disturbance starts waves of compression and rarefaction, which radiate out from the source, and, striking the drum of our ear, may (if of the right strength and quality) cause in us the sensation of "sound." Among such sensations some affect us merely as "noises"; in others we recognize a more or less well-defined "musical pitch" and "tone quality." Physically the "noise" differs from the "musical note" in that the former is an irregular disturbance, while the latter is periodic and of definite frequency. Not that there is any hard and fast line of demarkation: a rapid succession of impulses, which separately would be mere noises, may impress the ear with a definite sense of pitch. Thus the teeth of a saw, cutting in rapid sequence through a wooden board, produce a sound of definite pitch, though lacking perhaps in musical quality. Or again, a sharp noise of brief duration, proceeding from a point in the neighborhood of a series of equidistant obstacles, such as a line of fence-rails, or a flight of stone-steps, produces upon the observer a sensation in which a more or less well-defined pitch can be recognized. The explanation of this phenomenon is that the sound is reflected back from each fence-rail in turn, and since it takes time to travel, each echo reaches the observer a trifle later than that from the neighboring rail. This case is of special interest, because the sound "heard" contains an element quite foreign to the initial disturbance. Furthermore, the pitch of the sound heard differs according to the location of the observer, so that, borrowing an expression from optics, it might be said that the original disturbance is "analyzed" by reflection from the fence (grating) into its "constituent" waves—each traveling in its own direction, so that it can be singled out by the observer. It is possible that the means commonly employed to analyze light waves act in this way, and perhaps we are not quite justified in imagining "white" light for instance as "composed" of the various spectral colors, these being rather impressed upon it by the prism or grating or other device employed to "analyze" the light, as we commonly say.

Of all the forms of energy, sound would probably be of the least consequence to man, were it not for the one important fact, that sound is the normal vehicle for the transmission of intelligence between individuals. Certain special sounds are recognized by us not merely as "noises," or "musical notes," but as "words," which are associated in our minds with definite concepts, and whose mere mention immediately summons up before our imagination the concepts thus attached to them. Not that speech exhausts all the modes of sound-expression for mental states at our command. Indeed, more elemental and lower in the scale than speech are various inarticulate sounds, such as laughter and crying, calls of various kinds, the groan of pain, the sigh of relief, the shriek of fear, and a host of other emotional expressions. In these man approaches more nearly to the lower animals, who also possess "calls." But the range of our modes of expression by means of sound extends also on the other, the heroic side, beyond ordinary speech. The poet by rhythm and cadence conveys something more than his words alone would say, and in the symphonies of the great masters of music there is borne in upon us a wealth of thoughts that lie too deep for words.

If the ocean of air which envelopes us is the medium that carries sound to our ears, and thus places us in sentient communication with the other occupants of this globe, its shore, the void upon which the upper atmosphere abuts, is also the extreme limit of the range of space comprising all things audible to us. No sound, however loud, can ever pass from the earth into space beyond, neither can it penetrate from other orbs to us. The sun's burning eye looks down on us in splendor mute; for though his fiery ocean be lashed by furious gusts, in comparison with which the fiercest earthly gale is but as the soft sighing of the autumn wind, or as the breath of one that slumbers; and though monstrous explosions rend his very bowels, belching aloft great pillars of fire that tower thousands upon thousands of miles;

yet of all the crash and thunder and tumult not a whisper escapes to break the eternal silence of infinite space, and the empty void holds close the clamorous secret of the fiery orb.—*Scientific American.*

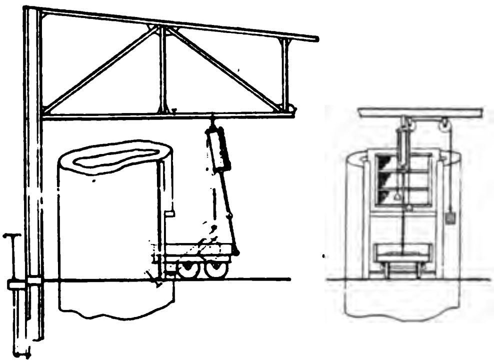


FIG. 1.

PNEUMATIC DEVICES FOR CHARGING CUPOLAS

In a paper by G. R. Braddon before the Pittsburg convention of the American Foundrymen's Association, the general subject of the mechanical charging of cupolas was discussed, including the unloading from railroad cars, the storage in the yard, the conveyance to the cupola and finally the dumping of the charge in detail into the cupola. We have here to do only with the latter operation.

Fig. 1 shows a type of charging car in which the load is carried almost entirely upon one axle, enabling the overhanging end of the car to project into the cupola and making a very light lift for the air hoist to dump the load.

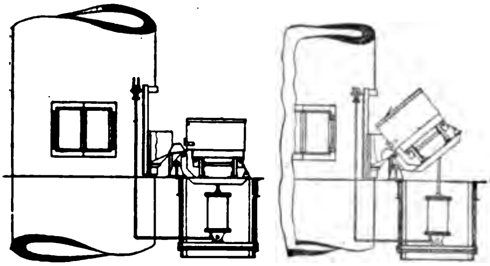


FIG. 2.

Fig. 2 shows a side dump charging machine in two positions. The car load in this case is borne equally upon all four wheels. The car is run upon a hinged platform flush with the floor and in front of the cupola door. The platform is then tilted by the pneumatic lift below and the load slips into the cupola.

In Fig. 3 is shown a compound charging machine in both normal and dumping positions. In this arrangement the platform with the car and its load is first lifted vertically by a direct acting lift below it, and then the platform is tilted and the load is dumped by another pneumatic lift. The cylinder of the latter, it will be noticed, is pivoted at the bottom, enabling it to swing as the platform tips and giving the piston rod always a direct thrust. The air-controlling valves for either of these devices are located by the side of the cupola where most convenient for the operator.

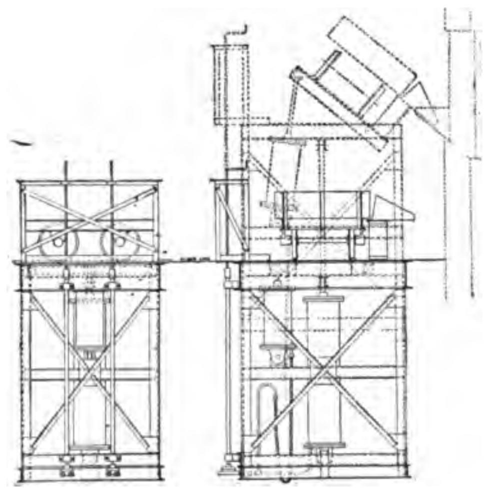


FIG. 3.

CARE OF PNEUMATIC TOOLS IN RAILROAD SHOPS

At the annual convention of the American Railway Tool Foremen's Association, held in Chicago in July, three important papers were presented relating to pneumatic tools and appliances, their reading being followed by the free and liberal discussion which prevails at the various railway conventions. The following, which can scarcely be called discussion, is a collection of brief statements of current practice in many railroad shops in the matter of lubricating, handling and maintaining pneumatic tools. The statements have been carefully abstracted by the *Railway Age Gazette*:

Mr. Martin:—We had a great deal of trouble with air motors, and employed a man who does nothing but oil and take care of them; it has been a paying investment.

Mr. Hendrikson:—We have the air motors turned in every night and they are oiled every morning.

Mr. Linck:—There are lots of machines that ought to be oiled during the day.

Mr. Meitz:—We had considerable trouble with the motors, but we now fill the inside of the motor case with artificial engine grease. It holds the oil in the motor and the motor is better lubricated all through. It lasts twice as long and is always lubricated.

Mr. Breckenfeld:—We have a helper go around the shop twice a week; he opens the motors and packs them with No. 3 grease, as they call it; I do not believe that we have had any trouble with a motor on account of not being lubricated in six months. On Saturday night we have all tools turned in and the helper examines the motors to see that they are properly oiled.

Mr. Fuhrman:—It is a good thing to have an atomizer for oiling pneumatic tools. Fill it up twice a day; it does away with a good deal of trouble. Our system is to always keep after the motors in the tool room, and if one is not running right it is immediately returned to the tool room.

A. Sterm (Chicago, Rock Island & Pacific, Chicago):—We use the automatic oilers.

J. B. Hasty (Atchison, Topeka & Santa Fe, San Bernardino, Cal.):—We pack air motors with grease once a week, over Sunday, and use grease altogether. We use a bath for the air hammers. They are turned in every evening and placed on pegs 5 or 6 in. long and are flooded at night with coal oil. The flooding arrangement is made of a reservoir in two sections; the lower section contains the oil, and the upper section the hammers; by admitting air to the lower part, it forces it up under the hammers and completely covers them with oil; they remain until morning. Just before the hour of opening, the night watchman opens the valves and the oil goes back to the lower tank; then we give them a touch of signal oil and pass them out. Nothing is done to them during the day.

Mr. Lugger:—We use the same system at our shop, but the oiling process during the day is worrying me considerably. A boiler maker takes a hammer out and after it passes into his hands in the morning, there is no oil put in it during the day. We send out an apprentice at different times during the day who puts in a little airolene, and that has to a great extent overcome our difficulties. In our air motors, we use airolene entirely, and have no trouble. The only difficulty we have experienced of late is in the air motor throttles. They get dry, due to the men neglecting them, and we have to overhaul them frequently.

Mr. Breckenfeld:—When we know a new man is going on a job—generally an unskilled laborer in the boiler department—we try to have the men in charge of the motors go out and give him a few minutes' instruction. It has a tendency to save in the breakage of air motors.

Mr. Pike:—We have a young man go around the shop every two hours; he oils the machines through the throttle and in the case, and the gasket if necessary. If a section of hose is leaking he condemns it. These duties keep him busy. The atomizer may be all right, but it added to our troubles in that it made an additional part to maintain; also when the air line became old, small particles of rubber would pass through and clog it up; the man using the machine expected the atomizer to be on the job when it was not, and as a consequence the machine went dry. It pays to have one man to be the judge of when a machine should come to the tool room for repairs. If he hears a squeaking or grinding, it must be taken out of service. A man using a machine will use it hours after the time when it should have been stopped. We placed all air tools in an oil bath until the insurance agents objected to the large quantity of oil being kept in the building, and we now find the individual inspection very satisfactory. We experienced some difficulty after the shop had been closed down for a few days with the throttle clogging owing to dampness. We used mineral lard which amalgamates well with the moist air. It is cheap, and we use it generously and have very little trouble.

Mr. McKernan:—When a hammer is brought in throw it in a tank of coal oil. When you check it out, blow it out and oil thoroughly, and I do not think you will have very much trouble. When a hammer is kept out any length of time the man who takes it out is held responsible for oiling it. If the hammer comes back in bad shape he cannot get his check until there is a satisfactory explanation, and that has to be O. K.'d by the general foreman in addition to his own foreman.

Mr. Meitz:—In our shop all tools are supposed to be turned in every night. The hammers go in a bath and lie there until five minutes before work time. No tool goes out without an oiling. When they come out of the bath we hang them up to drip, and they are oiled with valve oil and signal oil mixed. Valve oil alone is a little too heavy.

William Thomason (Pennsylvania, Renova, Pa.):—We have little or no trouble as far as the use and abuse of hammers is concerned. If a hammer is neglected we find out very quickly who is responsible. When a man checks a hammer out the boy knows what hammer he gets.

Mr. Fuhrman:—I believe the foreman who has charge of the men using the tools is the man who should be responsible for their proper use. He is the best judge. Sometimes he is not in favor of saving the tools; he wants the work and may abuse the tools worse than any man. There is a limit to everything, and every foreman ought to know what will bring the best results for his company. It does not pay to spend a day making a tool and have somebody spoil it in a half hour, even though you get the work out.

Mr. Lugger:—We should not confuse severe use with abuse. A machine designed for any kind of work should be used to its full capacity all the time; we should try only to eliminate the abuse of the tool. I do not believe in nursing a tool.

Mr. Pike:—When we purchase a motor we attach a brass plate to a prominent part before it goes into service. On the plate is the name of the shop, number and size of work for which the tool should be used, i. e., "Machine shop, No. 20, ¾ in. to 1¼ in. drill; 1 in. to 1⅛ in. tap." If the motor is not doing that work, we know it is the fault of the motor; it is not liable to be used on a larger tap or drill.

Mr. Martin:—We send in a breakage report which goes to the superintendent and he sends it to each foreman of the shop with a list of names and what they did in the way of breaking or damaging tools.

A pit pony has just died at New Hawne Colliery, Halesowen, Worcestershire, of Garratts, Limited, which has worked in the mines for 40 years.

GASOLINE FROM WASTE OIL-WELL GAS

By F. W. Brady, M. E.

[The following clear and interesting account of a recently developed by-industry of the air compressor we condense from the latest issue of *Mines and Minerals.* Ed. C. A. M.]

A striking example of waste has always been found in the great oil and gas fields of Ohio, West Virginia, and Pennsylvania. This does not mean that the oil has been wasted deliberately, for the supply is cared for remarkably well, but the direct loss has been through accident and carelessness, while the indirect loss has been from the light vapors passing off from the storage tanks, and the immense quantities of gas escaping from the wells.

Any one with a technical instinct who visits the eastern oil fields to-day will experience a feeling of relief, for the newest of the new things in oil production is the perfection of a process for manufacturing gasoline from the gas from oil wells. These plants are located here and there on the farms wherever a group of wells can be worked to the best advantage. The gasoline is shipped in 50-gallon iron barrels which are hauled by wagon to the nearest railroad station, while the by-product gas is turned into the pipe lines that for years have distributed the high-pressure natural gas supply.

Oil development is going on continually, each season seeing some new field where production is booming. At the beginning, most of the wells are self-flowing and some of them are real "gushers," producing five or six hundred barrels, or more, the first 24 hours; most of them, however, make less than one hundred barrels; the decrease of production is rapid and soon all the wells become "pumpers." At first the pumping is daily, then about twice a week, and finally a settled system of pumping once a week, or once in 10 days or so, is kept up for several years with those wells that continue to produce oil, the quantity in many cases averaging much less than 1 barrel per day. All this time, however, from the first strike of oil, and for long after the well is abandoned as an oil producer, there is a flow of gas from the well. In some cases the first strike was a "gaser," which afterwards turned to an oil producer. Generally, though, the reverse is the case, and practically all the oil wells close their careers as gasers.

Now it is this gas from the oil-bearing sands that has made the bulk of the waste. Especially has this waste been too bad where an oil well has been abandoned and the gas has been burned on the spot from the open pipe, or has escaped freely into the air. Millions upon millions of cubic feet of nature's best fuel have thus been disposed of. The final choking up of many abandoned oil wells by salt that encrusts in the casing will really be a boon to posterity. Not only has there been a direct waste of this kind of gas, but also there has been an indirect waste in the use of the gas piped from the oil wells. In the long pipe lines it has been a common occurrence for gasoline to collect wherever a down bend or pipe would trap it. Then the re-evaporation of the gasoline will produce a freezing effect that will clog the pipes with ice where water has collected. This re-evaporation may take place where the gasoline flows from a leak in the pipe and probably within the pipe also. The freezing of the gas pipes from this cause has been annoying, but it was due to this trouble that the apparatus for manufacturing gasoline from the gas was developed.

The process depends upon the condensation and liquefaction of gases—the direct processes being dependent on the laws governing the compression and refrigeration of the gas. The present plants are equipped with a refinement of the various apparatuses that have been perfected after a considerable experimentation with one thing and another.

The general arrangement of a gasoline plant in West Virginia is shown in Figs. 1, 2, and 3, and a plan of the arrangement of the apparatus in Fig. 4. This plant has a capacity for treating 150,000 cubic feet of gas in 24 hours, and produces from 500 to 800 gallons of gasoline having a gravity of 92 degrees Baumé.

Two direct 35-horsepower gas-engine-driven air compressors compress the gas. The first compressor, which may have a piston varying from 6 to 12 inches, draws the gas from the piping system connecting all the available wells in the neighborhood. From a partial vacuum of 15 inches the gas is compressed to 20 or 30 pounds. It then passes through a water cooler to the second machine, which has a 4½-inch piston, and which compresses to 150 pounds or over. The final pressure must be determined by trial, as the process depends considerably upon the quality of the gas and the refrigeration treatment. Thus in this plant 150 pounds compression was found to produce more gasoline than did 250 pounds compression.

The gas at 150-pounds pressure passes through an 80-foot water cooler, and then through a double 80-foot gas cooler, the latter using the by-product gas for cooling. The collecting and separating tank is of heavy boiler plate construction and resembles a 40-horsepower vertical boiler. The saturated refrigerated gas under a pressure of 150 pounds or over, enters the side of the accumulator tank at a point about two-thirds its height, measured from the bottom. A baffle plate riveted in the tank deflects the flow and pre-

FIG. 1. GASOLINE PLANT.

cipitates the gasoline. The accumulation of gasoline is shown by a gauge glass, and periodically the attendant blows it into a storage tank of 120-barrels capacity. A similar storage tank, located below the first one, is shown in the foreground of Fig. 3. The storage supply stands at about 20 pounds pressure. From the stock tanks the gasoline is loaded into iron barrels of about 50 gallons each.

The gas engines are of the tandem type and supplied with two flywheels. The gas-engine cylinder is at the head end and the gas compressor cylinder next to the crank end. Both the engine and compressor cylinders are water-jacketed. The crank case on some of these engines is closed and has a vent pipe leading above the building; thus, any gas leaking from the cylinders will be carried out of the building and the danger from fire or explosions is lessened. The make-and-break spark system is used for ignition, and a friction-driven magneto for each engine is located in a small building some 100 feet distant. A small gas engine operates these magnetos and also the generator for lighting the plant. An air starting outfit, consisting of one air pump compressing to 150 pounds, air receiver, starting valves, pressure gauges, etc., makes the starting of these large gas engines an easy and a safe operation. About 2 pounds gas pressure is used for the gas-engine service. A regulator placed outside the building is necessary to deliver the fuel at a uniform pressure.

Cooling System.—All the engine and compressor cylinders are water cooled. The gas as

FIG. 2. GAS COOLER, ACCUMULATOR AND LOADING HOUSE.

it comes from the wells is probably at 60 degrees F. The heated gas from the first compression goes to a water cooler consisting of a concrete vat 20 ft. × 4 ft. × 4 ft. A continuous flow of cool water passes through this tank in which a 10-inch pipe is laid lengthwise along the middle and to which the 3-inch delivery pipe from the first compressor is attached at one end, while to the other end an inlet pipe to the second compressor is attached.

The high-pressure gas from compressor No. 2 passes first through an automatic separator that removes any lubricant that may be carried

FIG. 3. STORAGE TANKS LOADING HOUSE AND MAGNETO BUILDING.

over from the compressor. It also catches any gasoline that may drain back from the second cooler.

The second cooler is 80 feet long and consists of a concrete tank like the intermediate cooler. A 10-inch pipe is placed lengthwise of the tank. The arrangement of the piping sys-

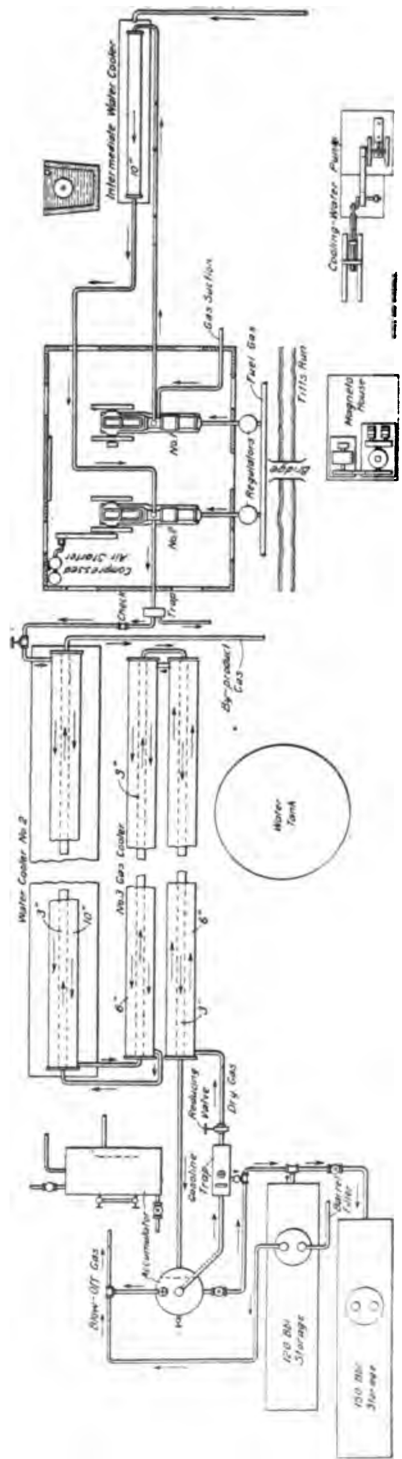


FIG. 4. LARGEST OF GASOLINE PLANTS.

tem for the second cooler and also that for cooler No. 3 is shown in Fig. 4. The 2-inch delivery pipe enters a special fitting at the rear end of the 10-inch pipe, and the water-cooled gas passes out a 3-inch pipe 80 feet distant. This 3-inch pipe enters the end of an 80-foot length of 6-inch pipe, and returns through a second 80-foot length of 6-inch pipe and thence to the accumulator tank. From the gas space in the top of the accumulator tank a pipe leads to a gasoline trap which collects any gasoline that may be carried over from the accumulator and returns it to the stock tank. This trap is also fitted with a pop safety valve that relieves the accumulator from any over pressure and delivers the gas that may be blown off to the fuel-supply gas mains. Above the gasoline trap the by-product gas passes through a reducing valve and enters at low pressure the lower 80-foot branch of the 6-inch gas cooler. This No. 3 cooler is made up of a loop of 6-inch pipe laid in a box packed with sawdust.

The peculiar design of the cooling system makes it necessary to use some specially designed pipe fittings. The cooling effect of the expanded by-product gas is considerable, as it flows 160 feet through the 6-inch pipe that encloses the 160 feet of 3-inch pipe carrying the compressed gas to the accumulator. From the 6-inch gas cooler, the expanded gas goes to the 80-foot water cooler and passes through a 3-inch pipe laid lengthwise through the center of the 10-inch pipe. From cooler No. 2 the by-product gas goes through a 2-inch pipe to the gas engine feed-line. The by-product gas not used by the plant goes into the natural gas mains and is sold. The overflow water from the concrete tanks flows by gravity to the water-jackets of the engines and compressors. The by-product gas is a blue-flame gas that is more desirable for fuel and lighting than the raw gas, as it does not deposit any soot or blacken at all the furnaces, gas mantels, cooking utensils, etc.

The partial vacuum produced by the first compressor as it draws its gas supply from the wells aids both the oil and the gas production; in fact, in some cases the gas is given to the gasoline plants, by the oil man, as the increase of oil due to the vacuum is quite an item to the well owner. At the same time, however, the owner draws back all the by-product gas he needs for pumping the oil.

The vacuum in the field lines is one of first importance in gasoline production. So great is this feature that in some gasoline plants a special independent low-stage vacuum pump and gas compressor has been installed so as to regulate the field pressure and increase the production. This machine can be operated at any desired speed necessary to keep the pressure conditions constant. With this low-pressure compressor 24 inches or more of vacuum can be held on the wells, and at the same time the efficiency of the regular compressor units not be lowered. The advantages observed from the use of the vacuum system have led to the reopening of abandoned oil fields, not for the oil but for the gas from which they make gasoline.

The business of making gasoline from natural gas is necessarily a hazardous one. It is a new business, and this, coupled with the usual combinations of ignorance and carelessness, makes a list of accidents that one would naturally expect. Even the empty barrels have exploded when standing exposed to the hot sun and with the vent plugs set tight. On one occasion an empty went up when standing on the freight station platform. Those old in oil-well service have become accustomed to handling nitroglycerine, and while they respect it, they treat it with a feeling of contempt. On the other hand, gasoline of from 92 degrees to 100 degrees Baumé is a new thing to them, and they have got "burned" as a consequence. Therefore, to hear an operator about a gasoline plant remark that he would rather carry "nitro" than gasoline is evidence of the fear in which it is held.

Gasoline cannot be produced from all natural gases, at least not in paying quantities. As a general thing, the paying proposition is in connection with oil wells. In some cases the profits have been very great, and in the present state of the art it is not believed that the highest efficiency is yet attained. Any one can see that the process is one of conservation of the very best order, and fetches to the owner "a smile that won't come off."

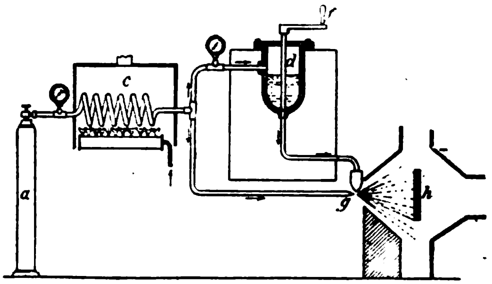
After a test of one month at the Gorgona shops, Panama, the sand blast method of cleaning, and the pneumatic painters in use, have demonstrated the economy of the method over the former method of hammering the scale from the cars and painting them by brush.

NEW METHOD OF METAL COATING

A Swiss engineer, M. Schoop, has invented a new process for producing a metal coating on various metals, by spraying a cloud of finely atomized metal particles upon the surface to be covered. The new method was first demonstrated before the Engineers' and Architects' Association at Zurich, and has since been presented also before the French Academy of Sciences by Prof. D'Arsonval.

The metal is melted in a crucible *d* and is allowed to escape by a capillary opening *g*, under a pressure placed upon the surface of the melted metal by compressed air or other gas. Just after emerging from the opening, the thread of melted metal escaping under pressure is atomized by a gas or steam spray, so as to form a cloud of finely-divided metallic particles. Through this cloud is passed very rapidly the object which is to take the coating. An inert gas is best used to give the pressure on the melted metal, while another kind of gas can be used for the atomizing. If desired, such a gas may be used at this stage as will oxidize the metal, so as to give a coating of oxide instead of metal. The action of depositing the metal appears to be as follows:

When the metal is atomized in the form of a cloud, its particles strike the surface which is to be covered, but here they lose their original spherical form and are flattened out upon the surface into blotches which unite together and form a continuous layer of a certain tickness over the object. The metal is projected at a very great speed from the orifice, and this explains why the particles which are no longer liquid when they reach the surface of the object, are able to make up a homogeneous and very compact layer whose density is about the same as for the metal in its usual state, as experiments made at the Zurich laboratory have shown. Even though the metal has been melted in the crucible, the vapor is not very hot when it is projected out by this process, so that there is no difficulty in depositing it upon readily combustile substances, such as paper, wood, celluloid, or even animal tissues. The deposits of metal thus prepared are much harder than those obtained by the usual methods. For instance, tin, when cast, showed only a little over one-half the hardness of tin applied by the Schoop



METAL COATING APPARATUS.

process, when tested by the Brinell method of dropping a steel ball and observing the mark made by it. Under the microscope there appeared to be no difference as to the fineness of the structure as compared with the ordinary metal.

The new process lends itself to a number of interesting and useful applications, since most of the common metals can be deposited in layers upon various surfaces. One very important use should be the coating of structural iron to protect it against weathering. The operation should be readily applicable to finished structures, such as cranes, bridges, etc. There should be no difficulty in making the coating apparatus portable, so that it can be used on the spot to coat the ironwork all over with a non-rusting metal layer more durable than any kind of paint, and, as the inventor claims, also more economical. Numerous applications which suggest themselves for the new process might be divided into two classes. On the one hand we may wish to coat an article for decorative or protective purposes; on the other hand the aim may be to form a crust over an article, in order to subsequently strip it off in form of a mold. Additional uses of a somewhat different character are the coating of wood, porcelain or glass, to render their surfaces conductors of electricity; and the metal coating of glass mirrors, whether parabolic, spherical, plane, or of any other kind.—*Paris Correspondent, Scientific American.*

One of the most marvelous things is the burning of a jet of hydrogen gas in liquid air. The smoke that arises from the combustion floats off in the air as pure snow. A flame burning brilliantly in the midst of a liquid, with snow given off for smoke!

COMPRESSED AIR LEAKAGE ON THE PANAMA CANAL

A series of tests has been made of the air mains in the Central and Pacific Divisions to determine the amount of waste from all causes, and the proportionate share of the cost that should be borne by each division. It was found that there was practically no leakage in the main between the Rio Grande compressor, and the beginning of the Pacific Division lines. On June 11, a test of all the mains and laterals showed a total loss of air of 24.89 per cent on the basis of the output of May, of which only 5.8 per cent. was on Pacific Division lines. At the time of the test, the flow of air into the Pacific Division mains was measured by a meter. It has been determined to cut out all laterals for the Pacific Division, north of the flow meter, and, since there is practically no leakage between the compressor plant and the meter, the proportion of cost of air compressing to be borne by the Pacific Division will be determined by the flow through the meter.—*Canal Record.*

HIGH ALTITUDE TESTS ON BLOOD

Under the auspices of the British Royal Society, Dr. J. S. Haldane and Dr. Gordon Douglas, both of Oxford University, England, and Dr. Yambell Henderson, of Yale University, New Haven, Conn., have begun a series of experiments on the summit of Pike's Peak, Colorado, to determine the effect of high altitude on human blood. The two former last summer experimented in this matter on top of Teneriffe, off the west coast of Africa. Their findings indicated that at high altitudes the red corpuscles of the blood increased in proportion to the amount of blood in the body. The object of further experiments is to determine whether the number of red corpuscles is actually increased, or whether the blood simply thickens by evaporation of water. In this connection it might be of equal interest and value to have the effect on respiration and the blood accurately determined by penetrating into deep mining shafts.

DRILLING RECORDS OF HAMMER DRILLS

Hammer drills in a Pennsylvania limestone quarry, where the stone is hard but is readily chipped, drilled holes of about 1¾ in. diameter to a depth of 4 ft. in 18 minutes, and in a test run 14 in. of hole was drilled in 4½ minutes. Sharp bits were found to cut 3 in. more than dull ones in a test run of 4½ minutes. No trouble was experienced with sludge in depths up to 5 ft. Similar drills sunk rows of holes for cutting sandstone blocks in an Ohio quarry at the rate of 25 sec. per hole of 18 in. depth. In block-holing hard granite in a crushed-stone quarry, holes averaging 18 in. in depth, but reaching 48 in. in some cases, were drilled at an average rate of 1 in. per minute, the speed sometimes reaching 2½ in. per minute. The air pressure averaged 80 lb. per square inch. In this case six men, each with a hammer drill, replaced 18 hand-drillers at a saving which is summarized as follows: Eighteen hand-drillers, at $1.50, $27. Six hammer drillmen, at $1.50; air-compressor operator, $3.50; one ton coal, $3; repairs, 60 cents; oil, etc., 30 cents; interest on plant, 60 cents; total, $17. This gave a saving per day of $10. The blacksmithing is not included as it was about the same in both cases.—*Engineering Record.*

WD DO NOT BELIEVE IT

GRAND FORKS, B. C., June 3.—An English sparrow flew into one of the compressor wheels at the Granby smelter April 15 and came out alive when the works was shut down recently. The wheel is thirty-three feet in circumference and travels 110 revolutions a minute. According to calculations, the bird traveled 40,590 miles in its forty-one days' journey. The bird lived without food or water, but was apparently in good condition when the compressor shut down, as it flew around the office several hours before escaping.—*Press Dispatch.*

[The arithmetic is not correct, anyway, and compressors are not run so long without a stop.—Ed. C. A. M.]

"I saw a sight down in Oklahoma last week that I never witnessed before," said "Jim" Findlay yesterday. "I saw 8,000 acres of wheat being threshed by a gas-driven threshing machine. Two immense gas wells were recently brought in near Ponca City, in Kay county, and Miller Bros., of 101 Ranch have piped the gas three miles to their ranch. The big wheat field is gridironed with pipe lines and the thresher is moved about the field, coupled to one of the pipe lines and started by the striking of a match.—*Kansas City Journal.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

THE UNIVERSAL COAL CARVER

While we are looking after the savings in practical coal mining there is nothing more really worth saving, nothing which it is more necessary to save, than the time and strength of the miner. The operation of coal getting is simply that of cutting out successive portions of the embedded mass. A knife such as that with which a loaf of bread is cut would be the ideal coal carver, but no one yet has found it. Next to that would be a saw, but the saw insists upon conditions which make it also impracticable, and the best we can do by any mechanical contrivance yet developed is to cut in slits as narrow and deep as possible and then to break the coal away by light blasting or otherwise.

The coal puncher idea is to work in a slit horizontally as far as possible under the coal and then break it down. Although it is not a very thin or precise slit that the coal puncher makes, still it suffices, and the device enables the men to get out more of the coal in a given time, but the handling of the machine profitably cannot be anything but real and strenuous work. The puncher, although getting to be extensively used, still insists upon its conditions. Its work is simply that of undercutting in seams nearly level. When pitching seams are to be worked there is additional labor in holding and handling the machine, and even then the incline must be only a slight one.

Here the radialaxe comes in, to work at any angle just as well as at any other. It does not necessarily take hold in cases where the horizontal working puncher is balked, but it can do all the work of the puncher right through. When the radialaxe is actually working the operator's work in manipulating it is easy. As compared with handling the puncher the man may be said to be resting when he is working. There is more work, in fact, in setting up and securing the radialaxe than in running it, but this is no more than the handling of the ordinary rock drill.

The precision with which the radialaxe bit is carried and guided makes the cut as thin as possible, so that comparatively little fine coal and dust is produced. This precision of location and perfect control of direction constitute an important feature when the radialaxe is used in cutting out a fireclay or slate band, such as often occurs in a seam, and which, if not removed, impairs the market value of the entire output. It would scarcely be thought that it could be provided for the proprietor of a coal mine to be able to boast of the excellence and purity of his product on account of the precision of working of the machinery employed, this being usually the privilege of the manufacturer alone.

Thus far we have thought of the radialaxe coal cutter as taking its cut from the puncher and doing its work also horizontally or in planes paralleling the seam, but in addition to this it cuts out lines of employment for itself which are independent of the puncher. Its more comfortable, and, as we might say, mort natural, way of working is in making vertical cuts, and in some cases by this means it may put the puncher entirely out of business. It may be used to rapidly cut a central slit vertically in the face of the coal, and then the coal can be broken down and thrown out by light shots, or otherwise.

The work of the machine may be laid out in the mind as the making of either lines or dots. The lines may be horizontal or vertical or at any angle, representing the slits or cuts which it is the business of the machine to make, and the dots are simply holes driven directly forward, as the radialaxe, stopping the radial feed, is besides all else a complete rock drill. Such a machine acts not only to conserve the effort of the coal miner, but also of the material which is being cut, and thus in a double sense becomes an element in the conservation of natural resources.

ATMOSPHERIC AGENCIES AND SOIL ACTIVITIES

Considering the soil factor, or more properly, factors, it is now clearly recognized that the living plant, or at least that part of it in the soil, the root, is always in motion while the plant lives. The soil solution, the natural nutrient medium for plants, is always in motion; for when water falls upon the soil there is always a movement into and through the larger soil interstices, mainly by gravity, and when the precipitation ceases there is immediately surface evaporation accompanied by a return to the surface of a portion of the absorbed water through the capillary interstices and in films over the soil grains. In like manner, the soil atmosphere is constantly changing, and it is obvious that the life of insects, bacteria, etc., in the soil is a process of growth and decay, and therefore of constant change.

The solid particles of the soil are likewise always in motion. The activities of insects, crawfish, earthworms, burrowing animals, etc., in translocating soil material are now recognized as being, in the aggregate, very large. Freezing and thawing produce considerable motion of soil material. It has recently been shown that every change in the moisture content of a soil is accompanied by necessary movements of the soil particles, and by changes in their state of aggregation, and it is obvious that under field conditions a soil is always either drying out or being wetted.

Besides these movements of the solid soil particles, resulting in profound changes from time to time, not the least of which is an interchange of the material between soil and subsoil, there is constantly in process a translocation of soil material from field to field, from area to area, and frequently over large distances. As a result, soils are notably complex as regards their composition—more complex by far than the individual rocks or rock magmas from which they have been derived; and, speaking generally, practically all soils contain all or nearly all of the common rock-forming minerals.

To produce this state of affairs, two natural agencies are competent—water and wind. The effect of water action in translocating soil material is enormous, but restricted by the facts that water can run down hill only, and is but occasionally in action. The effects of wind action are quite as important, for the wind is constantly in action, to a greater or less extent, and blows up hill as well as down. While the effects of water action may be more striking and impressive, the effects of wind action are quite as important, from the point of view of the soils, if not of the surface geologist.

It is clear that not only has the wind been an important agent in the past in soil translocation, but that it is equally important to-day, not only in forming and modifying great deposits and areas of soil, but in modifying and affecting more or less profoundly every farm and field. It is one of the most important factors in the complex system of soil movement affecting soil fertility. No fact in our knowledge of the soil is now more clearly defined than that the soil of a particular field is not just the soil that was there a few years ago, or just the soil that will be there a few years hence. Moreover, it appears that when this translocation is at a "normal" it is beneficial, and an important agency in maintaining fertility. But when excessive, "wind erosion" is one of the most baneful of the farmer's troubles. Its prevention and control is therefore one of the great practical problems of agriculture, one easily met in the majority of cases, but sadly neglected, nevertheless. Methods for controlling the action of the wind must be devised. Windbreaks, cover crops, rotation schemes, cultural and other methods are actually in use to this end, more or less successfully; but in few localities can it be said that the problems have been met with complete success, and an unusual opportunity is open for experimental work of a most useful kind.—*Bulletin No.* 68, Bureau of Soils, Dept. of Agriculture.

MISINFORMATION ON CONPRESSED AIR PRACTICE

[The following interesting matter is a portion of an article upon "Compressed Air in Mines," by Richard Sutcliffe, which appeared in a recent issue of *The Iron and Coal Trades Review, London.* We reprint it here chiefly as a curiosity. The article ostensibly and quite earnestly advocates the use of compressed air in mines. It may have been written a quarter of a century ago and just now resuscitated for publication. Whenever written it is more wrong than right all through, its errors being so glaring that it is not here necessary for us to call the attention of our readers to them in detail.]

Many and various attempts have been made to produce a satisfactory air compressor, but such an one has not yet been built, nor, in the writer's opinion, is there likely to be one whilst the matter is treated so illogically by makers of this class of machinery. But a little time ago we were asked to expect great things from compressing air in stages. These great things, however, have not materialized. Sixty pounds per square inch is ample pressure for all requirements, and this is easily got without stage compression; indeed, higher pressure is inconvenient for coal-cutting, conveying, and suchlike machinery, where hose pipes have to be used.

In order to deal properly with compressed air it must not be considered as though it were steam, for although compressed air and steam are alike in some essentials, they differ widely in others. In order to get the best results from steam it must be used at a high temperature and hence the most economical are the high-speed engines, and as compressing is done at present it is possible in speeding up the engine to over-run the compressor and so get no compressed air at all. The cause of this is, of course, that we have only atmospheric pressure to fill the cylinder and operate the inlet valves. A further disadvantage of the high-speed compressor is that the air is unduly heated, a clear proof that the best work is done by the slow-running machine.

Even when the air is compressed in the present illogical manner, it is all too often allowed to waste in driblets before doing any useful work. If, as is often the case, this happens on the surface, what may we expect below ground, when it is remembered that there are 586 joints in each mile of pipes laid, so that a small leak at each joint must and will leave a low pressure or small volume at the far end. These are trifles, perhaps, and in practice are too often forgotten or ignored, but they are trifles which are continuous and persistent and often form the dividing line between success and failure.

In former years the installation of such plants was often of an experimental nature and seldom received the care and forethought they now claim, and although every colliery manager knew that the friction of air in motion varied with the square of the velocity multiplied by the rubbing surface, etc., yet 3-in. or 4-in. pipes were the sizes often chosen to convey the air, with the result that there was not a working pressure at the coal-cutters, even when the compressor was blowing off at 60 lbs. pressure or more. Where air has to be transmitted, say for a mile, to two or three coal-cutters, the pipes should not be less than 8 in. in diameter, and the smallest leakage should not be permitted in the whole distance.

To sum up the subject of the use of compressed air in mines, it certainly appears that were it more expensive than it really is, it would still be a most desirable adjunct, even if used solely as a factor of wise precaution. In order to produce compressed air economically, it should be done by a slow-running compressor, whatever the form of prime-mover employed to operate it. The compressing engine should be fitted with governors actuated by the air pressure so as to prevent waste in blowing off air at the receiver. With these few precautions compressed air is quite capable of economical use in operating the various machines below ground, and with the present trend of legislation will probably be the only practical operating power permitted beyond the safe zone at the pit bottom.

COMMENT AND SUGGESTION ON THE BRITISH AIR RACE

The air race carried out in these islands since our last issue cannot be described from whatever point of view we regard it as anything else than splendid. As a spectacle it was inspiring; as a significant indication of the progress being made in aeronautical engineering it was surprising; and as an exhibition of sheer brutal pluck on the part of the aviators competing, it was magnificent. To fly over a set course of a thousand miles or so, and to do this in the face of fog, hail, rain, and blinding sun, is in itself a sufficiently great achievement for these early days of the art. But when we reflect that at least two of the aviators, "Beaumont" and Vedrines, kept to the scheduled time allowed for the different sections of the route with a precision which many railways might envy, we begin to grasp some idea of the portent which the art of artificial flight bears for the future and of which the shadow is already at our feet.

Add one other fact. Before the race commenced five essential parts of each aeroplane and five essential parts of each motor were officially stamped. For a competitor to establish a claim to the prize at least two of each sets of parts of his machine had to pass through the entire contest unchanged. As a matter of fact, the winner returned with all the marked parts in position. Here surely is proof that the engineering side of aviation is no less wonderful than the other. Man and motor have conjointly been tested, and the verdict pronounces them as equally successful. Twenty-one competitors left Brooklands last Saturday afternoon, and of these seventeen reached Hendon hard on one another's tails. Since then one by one their number has been diminished through accident and delay until, as Edinburgh, Glasgow, Carlisle, Manchester, Bristol, and Brighton were in turn passed, principal interest settled down on four, "Beaumont," Vedrines, Valentine, and Hamel. The first named was the first to reach Brooklands on the return trip, and won the £10,000 prize offered by the *Daily Mail.*

But when all is done, when the prize is awarded, and when the sensations of the moment abate, some thought may perhaps be given to the cost of such a race. We do not mean the monetary cost—for aviators have every chance of becoming wealthy at a moment's notice—but the cost in the way of lost nerve power and of shortening of life which the strain of flying exacts from the airman. The rapidity with which an aviator springs into public prominence is almost equalled by the suddenness of his retiral as an active exponent of his art. Those who a year ago were foremost in the field, and who have escaped the death continuously waiting for them while they were flying, have all retired from the active participation in public contests. The reason for this is only too obvious, and while we believe that chance is being gradually eliminated from the domain of aeronautics, it is certain that the nervous tension to which an aviator is subject during all the time of a flight is a more serious barrier, and one which will have to be reckoned with in the near future. It will, for instance, almost certainly entirely preclude for all time the participation of the majority of people in the pleasures and dangers of artificial flight.—*The Engineer,* London.

TUNNEL AIR AND THE CORROSION OF RAILS

Mr. Percy Longmuir in a paper before the Iron and Steel Institute of Great Britain, gives an account of investigations of the acid corrosion of rails in tunnels on the main lines of several English railways, involving analyses of tunnel air, tunnel water and the scale on the rails.

One of the distinct features in connection with the corrosion of steel by atmospheric action is an appreciably high content of sulphur. Samples of rust taken from widely different localities and environments showed distinctly higher sulphur content than the steel from which the scale was formed. Samples from main-line rails at four points remote from each other showed a sulphur content of 0.24 to 0.37 per cent. in open situations, and in one case, in a cut leading to a tunnel, showed 0.57 per cent., or, in terms of SO_3, 0.61 to 0.93 per cent. and 1.44 per cent., respectively. The general investigations in this connection show that samples of rust from rails laid in normal positions do not contain less than 0.2 per cent. sulphur, whereas the average sulphur content of British rails is below 0.06 per cent.

The difficulties of sampling tunnel atmospheres were recognized, in that a variation in the currents of air was found even in the absence of traffic, and a variation of the sample with the level from which it was taken. The results were therefore taken to refer only to the particular sample, and not necessarily as indicating the general conditions. Five samples, taken within a period of two hours in one wet tunnel, showed an acid content of 0.08 to 0.24 per cent., four out of the five being above 0.16 per cent.

In the same tunnel the sulphur content of the air was shown by the fact that water draining into the tunnel contained sulphates to the extent of 0.25 grains per gallon, expressed as SO_3, whereas that draining away from the track in the tunnel contained 1.59 grains per gallon and that standing in stagnant pools contained 13.60 grains per gallon.

An examination of the sooty deposit on the side walls showed the presence of 2.83 per cent. of sulphur, of 7.10 per cent. of SO_3. Two analyses of corroded deposits from the rails in the tunnel showed 3.68 and 2.89 per cent. of sulphur, respectively, or 9.22 and 7.29 per cent. of So_3.

About the same time as the above, an investigation was made of a second main-line tunnel, which was well drained, had no standing water and was generally of a dry character. Four samples of the air, taken within 1½ hours, showed acid traces in two cases and 0.10 per cent. acids in the other two. In general the acids were practically negligible in the tunnel air.

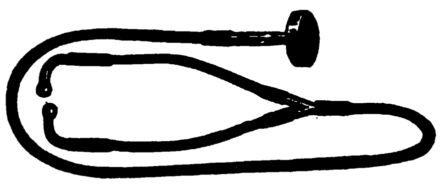
NEW BOOK

Railway Shop Kinks. Compiled by Roy V. Wright, New York, *Railway Age Gazette.* 290 pages, 9x12 inches, 803 illustration, $2.

The prizes offered by the *Railway Age Gazette* for shop "kinks" from railway shops brought out an astonishing number of labor-saving or otherwise profitable apparatus and contrivances in actual and successful use which were successively shown in the pages of that journal and are here reproduced in similar form. The work in railroad shops is so nearly like that of steam engine and machine shops in general as to render these kinks widely applicable. Pneumatic devices are shown in great variety.

Practical Applied Electricity. By David Penn Moreton, B. S., E. E., Chicago. The Reilly & Britton Co., 440 pages 7x4½ inches, 340 illustration, $2 *net.*

This, as the title page further tells us, is "a book in plain English, for the practical man." It is a clear, concise and comprehensive compendium of information such as the man of the ship or the man who is in charge of or in any way has to do with electrical apparatus will need to know. The language is plain, the computations are simple and the examples are to the point.



AN AIR COMPRESSOR STETHOSCOPE

The little halftone above shows an air compressor or steam engine stethoscope or knock finder. It is applied to cylinders, valve chests and other parts where there may be internal and abnormal knocking, known or suspected, and it intensifies the sound in a way which greatly facilitates the locating of the trouble.

No explanation is required. The sensitive corrugated diaphragm is lightly pressed against the machine surface and whatever knocking there may be within is greatly intensified as it reaches the ears through the air tubes. The instrument is moved about over the surface until the point of greatest sound intensity is found which locates the knock within. It can of course be used upon moving machinery of all types.

The Vibracator, as it is named, is made by Hopewell Brothers, Newton, Mass.

TESTING THE "CEMENT GUN" AT PANAMA

A test of the cement gun as a means of coating the surface of rock in Culebra Cut to prevent disintegration is in progress. The so-called "gun" is a compressed air apparatus [described in COMPRESSED AIR MAGAZINE, June, 1911] for forcing cement and sand from a tank through a nozzle, at the mouth of which water is mixed with these materials, forming a concrete which is cast upon the surface to be coated with such force as to become part of the rock itself. For the work in Culebra Cut, the apparatus is mounted on a flat car, at one end of which, is a bin for mixing the sand and cement. One day's supply is carried, or enough to coat 200 square yards with a layer one inch thick, in nine hours of work. The car was rigged up at Empire shops, and the machine was tested by allowing it to coat a boiler with asbestos. Five men are required in operating the plant, their work including mixing and delivering the materials, and operating the gun.—*Canal Record.*

NOTES

A single block of stone estimated to weigh 8000 tons is reported as recently blasted out in the Wilkensen stone quarries, Washington. It was about 56 ft. long by 50 ft. high, which should make its third dimension about 35 ft.

Some astonishing engine speeds were noted in a recent automobile race in England. One engine made 2,490 r. p. m. and 1,794 feet per minute piston speed as an average for the race, the maximum speeds being considerably higher.

Ammonia refrigeration tanks exploded July 30 during a fire at Brockton, Mass., which destroyed the Satucket Block and part of the Holbrook Building. Three firemen were badly injured. The tanks were a part of the cold storage plant of the Brockton Public Market Co.

A mine rescue tournament will be held at the experiment station of the Bureau of Mines at Arsenal Park in Western Pennsylvania on Sept. 16. Contests will be held in first-aid work, fire fighting and the use of oxygen helmets, and a number of new safety devices will be given a trial.

In one minute, in a state of rest, the average man takes into his lungs about 8 liters or 48.8 cubic inches of air. In walking, he needs 16 liters or 97.6 cubic inches; in climbing, 23 liters or 140.3 cubic inches; in riding at a trot, 33 liters or 201.3 cubic inches; and in long distance running, 57 liters, or 347.7 cubic inches.

The Illinois Traction System has equipped some of its new cars with air signal whistles in the place of bell signals for the use of conductors in signaling the motormen. The signal is operated by a bell cord, but the air whistle is believed to be more certain of operation than the bell. If this proves to be the case the whistles may be installed on all the cars of the company.

We are becoming familiar with denatured alcohol and now we are beginning to hear of denatured sugar, which in France is not to be subject to duty when used by textile manufacturers in spinning and weaving. The crystallized cane sugar is to be mixed in fixed proportions with blue vitriol. Glucose also comes under this heading, including invert sugar and dextrose, which are to be mixed with formaldehyde and ammonia sulphate.

The preservation of iron in concrete is again attested in the demolition of an old gasometer at Hamburg, Germany, as reported by *Fer et Acier,* of Brussels. This structure was built about 1852 and when taken down the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatsoever of rust.

At the laboratory of the Mines Company of America's property at La Colorado, a device for drying pulp and slime samples is installed which is of interest, because of its simplicity and effectiveness. Instead of drying the samples by heat, the moisture is extracted by a vacuum process, employing the principle of the Moore filter. A canvas is stretched across the bottom of a small sample-drying pan, and the vacuum applied at the bottom by a hand pump. The pans are 6 in. across and 2 in. deep.

The Hungarian government has decided to monopolize the tremendous natural gas source recently discovered at Kissarmas, in Transylvania, of which the daily yield amounts to 26,000,000 cu. ft. This is the most important source of gas in the world so far discovered. The gas comes out of the ground at a pressure of over 30 atmospheres. In view of the tremendous pressure, it is quite impossible to reach the orifice of the well, which promises to become a source of wealth for the whole country.

In 1908 the total value of stone products in the United States was $65,712,499.00, of which Vermont produced $7,152,624.00 and stood for the first time a leader. Of this total $18,420,-080.00 represented the value of granite. Vermont produced $2,451,933.00 and led all states. The value of marble produced during that same year was $7,733,920.00, of which Vermont supplied $4,679,960.00 and again stood first. Of the slate produced the totals are not obtainable, but it is certain that Pennsylvania led Vermont.

It is stated in *Cosmos* that recent researches seem to indicate that ozone is far from being the ideal air sterilizer and purifier. In experiments especially directed toward determining the efficiency of ozone in workshops it was found that while the reduction in the number of microbes was manifest, so that perfect sterilization by its use could be obtained in 10 or 12 hours, a desirable degree of purification could not be obtained unless the percentage of ozone passed the limit where it begins to be noxious, if not dangerous, to the human organism.

The volume of carbonic acid exhaled by a human being in the course of twenty-four hours is put at about 100 gallons; but by Boussingault's estimate, a single square yard of leaf-surface, counting both the upper and the under sides of the leaves, can, under favorable circumstances, decompose at least a gallon of carbonic acid in a day. One hundred square yards of leaf-surface then would suffice to keep the air pure for one man, but the leaves of a tree of moderate size present a surface of many hundred square yards.

East of the Missouri River in South Dakota, it is estimated, more than one thousand artesian wells now exist, drawing their water from the supply carried by the underlying sandstone formation, and supposed to come from the Black Hills and the Rocky Mountains. These wells, used mainly for irrigation purposes, are from 500 to 1,000 feet deep, and the pressure of water in the eastern part of the State is sufficient to give a surface flow, except on the highest lands. One well yields 3,292 gallons per minute, and furnishes power for a flour mill by day and for an electric light plant by night.

The city of Sherman, Tex., has recently closed contracts for the purchase of machinery for pumping water from wells in connection with the water-works system by means of air compressors. The contracts were placed with the De La Vergne Machine Co., 1107 E. 138th street, New York, for one 180-horse-power type "FH" engine, and with the American-Diesel Engine Co. of St. Louis for one 170-horse-power Diesel engine. Each engine is to operate a 700-foot Ingersoll-Rand two-stage compressor and a small triplex pump, both pump and compressor to be operated by belts from the engines.

A large subaqueous tunnel is approaching completion at Hamburg, the work having been in progress about five years and the cost approximating $2,640,000. The tunnel is being driven 20 ft. below the bed of the River Elbe and comprises two tubes 19.88 ft. in diameter and 1476 ft. long; the river is about 33 ft. deep at midstream. The tunnel ends at the one bank in the suburb of St. Pauli and at the other in Steinwarder, another suburb of Hamburg. The buildings on both sides of the river forming the entrances to the tunnel, with their copper-coated domes and ornamented with reliefs and pillars, will constitute noteworthy sights of the town. At each entrance there are six elevators for pedestrians and vehicles.

The fixation of atmospheric nitrogen for fertilizer purposes is growing rapidly in importance, and its remunerativeness is plainly shown in the report presented recently at a stockholders' meeting by the president of the Norske Hydroelektriska Aktie Sellskap, Norway, which is capitalized at about £400,000. During last year dividends amounting to 8 per cent. on the preferred stock and 5 per cent. on the common stock were paid. The gross earnings during the year amounted to £240,000, of which £70,000 was net income. The company is now developing, in conjunction with other financial interests, some 135,000 h.p. in different parts of Norway, all to be applied to the manufacture of nitrates from the atmosphere.

In a few months an interesting engineering feat will have been accomplished in Hamburg. This is the construction of a gigantic tunnel beneath the river Elbe which has cost nearly eleven million marks, and has now been in progress for nearly five years. The tunnel, which comprises two tubes 6.06 m. in diameter and 450 m. long, is 6 m. beneath the bed of the river, which in the middle is 10 m. deep where the tunnel crosses. The tunnel ends at the one bank in the suburb of St. Pauli and at the other in Steinwarder, another suburb of Hamburg. The buildings on both sides of the river forming the entrances to the tunnel, with their mighty copper-coated domes and ornamented with reliefs and pillars, will constitute noteworthy sights of the town. At each entrance there are six elevators for pedestrians and vehicles, which operate almost without attendants, the starting, speeding up, slowing down, and stopping all being effected automatically.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 4.

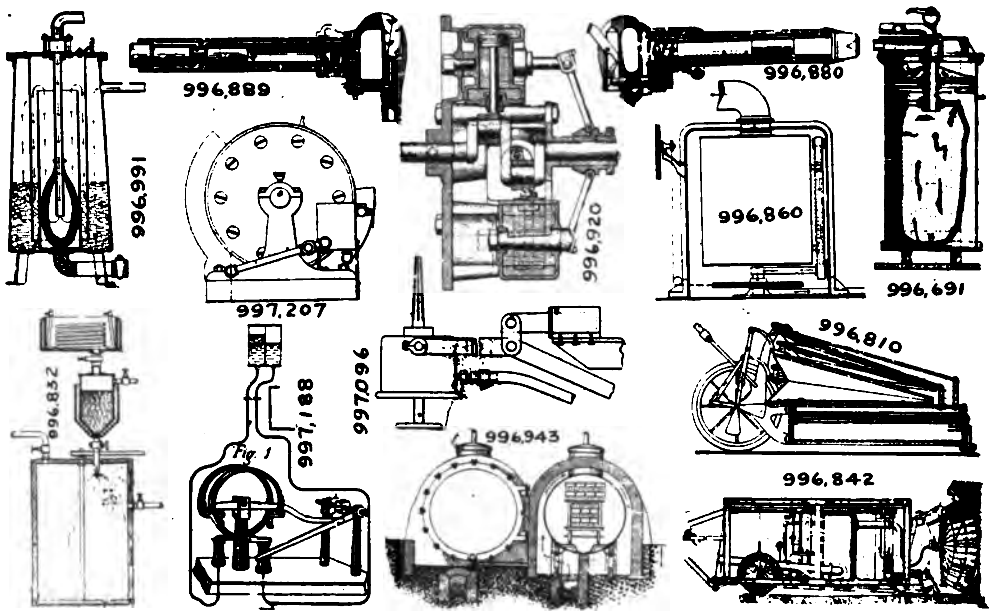
996,691. CLEANING APPARATUS. James L. Wallace and Harvey Wallace, Chicago, Ill.

996,705. PROCESS OF PURIFYING AIR. Anson K. Cross, Winthrop, Mass.

2. The method of purifying air comprising passing it through a suitable liquid electrolyte and adding to the air oxygen which is formed by electrolysis of the liquid performed in such a manner that the oxygen is conducted into the air current while the other gaseous constituent of the electrolyte is prevented from mixture with the air.

996,771. APPARATUS FOR DRYING AIR. James B. King and William E. Hughes, Clyde, Ohio, and Frank W. Hall, Detroit, Mich.

996,810. PNEUMATIC CARPET-CLEANER. Harold M. Sturgeon, Erie, Pa.



Pneumatic Patents July 4.

996,832. DESICCATING MILK. Charles H. Campbell, New York, N. Y.

996,842. TUNNELING-MACHINE. George A. Fowler, Denver, Col.

996,850. COMBINED OZONE GENERATOR AND INHALING APPARATUS. Robert P. Guiley, Akron, Ohio.

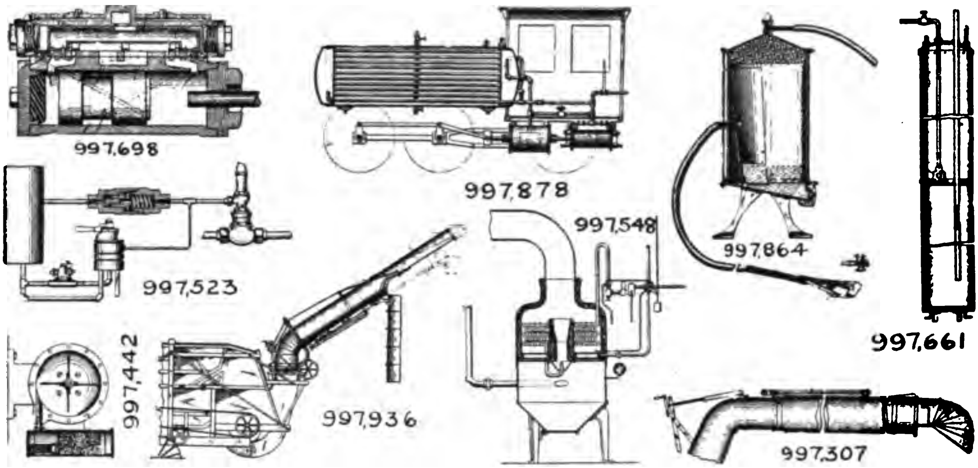
996,860. APPARATUS FOR CLEANING AIR OR GAS FILTERS. Paul Kestner, Lille, France.

996,880. PNEUMATIC HAMMER. Samuel Oldham, Philadelphia, Pa.

996,889. PNEUMATIC HAMMER. Henry Schumacher, Denver, Colo.

996,920. TRANSMISSION-GEAR. James H. Gibson and Henry L. Whitman, St. Louis, Mo.

2. In a transmission gear, the combination of a pair of shafts, one of which is provided with a plurality of cranks, and a plurality of fluid controlled means, each carried intermediate of its ends by the other shaft and each having a piston way and by-pass located wholly therein,



PNEUMATIC PATENTS JULY 11.

and pistons in the piston ways having piston rods connected in pairs with said cranks.

996,943. DRIER. LOUIS E. ROGERS, Chicago, Ill.

1. The combination with a kiln for burning clay articles, of a substantially air-tight drying chamber, a housing inclosing said chamber and spaced apart therefrom, a waste heat conduit connected with the kiln and provided with openings in said conduit whereby the heat is caused to circle exterior of the chamber and to communicate heat thereto, and means for maintaining a partial vacuum in the chamber to withdraw therefrom the vapor generated by the heat from the articles being dried therein.

996,991. VACUUM APPARATUS. PAUL C. LITTLE, Carnegie, Pa.

997,096. PNEUMATIC REAMER. JOHN S. SCHOFIELD, Gershom, Forest Hall, and JOHN SWIFT, Hull, England.

997,207. AIR-MOTOR. JAMES PETERACEK, Oberlin, Kans., administrator of Anthony Kolsky, deceased.

13,266. (Reissue). METHOD OF PREPARING LIQUID HYDROCARBON FOR COMBUSTION. EDWARD J. WIGGINS, Chicago, Ill.

1. The method of preparing liquid hydrocarbon for combustion, which consists in conducting separately liquid hydrocarbon and air, both in unheated condition, to a point of mixing the two while in such condition, spraying the unheated mixture in its course to the point of consumption into the atmosphere, thereby atomizing it while in such unheated condition and mixing more air with the resultant fluid, and thereupon immediately subjecting the mixture to a "cracking" temperature in said course.

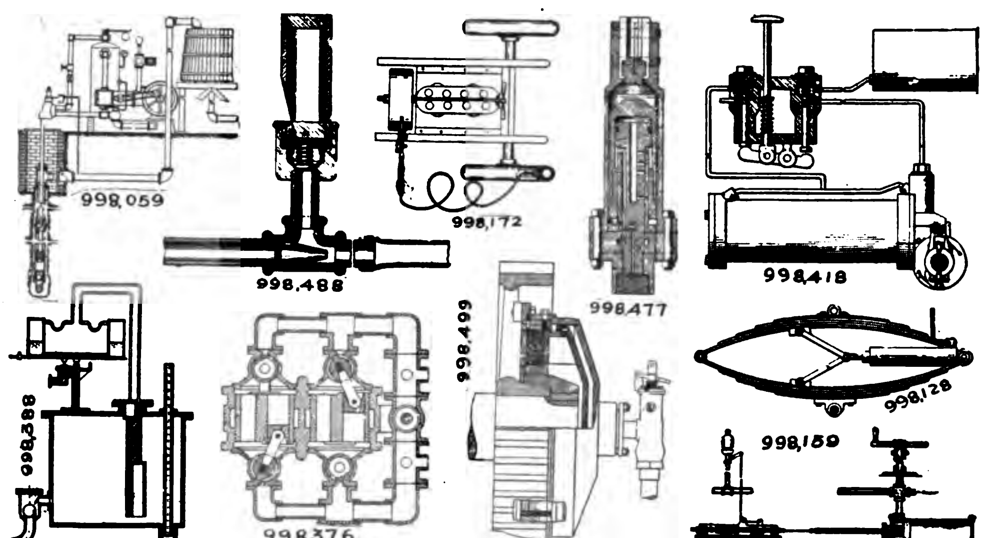
JULY 11.

997,307. PNEUMATIC STACKER. WALLACE F. MACGREGOR, Racine, Wis.

997,339. OZONIZER. JAN STEYNIS, New York, N. Y.

997,442. AIR FILTER AND PURIFIER. HARRY K. DIFFENDERFER, Lancaster, Pa.

997,523. DUPLEX PRESSURE-CONTROL APPARATUS. WALTER V. TURNER, Edgewood, Pa.



PNEUMATIC PATENTS JULY 18.

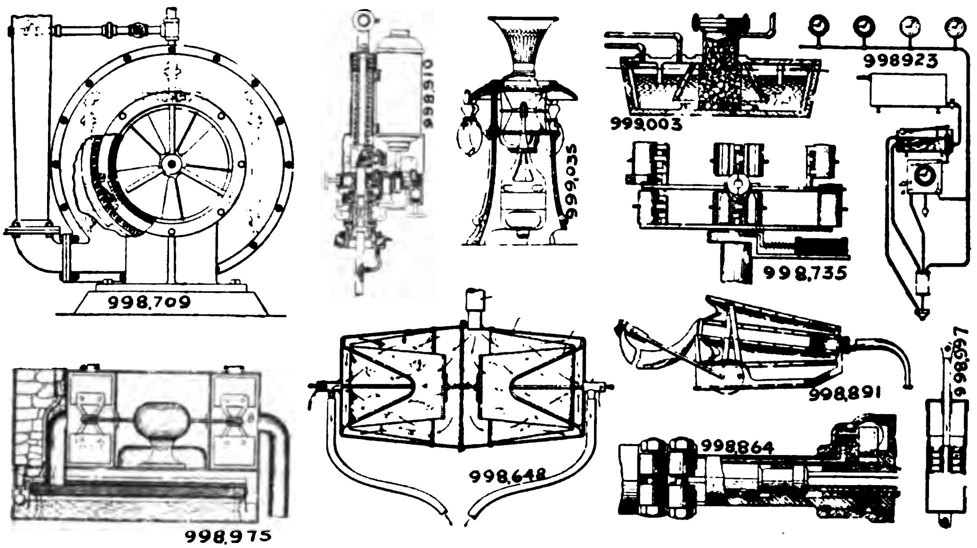
997,548. VACUUM CLEANING APPARATUS. LOUIS W. G. FLYNT, Rochester, N. Y.
997,661. PNEUMATIC WATER-ELEVATOR. VERNOR L. ELLISON, Shawnee, Okla.
997,698. MINING-MACHINE. ERNEST PENBERTHY, Painesdale, Mich.
997,732. PUMP FOR PORTABLE VACUUM-CLEANERS. IRVING K. BAXTER, Utica, N. Y., and CHARLES F. BARRETT, Bridgeport, Conn.
997,864. VACUUM-SEPARATOR. HERBERT A. SIMPSON, Homer, Mich.
997,872. AIR-COOLING MACHINE. WILLIAM W. WALLER, Washington, D. C.
997,878. HOT-AIR LOCOMOTIVE. SAMUEL J. WEBB, Minden, La.
997,936. PNEUMATIC STACKER. FREDERICK L. SATTLEY, Indianapolis, Ind.

JULY 18.

998,059. PUMPING SYSTEM. FREDERICK C. WEBER, New York, N. Y.
998,313. PNEUMATIC-ACTION FOR PIANOS. PETER WIGGEN, Chicago, Ill.
998,376. FLUID-PRESSURE APPARATUS. THOMAS MOSS, Portsmouth, and WILLIAM MOSS, Wigan, England.
998,388. VALVE-GEAR FOR APPARATUS FOR RAISING LIQUIDS. HARRY PAULING, Gelsenkirchen, Germany.
998,418. ENGINE-STARTING DEVICE. GREGORY J. SPOHRER, Franklin, Pa.
998,477. PNEUMATIC HAMMER. CHARLES F. DUVAL and HENRY MCDERMOTT, Leadville, Colo.
998,488. SIGNAL. BARRINGTON FERGUSON, Fernie, British Columbia, Canada.
998,499. FLUID-OPERATED SAFETY-CLUTCH. WILLIAM ALEXANDER GORDON, Shelton, Conn.

JULY 25.

998,648. DUST-COLLECTOR FOR VACUUM CLEANING SYSTEMS. GULBRAN SNIPEN, St. Louis, Mo.



PNEUMATIC PATENTS JULY 25.

1. In a pumping system the combination of a source of fluid pressure supply, a liquid chamber having inlet and discharge valves, means for admitting fluid pressure from said supply to said chamber, and for exhausting said pressure therefrom, said means including a differential pressure and gravity actuated valve.
998,111. SAND-BLAST APPARATUS. JOHN D. MURRAY, San Francisco, Cal.
998,115. COMBINATION VOLTMETER, AMMETER, AND PNEUMATIC PRESSURE-GAGE. LOWELL P. NORTON, Los Angeles, Cal.
998,128. COMBINED AIR PUMP AND CUSHION. BENJAMIN W. SMITH, Montpelier, Ind.
998,157. STARTING DEVICE FOR GAS-ENGINES. GUSTAV CHEDRU, Buffalo, N. Y.
998,159. DEVICE FOR BLOWING WHISTLES ON VESSELS. JOHN S. CLARKE, East Cleveland, Ohio.
998,171. PNEUMATIC FOR AUTOMATIC PLAYER PIANOS. AXEL G. GULBRANSEN, Chicago, Ill.
998,172. PUMP FOR INFLATING RUBBER TIRES. CYRUS A. HAAS, St. Louis, Mo.
998,201-2. REGULATOR FOR FLUID-COMPRESSORS. WARD RAYMOND, Easton, Pa..
998,226. PNEUMATIC HAMMER. GEORGE L. BADGER, Quincy, Mass.
998,659. PNEUMATIC TOOL. WILBER H. VAN SICKEL, Philadelphia, Pa.
998,709. TURBINE-BLOWER. WILLIAM MCCLAVE, Scranton, Pa.
998,735. MACHINE FOR FORMING AND BLOWING GLASS ARTICLES. JOHN I. ARBOGAST, Pittsburg, Pa.
998,841. HOSE-COUPLING FOR AIR-BRAKES. NELSON CLEGG, Neodesha, Kans.
998,864. ROTATION DEVICE FOR FLUID-PRESSURE-OPERATED HAMMER-TOOLS. ALBERT H. TAYLOR, Easton, Pa.
998,891. VACUUM-CLEANER. JOSEPH E. GEARHART, Clearfield, Pa.
998,910. ROCK-DRILLING MACHINE. PAUL LANGE, Brieg, near Breslau, Germany.
998,919. PNEUMATIC HAMMER. REINHOLD A. NORLING, Aurora, Ill.
998,923. PNEUMATIC CLOCK. PIERRE POETTO, Paris, France.
998,975. HEATING, COOLING, AND VENTILATING SYSTEM. FRANK P. MIES, Chicago, Ill.
998,997. PNEUMATIC SHOCK-ABSORBER. GIUSEPPE TARAGLIO, Rome, Italy.
999,003. PROCESS OF OBTAINING NITROGEN. CHARLES E. ACKER, Ossining, N. Y.
999,035. AIR-CIRCULATOR. JAMES KEITH, London, England.

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Powell Co., Wm.

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Galigher Machinery Co.
Stearns-Roger Mfg. Co.

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Jewett.

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Chicago Pneumatic Tool Co.
Galigher Machinery Co.
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Pipe Joint Compound.
Galigher Machinery Co.
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Plug Drills.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
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Sullivan Machinery Co.

Pumping Systems, Pneumatic.
Bury Compressor Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.

Pumps, Air.
Cameron Stm. Pump Wks, A. S.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Pneumatic Displacement.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Steam.
Cameron Stm. Pump Wks, A. S.
Galigher Machinery Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Quarry Machinery.
Bury Compressor Co.
Cameron Stm. Pump Wks, A. S.
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DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. xv OCTOBER, 1911 No. 10

TUNNEL DRIVING IN THE ALPS*

By W. L. Saunders.

The first Alpine tunnel was the Mont Cenis, length 7.5 miles, driven with a progress that averaged about 7.75 ft. per day. Next came the Saint Gothard, 9.5 miles long, 18 ft. per day; Arlberg, 6.5 miles long, 27.25 ft. per day; Simplon, 12.25 miles long, 36 ft. per day.

The figures represent progress when driving from two headings, so that by dividing them in two we get the daily single-heading progress. The latest of the Alpine tunnels is the Loetschberg. In this work the world's record has been beaten by a single day's record in one heading of 36 ft. and by an average daily record in one heading of 29.5 feet.

The advance of the heading or "pilot"—irrespective whether it be driven top or bottom—is the factor controlling the rate of advance, as, under normal conditions, the enlargement to full size, timbering, and lining, readily keep pace with the advance of the heading. The manner of mucking in the headings and the time required to do it average about the same. The increased average gain in the rate of advance has been concurrent with the improvement in the machinery employed in the headings. Experience has led to great advances in speed and economy, as will be seen from the particulars of the tunnels through the Alps.

	Length. Miles.	Progress Daily. Linear Yds.	Cost per Linear Yd.
Mont Cenis	7.5	2.57	£226
Saint Gothard...	9.5	6.01	£148
Arlberg	6.5	9.07	£108
Simplon	12.4	12	

In 1857 the first blast was fired in connection with the Mont Cenis work; in 1861 machine-drilling was introduced; and in 1871 the tunnel was opened for traffic.

In 1872 the Saint Gothard tunnel was commenced, and in 1881 the first locomotive ran through it. Mechanical drills were used from the commencement.

The driving of the Arlberg tunnel was commenced in 1880, and the work completed in little more than three years. The main heading was driven along the bottom of the tunnel and shafts were opened up from 25 to 70 yd. apart, from which smaller headings were driven right and left. The tunnel was enlarged to its full section at different points simultaneously in lengths of 8 yd., the excavation of each requiring about 20 days, and the masonry 14 days. Ferroux percussion air-drills and Brandt rotary hydraulic drills were used, and the performance of the latter was especially satisfactory. After each blast a fine spray of water was injected, which assisted the ventilation materially. In the Saint Gothard tunnel the discharge of the air-drills was relied on for ventilation. In the Arlberg tunnel more than 8,000 cu. ft. of air per min. was thrown in by ventilators. In long tunnels the quick transport of materials is of equal importance with rapid drilling and blasting. In the Arlberg, to keep pace with the miners, 900 tons of excavated material had to be removed, and 350 tons of masonry to be introduced, daily, at each end of the tunnels, which necessitated the passage of 450 cars. This traffic was carried on over a length of 3.5 miles on a single track of 27-in. gauge with

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*Abstract of a paper read before the American Institute of Mining Engineers, Wilkesbarre, Pa., June, 1911.

two sidings. When the locomotives ran into the tunnel the fires were damped down, and as the pressure in the boiler was 15 atmospheres, the stored-up heat in the water furnished the necessary power.

THE SIMPLON TUNNEL.

Water power was employed for all purposes at each end of this tunnel. It runs upgrade from each end towards its center, hence there is a natural drainage, which saves pumping. The distance between portals is 12.4 miles, and except for a short curve at each end, the lateral alignment is straight.

The work consists of twin single-track tunnels exactly parallel in plan and profile, and lined throughout with masonry. The centers of the tunnels are 55.76 ft. apart; at the summit-level the cross-section is increased in dimensions to accommodate two tracks.

A center bottom drift was first driven by power drills, and then timbered and covered with a closely-boarded roof. From this drift a shaft was driven upward to the roof-line every 164 ft. (50 m.). The top heading was then excavated by working in both directions from each of these shafts. Next in order, the floor of the upper heading is removed and then the two side cheeks of the bottom drift. The lower drift being timbered, no interruption of the traffic in it was caused by the removal of the rock above.

The advance drift was the only part of the operation performed by power-drills. The drills employed were Brandt rotary machines mounted in groups of two on a heavy thrust-bar about 12 in. in diameter. This thrust-bar was pivoted to a drill-carriage and was counter-balanced.

The section at the heading was nominally 6.5 by 9.5 ft., or 61.75 sq. ft., and as the depth of each blast was roughly 4.5 ft., the material removed by each blast ranged from 265 to 275 cubic feet.

The average daily advance was about 16 ft. at the Italian end and from 20 to 21 ft. at the Swiss end. This work was in gneiss rock. In rock of more friable nature, such as anhydrite or calcium sulphate, an advance of as much as 34 ft. in 24 hr. was made. After each blast, the time required to clean the heading, set the drills, complete the boring, and remove the drill-carriage, was more than an hour.

The spoil was cleared from the face by one gang while another gang loaded the collected muck into narrow-gauge cars hauled by horses. No machines were used, all the material being handled by manual labor. The work of clearing the heading was rushed to enable the drills to be put to work as soon as possible. To this end the clearing-gangs were composed of men who had been previously rested by performing light work only, and only the most skilled and energetic laborers were employed. The majority of the workers were from southern Italy. There were 14 or 15 men at each heading, worked in three shifts daily.

The time spent in clearing away the spoil equaled that consumed in drilling, and it is in this clearing that a saving of time is likely to be effected rather than in the process of drilling.

THE LOETSCHBERG TUNNEL.

The main tunnel is 47,678 ft. long, and it was first planned to be on a tangent. On July 24, 1898, when the main heading had reached a point 1.6 miles from the portal, it struck a cleft filled with sand, gravel, and water. There was a sudden and violent inburst of these materials, which in a few moments filled up the tunnel for a length of 5,900 ft., burying 25 workmen and all the drills and other installations beyond hope of recovery. It is estimated that about 8,000 cu. yd. of sand and gravel entered the tunnel. To avoid any further irruption of the materials, the tunnel was walled up by a 33-ft. wall at a point 4,675 ft. from the portal. The new line leaves the original location at a point 0.75 mile from the north portal. No further serious difficulty was experienced in tunneling through the diversion.

Driving of the headings was begun on Oct. 1, 1906, for a single-track tunnel, and continued until Oct. 1, 1907, when it was decided to drive a double-track tunnel; 86 per cent. of the tunnel had been driven by Oct. 31, 1910. The headings met Mar. 31, 1911. On Oct. 31, 1910, the 4,000 ft. of heading which had been abandoned after the cave-in of 1908 had been regained.

The power-plant for the south heading is situated at Goppenstein. It is driven by electric power. The current is brought at 15,000 volts, and stepped down to 500 volts for power-purposes. Compressed air for the drills (Ingersoll-Rand) is furnished by 3 two-stage

FIG. 1. CAR WITH DRILLS SWUNG AROUND TO RUN CAR BACK.

Ingersoll-Rand compressors, each having a capacity of 1,950 cu. ft. of free air per min., and a compression of 145 lb. per sq. in. They are driven by 400-h-p. electric motors. Compressed air for the locomotives is furnished by 2 four-stage Ingersoll-Rand compressors, having a capacity of 460 cu, ft. of free air per min., and a compression of 1,760 lb. per sq. in. They are driven by 250-h-p. electric motors.

At the north heading air for the drills is furnished by two units, each consisting of a two-stage Meyer air compressor, each having a capacity of 1,770 cu. ft. of free air per min., and a pressure of 117 lb. per sq. in. They are belt-driven by 450-h.p. electric motors.

Compressed air for the locomotives is furnished by two units, each consisting of a five-stage Meyer high-pressure compressor, with a capacity of 565 cu. ft. of free air per min., and a pressure of 1,760 lb. per sq. in. They are belt-driven by a 250-h.-p. electric motor.

The records made in driving the headings are due to the excellent organization, and to the methods of setting up and taking down the drills. A drill-carriage of simple but efficient design was devised by the contractors. Each carriage carries four or five drills. Fig. 1 is a view of a carriage with drills mounted and swung into position to be taken from the heading before a blast and Fig. 2 shows the carriage with bar and saddles for four drills swung crossways as in use. Fig. 3 shows the carriage, together with the drilling-machines, when brought forward just after mucking in the heading. Fig. 4 shows the horizontal shaft swung into position ready for being jacked, and the drills ready to be swung into the position shown in Fig. 5. It can be easily seen from Fig. 5 that the drills can be independently swung through an arc of a circle or moved sideways, while in Fig. 6 the different positions which the drills can be given by being swung in a vertical plane are shown.

The time required to change the machine from the position shown in Fig. 3 to that shown in Fig. 5 and to commence drilling is usually from 6 to 8 min. This fact alone shows the superiority of this system of carrying the drills for such work over any other method used up to the present time.

The sequence of excavation is illustrated in Fig. 8. A bottom heading 6.5 by 10 ft. is first driven several hundred feet in advance of the

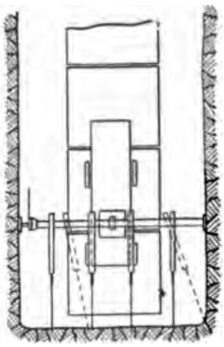


Fig. 5.—Horizontal Adjustment of Drills.

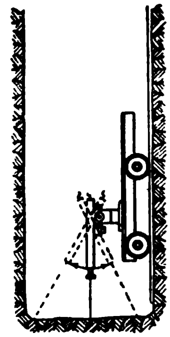


Fig. 6.—Vertical Range of Drills.

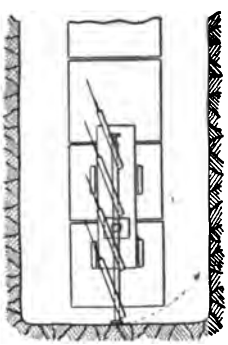


Fig. 8.—Carriage brought Forward after Mucking.

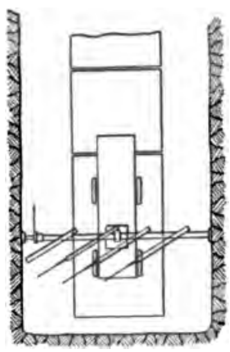
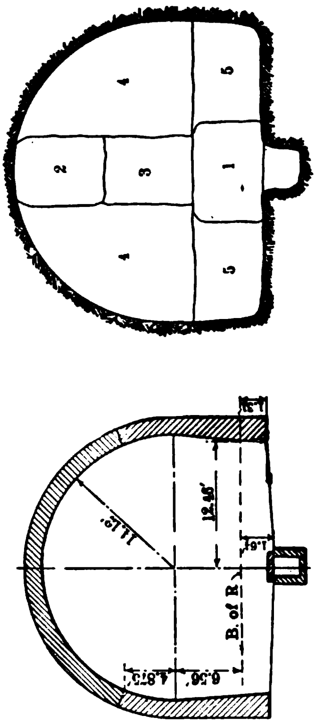


Fig. 4.—Drill-Shaft in Position to be Jacked.



Excavation-Diagram

Standard Section.

Fig. 7.—Standard Section and Excavation-Diagram of Loetschberg Tunnel.

enlargement. Upraises are then driven from 500 to 600 ft. apart, and a top heading started back and forth. The top heading is then enlarged as shown by the sections in Fig. 8.

When the inclination of the strata is vertical or the formation is of a treacherous nature, the method illustrated by Sections B-B and E-E in Fig. 8 is used.

In the bottom heading the mining-operations proceed as follows: The drill-carriage is run forward from its siding close to the face of the heading, passing over 5 ft. by 5 ft. by ⅜-in. steel plates laid on the floor of the heading for a length of about 30 ft. Each plate is provided with 1-in. holes at the corners for ease in handling with a pick.

The water-and air-pipes laid on one side of the heading to about 40 ft. from its face are connected with the drill-carriage, and the drilling begins with the top holes. Water-sprinkling is frequently done, especially in starting the holes, in order to lay the dust.

Without interfering with drilling, mucking is going on just behind the drill-carriage, and the loaded muck-cars are run back to a siding, where trains of from 20 to 30 cars are formed and hauled out by air-locomotives.

Drilling being completed in the heading, the drill-carriage is run back to its siding, and the steel plates laid on the floor are covered with a layer of muck about 4 in. thick to prevent deterioration.

The bore-holes are then loaded and carefully tamped, and the last man to leave the heading, after firing the fuse, opens the air-pipe valve, and escaping air thus creating a cushion of fresh air from the face of the heading back to a certain distance, so that, after, blasting, the muckers are able to go to work without delay.

A high-grade explosive only is used in the heading, which breaks the rock in small pieces and renders mucking with shovels easy. The bore-holes, having an average depth of about 4 feet, are started with a 3-in. drill and finished with a 2-in. drill. On account of giving better results, firing is done with fuses, about 4 ft. long, the center holes being fired first.

Mucking-operations proceed as follows: Two empty cars are run to the heading, the first one being immediately loaded by two or three men shoveling without interruption until the car is fully loaded. This operation is

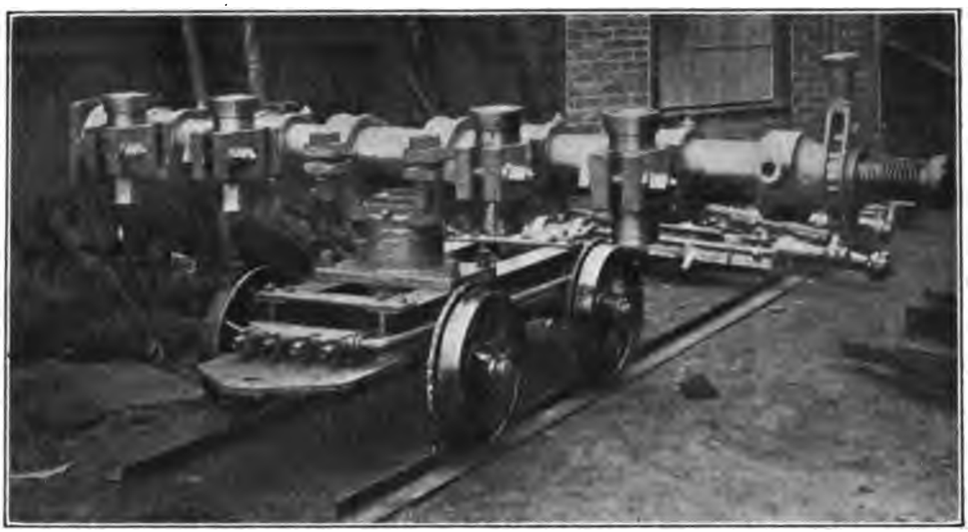


FIG. 2 BAR IN POSITION FOR WORKING FOUR DRILLS.

performed in 3 or 4 min., which means that 1 cu. yd. is loaded in from 2.5 to 3 min.

Owing to the manner of drilling and blasting and to the shallow holes, the muck, instead of piling up in front of the face of the heading, is thrown back, and forms a layer over the floor, which enables the track to be cleared rapidly.

Getting rid of the muck is always a problem in tunnel-driving. At Loetschberg a cubic-meter car (35.5 cu. ft.) is filled in 5 min., and it takes only 1 min. to get this car away and bring an empty car to the heading. In order to do this, small entries or chambers are excavated at intervals in the lateral wall of the main heading, which enable an empty car to be thrown from the track on the side, thus clearing the track and allowing the filled car

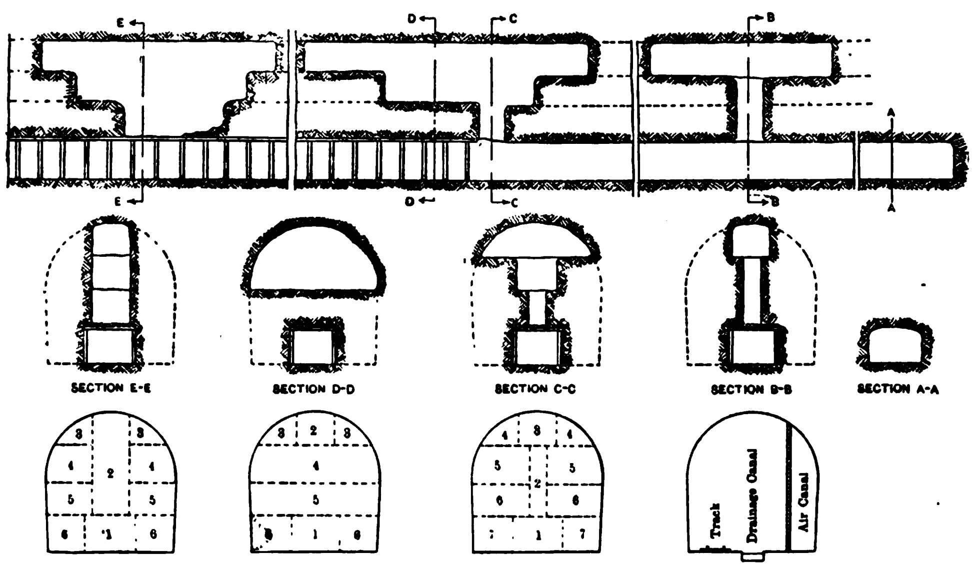


FIG. 8

to pass, whereupon the empty car is turned up on its wheels and rolled into the heading. Here we have an illustration of an improvised siding in a narrow heading, by means of which one car may pass another. This system is shown in Fig. 9, the operation being as follows:

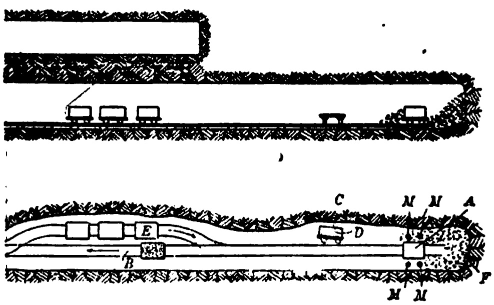


FIG 9.

When the car, *A*, is filled, it is taken away on the track, *B*, and immediately after it has passed the point, *C*, the empty car, *D*, which had been reversed on its lateral side, is thrown back on the track, brought to the advancement and filled again in the space of one minute. As soon as car, *D*, has been brought to the advancement, another empty car, *E*, is brought to the same point, *C*, reversed on its side, and waits until car, *D*, is filled and taken away again, etc. In one instance, 14 carloads, each of 1 cu. m. volume, were taken away in 1.5 hr., which cleared the heading completely and allowed the drill-wagon to be brought in. Ten men are busy removing the debris, two of which number get at the extreme limit marked *F*, and their work consists in searching the debris for the dynamite cartridges which might not have exploded. Of the remaining eight men, four work to fill the car, as shown at *M*, which takes 5 min.; they then rest for 5 min., while the second gang of four men come and fill the second car, etc.

Drilling is started not more than 5 min. after the removal of the last car-load. This result, which at first sight seems impossible, is only obtained by absolute discipline.

The man who knows that his only work at this moment is to connect the air-main to the drill-carriage does not do anything else; the men whose duty it is to screw the carriage tightly to the wall immediately jump to the right place.

The system has been adopted of low and wide gallery in the proportion of 1:2; the gallery being 6 ft. high by 12 ft. wide.

The rate of drilling is, 15 or 16 holes in 1.1-1.15 hours.

Drilling in the top heading is accomplished by means of two or three drills carried on tripods or on a horizontal bar, while hammer hand-drills are used generally for the enlargement.

Mucking-operations in the top heading are very simple, since all blasted material is dumped directly through the up-raiser into cars running on a siding in the bottom heading.

The operations of blasting, mucking, timbering, and hauling are performed without interruption and without interference with each other, and a special force of engineers is required in order to obtain such a result.

All employees and workmen are insured against accident or death, by the contracting company, and great care is therefore exercised in handling explosives and in operating the trains.

UNRELIABLE CURRENTS OF THE UPPER AIR

An English investigator, in a recent lecture before the Aeronautical Society, stated the following facts which he had observed: On an island, the wind has a greater velocity a few hundred feet above the ground. Above 2,000 ft., an easterly wind does not increase much. A southwesterly or westerly wind increases even between 2,000 and 3,000 ft. A wind that is southeasterly in the stratum near the earth veers to south or even southwest at a short distance from the ground. A northerly wind sometimes changes direction higher up, becoming northwesterly. As a general rule, for other winds than northerly, a change in direction of two points on the compass (one point equals an angle of 11¼ degrees, the compass having 32 points) and a doubling of the velocity may be expected between the ground and an altitude of 3,000 ft., excepting on warm, sunny spring and summer days, when the currents mix and become equalized.

The English journal, *Flight*, adds the following facts: The limits between which a 20-mile wind varies are 15 miles and 25 miles. The time interval between variations may be less than four seconds, as many as 17 changes in one minute having been observed. These variations affect not only the velocity but also the direction. One has not been able, however, to find any regular coincidence of the changes in direction and velocity.

Flug-Zeitschrift, published at Vienna, gives an account of similar investigations, the results of which, in the main, correspond with those obtained in England. In this journal an attempt is made to explain the phenomena as being caused by the earth's rotation and by obstructions on its surface.

A writer, in *L'Aero,* recounts similar experiences reported by French airmen who also call attention to sudden gusts of wind in a vertical direction, whereby the aviator may be suddenly elevated 70 to 80 ft., and as suddenly brought down again, or vice versa. The changes in the horizontal plane are not much feared by experienced airmen, but they often precede and give warning of a gust in the vertical direction, and the aviator should be on his guard.

FIG. 1. PNEUMATIC HAMMERS AT ZURICH.

FIG. 2. AFTER THE HAMMERS.

PNEUMATIC HAMMERS FOR TEARING UP STREET PAVEMENTS

By Frank Richards.

A job of all too frequent occurence is the tearing up of street pavements for the laying or changing of rails, pipes, wires, etc. It is always hard work, and in the way in which it has generally been done by hand it has been also costly and in many respects unsatisfactory. Figs. 1 and 2, which are almost entirely self-explanatory, show how this work has recently been done on an extensive scale in the streets of Zurich, Switzerland, by the use of Ingersoll-Rand pneumatic hammers.

The city Tram Co. of Zurich had miles of track to relay, and as the rails were bedded in concrete it was necessary to tear this up for a certain distance outside the rails and all of it between the rails. The track gage as given the writer is 3 ft. 3 ins., but is probably one meter. The data for the account which follows I have received from Mr. J. Waldenberg of Düsseldorf, Germany.

The portable air compressor outfit used, seen at right in Fig. 2, was mounted on a special flat truck having four wheels of wide face, with long plate springs to the axles. The 8x8-in. single-stage Ingersoll-Rand compressor was belt driven by a 550 volt, D. C., 21 H. P. motor, the belt having a tightener actuated by a lever and weight. A vertical air receiver and a water tank of about 18 cu. ft. capacity were provided and a tool box was attached below the truck frame. The tools used in connection with this air supply were four heavy chipping hammers, equipped with round bushings.

FIG. 3. CUTTING ASPHALT, BROOKLYN.

On each side of each rail, the workmen tear away by means of these hammers strips about 6 to 8 ins. wide, thereby freeing the rails from the concrete, which is about 10 ins. thick. After these strips are cut away, solid pieces of concrete 10 to 20 ins. long are lifted by crowbars from between the rails, also from between the rails and the sidewalk. It is then an easy matter to break up these large blocks with sledges.

The chisels or picks used in connection with the hammers were made of ordinary machine steel, as the company found out by experience that it does not pay to use a good grade of tool steel for this kind of work. When made of hardened steel, the chisels break much easier than if soft steel is used, the breaks occurring in the shanks as well as at the points. The shanks are round and the points are chisel shaped, the chisel being tapered down with a long slant at the sides so that the straight cutting edge is only about ¼-in. wide. This shape proved to be the most satisfactory, as if made with a point the bits broke in a very short time regardless of the material of which they were made.

Four men, each operating a pneumatic hammer, would accomplish about as much work as 16 to 20 men working entirely by hand. One pneumatic hammer therefore takes the place of from four to five common hand-hammers and chisels. One man can cut with one hammer per hour a strip 8 to 10 ft. long, and as the strip is about 8 ins. wide the average work for one pneumatic hammer per hour is about 5.3 sq. ft. This capacity refers to

FIG 4. THE ASPHALT FURROW.

work in solid, hard concrete. It is to be taken into consideration, the writer is informed, that the workmen in Zurich do not exert themselves too much, being employed by the city and being entitled to minimum wage regardless of the amount of work done. On the other hand, of course, the interest and depreciation on the plant, the cost of transportation, power consumption, etc., would have to be considered in making a fair estimate of the advantage gained by the use of the pneumatic outfit.

CUTTING ASPHALT AND MACADAM.

It is to be remembered that the work at Zurich above described was the cutting of concrete. In entire ignorance of this operation there has been developed almost simultaneously by the Brooklyn Union Gas Co. at Brooklyn, N. Y., a quite similar application of the pneumatic hammer, but in this case for cutting asphalt pavement. Those who have seen the operation of breaking up or breaking into an asphalt street pavement by the old methods will realize not only the strenuousness of the task but also the difficulty of following any precise line of cleavage. The method of cutting the asphalt with the pneumatic hammers is graphically told in Figs. 3, 4 and 5. A chalk line is marked on the surface and the chisel follows the line exactly, turning the asphalt over as if it were leather, although in hardness and tenacity it is more like copper or iron. In this case, the hammers were used for breaking up the surface where a 4-ft. gas pipe was to be laid through the street. Mr. E. J. Byrne is chief engineer of District No. 1, in which the work lay, and Mr. E. D. Jones and Mr. John E. Setchell were the assistant engineers in immediate charge of the work.

The portable air-compressing outfit was mounted on a truck similar to that in use at Zurich, but with an Abenaque gasoline engine for the driving instead of the electric motor, and an Ingersoll-Rand compressor as before. A 2-in. iron pipe was laid on the surface of

FIG. 5. READY TO DIG TRENCH.

the pavement close to the curb and was connected to the receiver of the compressor. The tools could then be connected at various points along the pipe, obviating the necessity of frequently moving the compressor as the work progressed. There was here as well as in Zurich some experimenting as to the best hammer to use, the one finally adopted being of a type extensively used in coal mines. The cutting tool was like a big chipping chisel, an inch and a half wide. This was run along the two lines defining the width of the trench, cutting through the asphalt and giving it a turn partly over as a plow would do. The sheet of asphalt was then pried up by a crowbar gang, while one man would break it with a sledge.

Some data of the actual rate of cutting the asphalt with the pneumatic hammers are furnished the writer by Mr. John E. Setchell as follows:

From observation of about 3,000 linear feet of cut (1,500 ft. of trench), with two men and sometimes three using the hammers, the average asphalt cut was 20 ft. per man per hour.

On June 1, 1911, on a 45-minute hand test (hand-held chisel and sledge) we cut at the rate of 12 ft. per man per hour, but the men were exhausted and had to stop.

The material under the asphalt was macadam, close and hard, and for breaking this also the "coal picks" did good service. The chisels were exchanged for pointed picks for this work.—*Engineering News,* with additions by the writer.

SQUANDERING THE PRINCIPAL

You may take all the water from a well and the rainfall will restore the water. You may exhaust the fertility of the soil, but by careful cropping and fertilizing the fertility is renewed. You may cut down the forests, and new forests will grow, but when you take from the earth the minerals, the oil, the gas, the coal, contained therein, these minerals are never replaced. When gas was first encountered in Bartlesville, Oklahoma, it was permitted to escape unchecked. The roaring of the gas was so persistent that people in the town could not sleep at night, and so the gas was carried in pipes outside of the city limits, where it might escape without the noise disturbing the sleepers.

EMERGENCY PNEUMATIC PUMPING

A threatened shortage in the water supply for St. Paul, Minn., during 1910 made it necessary to provide means for supplementing the flow from the existing water-works system. The original supply is obtained from a system of lakes, north of the city, having a drainage area of about 100 square miles, including the lake surface. From this area, in addition to the water used for the city's supply, there is usually a large runoff which might be held by increasing the reservoir area. The year 1910 was the driest ever recorded by the water department, whose statistics cover a period of 74 years; the total precipitation was a little more than 10 in., while the average rainfall is 28 in. It became apparent in June of last year that the lake supply was in danger of being exhausted and if another dry year should follow there would certainly be a great deficiency in the water supply. Some immediate action had to be taken and as there was no other lake or river which could be utilized within the time required Mr. L. W. Rundlett, then Commissioner of Public Works, recommended the sinking of artesian wells at the existing McCarron Lake pumping station, located at the end of a conduit 4½ miles long which carries the water from Vadnais Lake, the nearest of the lakes in the present supply, to a terminal chamber, from which point it flows by gravity into the low service system and is pumped into a reservoir for the high service system.

In accordance with this recommendation, six 12-in. artesian wells were sunk to a general depth of 700 ft. (one well being carried down to a depth of 1000 ft. without materially increasing the flow). It was hoped to obtain flowing wells, but the height with which water rises from the sandrock strata varies considerably in different localities in the vicinity of St. Paul. In this instance the water rose to an average height of about 18 ft. below the surface of the ground. Tests of two wells showed a suitable supply of water both in quantity and quality. Under the existing conditions it seemed expedient to place a separate pumping unit at each well and to deliver the water through a pipe system to the terminal chamber, where it could be used on both the high and low services.

Bids were received for installing either an air plant or an electric plant. The lowest price with the highest guaranteed efficiency was secured on the air plant, and the contract was awarded to the Robinson, Cary & Sands Company, in the sum of $27,817.00, they furnishing the air compressor, condenser, air pump and everything necessary to operate the machine, all the air piping, including the well connections, the towers and tanks into which the water was discharged, (the water being carried by gravity from the tanks to the terminal chamber), while the Board of Water Commissioners furnished the addition to the pumping station for the compressor, the additional boiler capacity required and the piping from the boiler to the compressor, steam at 125 lb. pressure, the necessary water pipe system to take the water from the wells to the terminal chamber and a weir for the accurate measurement of the water as furnished.

The efficiency based upon the computed foot-pounds of work in the steam supplied was guaranteed to be not less than 4.83 per cent. with a penalty of $100 for every one-tenth of 1 per cent. below this standard and a bonus of $100 for every one-tenth above.

The result of the test was as follows:

Results of Tests of Compressed Air Pumping Plant.

Duration of test from 8 a. m. to 5 p. m.	9 hours.
Average r.p.m. of compressor	80.26
Average steam pressure gauge, lb. per sq. in.	126.4
Average vacuum referred to 30-in. barometer	26.9 in.
Total pounds of condensed water	35,651
Average temperature of condensate	101.5° F.
B.t.u. per pound of steam at average pressure	1189.7
B.t.u. per pound of condensate	69.1
B.t.u. consumed	1120.6
Av. cu. ft. water per second over weir = 6,350,000 gal. per day.	9.78
Average total head in feet	76.83
Total foot-pounds water delivered ÷ total foot-pounds steam consumed = efficiency =	4.90%
Efficiency covered by contract	4.83%

This result gave the contractor a bonus of $70.

The plant in the test delivered at the rate of 6,350,000 gal. per day against an average total head of 76.83 ft. The cost of running the plant in connection with the pumping engine already installed is about $35 per day.

The air compressor is an Ingersoll-Rand machine with compound steam cylinders and cross-compound air cylinders rated at 2,588 cu. ft. of free air per minute at 125 r.p.m., the air to be delivered at 100 lb. per square inch gauge pressure. The condenser is a Wheeler surface condenser containing 525 sq. ft. of cooling area made up of ¾-in. brass tubes. The boiler feed is warmed by a Wainwright feed-water heater having a rating of 300 h. p. equipped with a Harris Air Pump Company's pump constructed of bronze, and standard well tops and umbrella discharge equipment. Over each well there was placed a substantial steel tower, supporting a steel tank 5 ft. in diameter by 6 ft. high.—*Engineering Record.*

UNWATERING A CUBAN MINE WITH THE AIR LIFT

By E. H. Emerson.*

In 1910 an interesting experiment with the air lift was made at El Cobre Mines. The following are the results:

The water stood at the 200-foot level, held by two Cameron station pumps. The shaft was 800 feet deep, with one cage road, 4x8 feet, open to the 800-foot level. The other compartments were blocked with platforms. Water was acid, and contained up to 400 grs. Cu per cubic meter. A tunnel from the 50-foot level through the mountain allowed a reduction in the head.

INSTALLATION FOR BLOWING.

Tests showed the shaft to be blocked by old timber and guides, so that a cone was made to run on an old cable guide, lowered in the center of the compartment with a two-ton weight. The wood pipe was built upon this and lowered as put together.

The wood pipe twisted around the center cable in a spiral, so that it had made a complete turn in 200 feet without doing the slightest harm. Three columns were built up on the cone and tied together with new 1½-inch rope, which, when wet, held them together very firmly. They were 750 feet long, each, and had no support, as the guide and lowering ropes were soon eaten off by the water.

With 600 feet under water and 150 feet above, the wood columns were nearly floating. After being water-soaked they become very heavy.

The wood pipe was 10 inches inside diameter. Air pipe was 2½-inch iron pipe, which was thoroughly tarred and changed as it was eaten by the water.

The high limit of our compressors was 140 pounds pressure.

Two pipes were used, the third being in re-

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*Manager, El Cobre Mines, Cuba.

serve and operated in case of breaks in the others.

RESULTS OBTAINED.

The out-flow was measured hourly by weir.

The head at the start was 150 feet, submergence of air pipe 50 per cent. Head of finish was 360 feet, with 39 per cent. submergence.

The water removed was 113,120,000 gallons. Cost 7.434 cents per 1,000 gallons.

The pipes averaged 950 gallons per minute, each, or 105 cubic feet of air for 100 gallons of water.

The lowest speed was with 360 feet head, 1,500 gallons per minute for the two pipes, or 160 cubic feet of free air for 100 gallons of water.

SECOND STAGE.

After reaching the 400-foot level, a 2,000-gallon pump was installed, and the discharge of the blow pipes turned into the pump sump.

Under no head, one-inch pipe threw 2,200 gallons per minute with air cut down. This was the pump limit on a burst of speed.

A special test was made in lowering the water for seven days. The results were as follows:

SEVEN DAYS TEST BLOWING AND PUMPING.

Feet lowered	57' 6"
Feet lowered per day	9' 2½"
Gallons per foot lowered	307,100
Gallons pumped, total	17,659,980
Gallons pumped, per day	2,522,954
Gallons pumped, per minute	1,750
Head on blow-pipe, at start	21' 6"
Head on blow-pipe, at finish	79'
Head on blow-pipe, average	50' 3"
Submergence at start	179.89 per cent.
Submergence at finish	100.50 per cent.

Air pressure, 100 lbs., gage.

2½ inch air pipe inside 10 inch wooden pipe.

43 cubic ft. of free air to 100 gallons of water.

Cost: 2.32 cents per 1,000 gallons.

In this case the pipe was limited by the capacity of the pump; 3,500 to 4,000 cubic feet could be blown from the one pipe with 1,000 cubic feet of free air. The actual inflow of the mine is 213 gallons per minute.

The cost per 1,000 gallons by blowing down 60 feet once in two months, and pumping the water to the surface is 5.23 cents per 1,000 gallons. The cost for the pump alone, working at its full capacity, is 2.91 cents per 1,000 gallons (with labor proportioned to the blowing), but handling only the inflow with pumps of smaller size the cost was 8.3 cents per 1,000 gallons. There is therefore a savnig of 3.02 cents per 1,000 gallons by the combination method of holding the water at the 400 foot level. This is a real saving, since in flood time the full 2,000 gallon capacity is necessary, and therefore there is no unnecessary investment. A great advantage is that an enormous sump is provided, which insures against drowning by the sudden floods.—*Mexican Mining Journal.*

POWERFUL EFFECTS FROM MINUTE VIBRATIONS

The following, from the *Scientific American,* having to do with the effects of rapid vibrations upon metals and other solids, and then the exciting of such vibrations by means of sound waves transmitted through the air from musical instruments, of course is entirely pertinent to our columns, as are all phenomena in which air—which always is compressed air—is concerned.

It has been contended that solid metals may reveal by their structure the vibrations to which they have been subjected. In explaining this phenomenon, experiments were made in England to show that a beautiful wave structure can be imparted to the surface of mercury by the vibrations of a tuning-fork, and that even the surface of solid lead which has been subjected to similar vibrations possesses a structure resembling that of a vibrating surface of mercury. Mild steel was defined as a "solid solution" of iron and carbon, free from cinders. Metallurgists have doubled the strength of steel as it was known in early days.

Iodide of nitrogen, a black powder, is one of the most dangerous of all explosives. When dry, the slightest touch will often cause it to explode with great violence.

There appears to be a certain rate of vibration which this compound cannot resist. In experiments to determine the cause of its extreme explosiveness, some damp iodide of nitrogen was rubbed on the strings of a bass viol. It is known that the strings of such an instrument will vibrate when those of a similar instrument, having an equal tension, are played upon.

In the present case, after the explosive had become thoroughly dry upon the strings, another bass viol was brought near and its strings were sounded. At a certain note the iodide of nitrogen on the prepared instrument exploded.

It was found that the explosion occurred only when a rate of vibration of 60 per second was communicated to the prepared strings. Vibration of the G string caused an explosion, while that of the E string had no effect.

The question is often asked, What force least expected does the greatest damage to buildings? One architect's answer to this question may be a surprise to those who do not understand that it is the regularity of vibration that makes it powerful.

"I venture to say," remarked this architect, "that you would never suspect that violin-playing would injure the walls of a building. Yet it certainly does. There have been instances when the walls of stone and brick structures have been seriously damaged by the vibrations of a violin. These cases are, of course, unusual, but the facts are established.

"The vibrations of a violin are really serious in their unseen, unbounded force, and when they come with regularity, they exercise an influence upon structures of brick, iron or stone. It follows, of course, that there must have been continuous playing for years to cause the loosening of masonry or to make iron brittle, but it will do so in time."

OXYGEN CONSUMED BY A LAMP

The most recent tests to show the oxygen-consuming power of a naked flame are some experiments in Scotland: A lamp burning oil consumed 1.13 cu. ft. of oxygen, and produced 0.78 cu. ft. of carbonic acid per hour. The same lamp when burning tallow, consumed 2.49 cu. ft. of oxygen, and gave off 1.74 cu. ft. of carbonic acid in one hour. The investigators determined the candlepower of various lamps by photometry. An oil lamp (naked flame), consuming 13.8 grams of oil per hour, averaged 1 c.-p. The kind of oil used, of course, affects th ecandlepower considerably. A miner's tallow lamp consuming 17.4 grams of tallow per hour, averaged, with uniform flame for 15 min., 2.3 c.-p. A lamp consuming 13 grams paraffin wax per hour gave 1.6 candlepower.

DEVELOPMENT IN COMPRESSED-AIR POWER STORAGE

By Frank Richards.

One of the most unsatisfactory features of compressed-air practice up to the present time has been in the inadequacy of the means provided for storing the air between its compression and its use, or for maintaining a full and constant pressure under a varying rate of consumption. It may be said that compressed air wherever employed, is always used more or less intermittently, and never at any constant rate, except in cases where the entire output of a compressor or of a large compressing plant is employed in a single water-pumping operation.

The air receiver usually provided with an air compressor has a total air capacity not exceeding the output of the compressor for a single minute, so that, if the compressor stops or is slowed down to below the capacity to supply the consumption, the pressure instantly begins to fall. To insure somewhat reliable maintenance of pressure and volume it is the practice to provide a maximum compressing capacity somewhat in excess of the maximum demand, and then to automatically reduce the speed of the compressor as the rate of consumption diminishes. Even this arrangement usually does not completely satisfy the fluctuating requirements, and so we have various unloading or choking contrivances which will still more reduce the output without actually stopping the machine. However satisfactory the results thus obtained may be, it is evident that they are secured only by more or less complication of apparatus and a sacrifice of the essential conditions of power economy in the running of the machine.

A magnificent opportunity for the solution of this air-power storage problem opened to the engineers of the Anaconda Copper Mining Company, at Butte, Mont., when it was proposed to find a cheaper means of driving their great mine hoists than by the use of steam. There were at Butte 25 large steam-driven hoists with an aggregate capacity of 40,000 horsepower, but the service required of the hoists was so intermittent, and the actual time of working of each was so short, that it was estimated that 4000 horsepower in constant operation would be sufficient for all the requirements, but it was imperative that the power should be always ready and always sufficient for each individual hoist.

. The cost of steam had been about $80 per horsepower yer pear, while electric horsepower per year could be had for about $25. There were, however, serious objections to the adoption of the electric drive for each separate hoist, besides the enormous first cost of such an installation. Here, also, there could be no power storage, so that it would be necessary at times to have current available for nearly all the hoists at once.

So far as the steam hoisting engines were concerned, they could be adapted to the using of compressed air at comparatively slight cost, if only the power-storage problem could be solved, so that a constant drive of sufficient average capacity could be made able to take care of the peak loads whenever they should occur, even up to the running of all the hoists at once. The problem has been solved with a success and completeness seldom surpassed in great engineering undertakings.

It is not intended here to give more than the briefest sketch of the compressor installation and operation, the purpose being only to call attention to the air-storage scheme.

The electric current which drives the compressors is transmitted 130 miles from the new plant at the Great Falls Water Power and Townsite Company, at Rainbow falls, just below the Great falls on the Missouri river. There are three compressors, each with a direct-connected Westinghouse motor of 1,500 maximum horsepower. The compressors, furnished by the Nordberg Manufacturing Company, are two-stage machines of the highest class, with low-pressure cylinders 50 inches diameter and high-pressure cylinders 30 inches diameter, and a common stroke of 48 inches. The combined free-air capacity of the three compressors I would estimate roughly at 20,000 cubic feet per minute (not knowing the builder's specifications as to speed, etc.)

THE AIR RECEIVERS.

From the compressors the air passes to the battery of air receivers. There are 32 of these, vertical, each 10 feet diameter and 30 feet high, their combined cubical content being, say, 70,000 cubic feet, which, at 90 pounds gage pressure, may be said to equal 500,000 cubic feet of free air, a volume which it would take the combined compressors nearly half an hour to compress and deliver. This is very different, to begin with, from the less than one minute capacity of the air receiver usually provided.

But there is a more important feature and a greater difference and advantage to be noted in the present installation as compared with long established air receiver practice. The too familiar experience is that as soon as any air is withdrawn from the receiver in excess of what the compressor is delivering, or if for any reason the compressor stops, the pressure in the receiver falls rapidly and constantly with the drawing of the air. Under the arrangement here being considered, when the quantity of air contained in the receivers is diminished by any air consumption exceeding the delivery, instead of a drop of pressure rendering the remaining contents of the receiver ineffective and useless, the pressure is maintained and the entire contents of the whole battery of receivers, including the original inert filling of air at atmospheric pressure, can be used at full pressure and effectiveness until the receivers are emptied. In practice the withdrawal of the air never goes as far as this. As these compressors run all day and all night, when there is at any time a simultaneous call for operating an unusual number of hoists, there is always the full capacity of the working compressors and also the entire contents of the battery of receivers to draw from until the unusual and excessive demand for air ceases. When there is such an unusual simultaneity of hoisting it is necessarily succeeded by a period when the hoisting and the demand for air are less than the compressor output, and then the receivers are automatically filled again.

HOW THE AIR PRESSURE IS MAINTAINED.

The device by which the air pressure is maintained in the receivers nothwithstanding the diminution of the contained air is essentially a simple one. It is accomplished by the use of a standpipe or its equivalent, the same as in waterworks service. On a side hill at an elevation sufficient to give the required gage pressure of 90 pounds, there is an open water tank 100 feet in diameter and 15 feet deep. A depth of 10 feet in this tank gives a water capacity somewhat greater than the total cubic capacity of the battery of air receivers. As 2.3 feet of water gives 1 pound pressure, the mean elevation of the tank above the receivers should be $90 \times 2.3 = 207$ feet. There is a large pipe connection from the bottom of this tank to a horizontal pipe in free communication with the lower ends of all the receivers. No valves of any kind are required, and little, if anything, need be allowed for the fricton of the water in the pipes, it being free to flow in either direction, according to the changes of the volume of air in the receivers. No safety valves are required, and it is impossible to produce any pressure in the receivers greater than that due to the head of water.

The compressed air as it is delivered from the operating compressors does not pass through the receivers, and, indeed, does not enter them at all except when the air production is greater than the consumption at the moment, when the surplus passes into the receivers, driving out and up into the elevated tank some of the water at the bottom of the receivers. When the call for air is greater than the compressor supply then the deficiency is made up by a flow of air from the receivers, the water from the tank displacing it.

The contact of the air with the water does not make it any wetter, as after compression it is quite certain to be saturated with water in any case. In the service for which this air is used, there is no call for "dry" air, as special means are provided for heating the air before it enters the hoisting engines, and moisture would be an advantage rather than otherwise.

Long continued records of the hoists as they had been run by steam made it possible to compute the compressor capacity required, and to adapt the compressors to the work so that they could be operated at the point of best economy.

The plant is unique as it stands, but in the use of the elevated tank it sets an example which, since there can be no monopolizing of the principle, we may expect will in time be widely adopted. For the maintenance of a constant air pressure with considerable storage capacity it seems to recognize and fill a long persisting requirement. The elevations which will give gage pressures of 50, 60, 70, 80, 90 and 100 pounds are, respectively, 115, 138, 161, 184, 207 and 230 feet. These heights can, of course, be secured as well by sinking the receivers as by elevating the tanks, or by a combination of both until the vertical difference is secured.

It is to be noted that no water is consumed or wasted in the operation; it simply flows back and forth out of the receivers and in again as the volume of air in storage increases or diminishes. Why not then dispense with the special elevated water tank and connect direct to a city or other water service where sufficient pressure is maintained, as it usually is? If the water pressure is constant and is somewhat greater or less than the air pressure desired the latter might be adjusted by placing the air receiver above or below what would otherwise be its normal position.—*American Machinist,* with additions by the writer.

AIR COOLING AND MOISTURE PRECIPITATION*

By F. E. Matthews.

Before proceeding to illustrate the method of calculating the amount of refrigeration required to cool a mixture of air and water vapor it may be advisable to define terms.

Air is a mechanical mixture of nitrogen and oxygen in the practically constant proportion of 80 parts of the former to 20 parts of the latter, a very small percentage, about 3 or 4 hundredths of 1 per cent., of which is replaced by carbon dioxide. Into this uniform mechanical mixture water vapor enters in widely varying proportions. When the air contains all the moisture that it can hold it is said to be saturated. The higher the temperature of the air the more water vapor it is capable of absorbing before becoming saturated. At a given temperature saturated air always contains a certain fixed quantity of water vapor.

It must be remembered, however, that the temperature of the air does not fix the amount of moisture that it contains except in the limiting case of saturation. In general, air is not saturated, and it may contain different amounts of water at the same temperature as it varies in degree of saturation; or it may contain different amounts of moisture at the same degree of saturation at different temperatures. Since the amount of water that it is possible for air to hold in suspension increases with increasing temperature, and decreases with decreasing temperature, it is evident that the air may or may not contain less moisture after cooling than before, according to whether the cooling is carried below the temperature at which the air becomes saturated.

POUNDS OF AQUEOUS VAPOR IN 1000 CU.FT. OF AIR AT DIFFERENT TEMPERATURES AND PER CENT. SATURATION

At	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
100° F.	0.282	0.423	0.056	0.705	0.847	0.988	1.130	1.270	1.411	1.552	1.694	1.835	1.976	2.117	2.259	2.400	2.541	2.682	2.823
95° F.	0.244	0.366	0.489	0.621	0.733	0.853	0.978	1.100	1.223	1.345	1.467	1.589	1.712	1.844	1.977	2.089	2.201	2.323	2.446
90° F.	0.211	0.316	0.422	0.527	0.633	0.740	0.847	0.951	1.056	1.161	1.267	1.373	1.479	1.584	1.690	1.795	1.901	2.005	2.110
85° F.	0.182	0.272	0.363	0.454	0.545	0.636	0.727	0.818	0.909	1.000	1.091	1.182	1.273	1.364	1.455	1.546	1.637	1.728	1.819
80° F.	0.156	0.234	0.312	0.390	0.468	0.546	0.624	0.702	0.781	0.859	0.937	1.015	1.093	1.166	1.249	1.327	1.405	1.483	1.562
75° F.	0.133	0.200	0.267	0.334	0.401	0.467	0.534	0.601	0.666	0.735	0.802	0.868	0.935	1.002	1.069	1.135	1.202	1.269	1.336
70° F.	0.114	0.171	0.228	0.285	0.342	0.399	0.456	0.513	0.570	0.627	0.684	0.741	0.798	0.855	0.912	0.964	1.026	1.083	1.140
65° F.	0.096	0.144	0.193	0.241	0.290	0.338	0.387	0.435	0.484	0.532	0.581	0.629	0.678	0.726	0.775	0.823	0.872	0.920	0.968
60° F.	0.082	0.123	0.164	0.205	0.246	0.286	0.327	0.368	0.410	0.451	0.492	0.533	0.574	0.615	0.656	0.697	0.738	0.779	0.820
55° F	0.069	0.103	0.138	0.172	0.207	0.242	0.277	0.311	0.346	0.380	0.415	0.449	0.484	0.519	0.554	0.588	0.623	0.657	0.692
50° F	0.058	0.087	0.116	0.145	0.174	0.204	0.232	0.261	0.291	0.320	0.349	0.378	0.407	0.436	0.465	0.494	0.524	0.553	0.582
45° F.	0.048	0.072	0.097	0.121	0.146	0.170	0.195	0.219	0.243	0.267	0.292	0.316	0.341	0.365	0.390	0.414	0.439	0.463	0.487
40° F	0.040	0.060	0.081	0.101	0.122	0.142	0.162	0.182	0.203	0.223	0.244	0.264	0.284	0.304	0.325	0.345	0.366	0.386	0.407
35° F.	0.033	0.050	0.067	0.084	0.101	0.118	0.135	0.152	0.169	0.185	0.202	0.219	0.236	0.253	0.270	0.287	0.304	0.321	0.338
32° F.	0.030	0.045	0.060	0.075	0.090	0.105	0.120	0.135	0.150	0.165	0.181	0.196	0.211	0.226	0.241	0.251	0.271	0.286	0.301
30° F.	0.027	0.041	0.055	0.068	0.082	0.096	0.110	0.124	0.138	0.151	0.165	0.179	0.193	0.207	0.221	0.234	0.248	0.262	0.276
25° F	0.022	0.033	0.044	0.055	0.066	0.077	0.088	0.099	0.110	0.121	0.133	0.144	0.155	0.166	0.177	0.188	0.199	0.210	0.221
20° F.	0.017	0.026	0.035	0.043	0.052	0.061	0.070	0.079	0.088	0.096	0.105	0.114	0.123	0.132	0.141	0.149	0.158	0.176	0.176
15° F.	0.014	0.021	0.028	0.035	0.042	0.049	0.056	0.063	0.070	0.077	0.084	0.091	0.098	0.105	0.112	0.119	0.126	0.133	0.140
10° F	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.049	0.055	0.060	0.066	0.071	0.077	0.082	0.088	0.093	0.099	0.104	0.110
+5° F.	0.008	0.012	0.017	0.021	0.026	0.030	0.035	0.039	0.043	0.047	0.052	0.056	0.061	0.065	0.069	0.073	0.078	0.082	0.087
0° F.	0.006	0.009	0.013	0.016	0.020	0.023	0.027	0.030	0.034	0.037	0.041	0.044	0.048	0.051	0.055	0.058	0.061	0.064	0.068
—5° F	0.005	0.007	0.010	0.012	0.015	0.018	0.021	0.023	0.026	0.028	0.031	0.034	0.037	0.039	0.042	0.044	0.047	0.049	0.052
—10° F	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.034	0.036	0.038	0.040
—15° F.	0.003	0.004	0.006	0.007	0.009	0.010	0.012	0.013	0.015	0.016	0.018	0.019	0.021	0.022	0.024	0.026	0.028	0.029	0.031

The accompanying table shows the amount of vapor in pounds per thousand cubic feet of air at different degrees of saturation at different temperatures. At 100 degrees Fahrenheit and 100 per cent. saturation, for example, 1,000 cubic feet of saturated air will contain 2.82 pounds of water vapor, while at 75 degrees Fahrenheit, the amount is only 1.33 pounds, or less than one-half that quantity, and at 15 degrees Fahrenheit, it is still further reduced to about one-tenth of what it is at 75 degrees Fahrenheit.

In the general case, air cooling involves cooling not only the mechanical mixture of oxygen and nitrogen, but a large quantity of water vapor as well. If the air contains sufficient moisture so that the cooling brings it to the point of saturation, the heat that must be abstracted from the water vapor will be only that represented by the specific heat of the vapor and the number of degrees cooled through. If it is cooled below the point of saturation, as usually happens in cold-storage practice, not only the specific heat of the vapor but the latent heat of that part of the vapor precipitated as well must be removed. Generally the process is carried still farther and the precipitated moisture is chilled to the freezing point and finally frozen, when not only the specific heat of the liquid but the latent heat of fusion is involved. If the ice is cooled to a lower temperature the specific heat of the ice is also involved.

It is required, for example, to cool 2,000 cubic feet of air per minute from 80 degrees Fahrenheit to 36 degrees Fahrenheit. In the following calculations it is assumed that the amount of air to be cooled is 2,000 cubic feet before it is cooled, and not, as it might be construed to mean, 2,000 cubic feet of cooled air.

For the sake of simplicity the air is assumed to be dry.

Dry air at 80 degrees Fahrenheit weighs 0.0731 pounds per cubic foot; 2,000 cubic feet would weigh, in pounds, 146.2; the specific heat of air is 0.2377; B.t.u. required to cool 2,000 cubic feet 1 degree Fahrenheit, 34.75; B. t. u. required to cool 2,000 cubic feet 44 degrees Fahrenheit, 1,529.

One ton of refrigeration is sufficient to dispose of heat at the rate of 288,000 B.t.u. per 24 hours, or (dividing this number by 1,440, the number of minutes in 24 hours) the equivalent rate per minute is 200 B.t.u.

On this basis, the cooling of 2,000 cubic feet of air per minute from 80 degrees Fahrenheit to 36 degrees Fahreheit would require the expenditure of

$$1{,}529 \div 200 = 7.64 \textit{ tons.}$$

of refrigeration.

Had the requirements been for 2,000 cubic feet of cooled air, the amount of refrigeration needed would have been 8.36 tons, the difference being accounted for by the difference of weight per cubic foot of air at 80 degrees Fahrenheit and 36 degrees Fahrenheit, respectively.

Cold storage and refrigerating warehouses in New York State have been placed under the jurisdiction of the State Commissioner of Health by an Act recently passed by the Legislature. Besides giving the power of inspection and supervision, the Act also limits the period of storage of any kind of food to 10 months, except that butter may be kept in cold storage for 12 months.

SAFETY AND ECONOMY, OR THE REVERSE, IN COAL MINING

The following is a portion of a letter by Mr. S. M. Sexton, Blossburg, Tioga county, Pa., in a recent issue of the *Scientific American*:

The lower drift at Arnot, Pa., has been worked since 1866. There was seldom less than 800 miners employed in it. The workings extend over 23,000 acres and 96 per cent. of the coal is taken from the workings. In the forty-five years the mine has been worked but six men have lost their lives while digging coal, and an accident is a very rare occurrence. That I term the correct method of working a coal mine.

In Sullivan, Indiana, a coal mine has been worked seventeen years. About 150 miners are employed. The workings extend over 600 acres. An average of seven men have been killed in it each year, while accidents are of almost daily occurrence. That I call the incorrect method, for less than 60 per cent. of the coal is taken out.

The method of working at Arnot, Pa., is this: All coal is both undercut and sheared by pick or machine; then a few ounces of powder brings down the coal without shattering the strata above, so that when the outcrop is reached the pillars can be drawn, thus leaving but three or four per cent. of the coal behind.

The freedom from death and accident is due to this: When the miner reaches his room he immediately takes his lamp from his head and cautiously raises it once in a while to see if the flame will denote the presence of firedamp. If so, he does not blow it out, but slowly puts it down on the ground and extinguishes the lamp by placing his coat over it. When the miner reaches the "face" he takes a pick and sounds the roof to find out if there is any loose rock overhead. If so, he either wedges it down or sets a prop under it. Though the mine is full of coal dust no dust explosion ever took place in it.

At Sullivan, Indiana, the coal is "shot from the solid." Little or no under-mining is done. Each miner uses from five to ten pounds of dynamite or an equally strong explosive each day. This not only loosens the coal, but shatters the roof also, so that if a vein of coal is above the one worked it is extra hazardous. It does more. It causes the almost daily accident and the loss of about 40 per cent. of the coal in the mine. It is rarely possible there to draw the pillars. So the net result is the loss of 40 per cent. of the mine worked, the almost entire loss of the vein above and a continuous maiming and killing of the miners.

Consider this matter in another way: Supposing a half ton or more of dynamite were exploded in five and ten-pound charges in the streets of a city within one hour. What would be its effects in the open? Apply this, then, to what must be the effect of the explosion of a similar amount in a mine where the effect of the explosion has but a single direction to expand. All this is to take place within the area of fifty acres.

The method used in Indiana is in vogue all over the West. It is wasting, criminally wasting, a large percentage of the most valuable of nature's gifts and causing a wholesale slaughter of men. I edited the national official organ of the coal miners for seven years, and my observations, extending practically all over the coal field, taught me that there was but one way to prevent the slaughter of miners and the criminal waste of coal, to wit: To make it a penal offense to shoot coal from the solid or to attempt to get it without undercutting and shearing the "shot" with either pick or machine.

What would be the result? But one-tenth of the powder would do the work; there would be no dust explosions, for little dust would be made; the strata above would be practically unharmed, thus preventing the killing and maiming of miners and securing over 90 per cent. of the coal.

That this is so is again illustrated by coal regions separated only by county lines, Allegany County, Maryland, where the method used is similar to that used in Arnot, Pa., with similar results, and Allegheny County Pa., where the Indiana method is used and the same results ensuing.

When I stated these things in the miners' organ the operator would sneer at them because he wanted to get the greatest amount in the shortest time regardless of the wrong he was doing to the country and the injury to future generations. Many miners indulged in somewhat heated criticisms of myself, for they too, wanted to get the most for the least.

At Penticton, B. C., a hydro-electric plant is being installed with a static hydraulic head of 2,115 feet.

DEVICES OF VARIOUS PNEUMATIC INTEREST

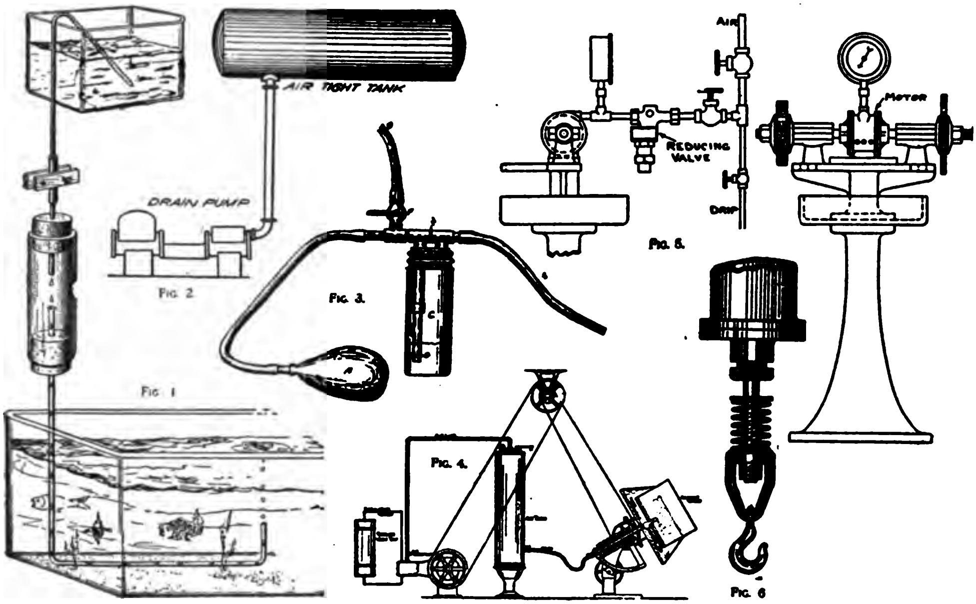
Pneumatic apparatus, or devices with which the air has something to do, are appearing constantly in all the technical papers. They are indeed so familiar that it is not worth while to call attention to them unless they are in some particular a little out of the usual line. In the cut upon the opposite page we have grouped together several clipped from recent exchanges. It is probable that each will be of interest to some of our readers. Fig. 1, an aerating apparatus for a fish tank is from *Popular Mechanics*. Place immediately above the fish tank a small reservoir. Procure a siphon tube 3/16 inch in diameter and a short tube of about ⅝ inch in diameter, the latter to serve as an air chamber. In the side of the chamber file a hole; fit each end of it with a cork. Through the upper cork pass a short length of glass tube, and connect this with the end of the siphon tube by a bit of rubber tubing. On this rubber tubing mount a regulator, which will govern the amount of water flowing through the siphon tube. The regulator may be made of two small pieces of wood arranged to be clamped together by means of a pair of screws, so as to squeeze the rubber tube, and thus reduce the flow of water through it. Through the lower cork of the air chamber run a glass tube, as indicated in the drawing, leading to the center of the fish tank. The upper end of this tube should be slightly flared, to form a funnel-shaped mouth directly under the upper tube. In operation, the regulator should be adjusted to cause the water to drip slowly from the siphon. The dropping water will fall into the mouth of the lower tube, and the air between each drop of water will be imprisoned within the tube. The alternate drops of water and air spaces will then travel through the tube to the fish tank, spreading through the water of the fish tank and thoroughly aerating it.

Fig. 2 is not a pneumatic device at all. It is from the *Practical Engineer* and merely graphically propounds a question which no one can answer without at least thinking of and referring to the air. If the suction pipe of a pump is connected to the under side of an air-tight tank filled with water and at a higher level than the pump, as shown in the sketch, can the water be drawn from the tank?

Fig. 3, a portable instantaneous leak detector, is from the *Progressive Age*. It normally has to do with gas, but is equally applicable to air piping at light pressures. It will immediately indicate the smallest leak in a closed system to which the apparatus may be attached. A mouthpiece or pressure tube "B" is connected through a cock "F" with both an elastic rubber bag "A" and with a glass tube "D" which projects below the water in the air-tight bottle "C." The joint at "H" is blank and the tubing connects the system to be tested with the air chamber above the water in bottle "C." In operation, pressure is applied at "B" with cock "F" open. It immediately equalizes throughout the system. The cock "F" is then closed and if there is any leak, the pressure beyond "I" will be reduced and the pressure from the elastic bag will cause bubbles to pass through the water in the jar "C" at a rate proportional to the size of the leak. This apparatus is very handy in the shop for testing for leaks in fixtures, tanks, etc., while out on a job it is especially adapted to test house-piping.

Fig. 4, from *Machinery*, shows a tilting sand blast tumbling barrel for cleaning castings, built by the Globe Machine and Stamping Company, Cleveland, Ohio. In this apparatus, as will be seen, are combined the two methods of cleaning, namely, tumbling and sand blasting, and the result is an embodiment of the simplicity and cheapness of the tumbling barrel with the efficiency of the sand blast. The operation of the outfit is as simple as that of an ordinary tumbling barrel. The contents can be watched closely while the barrel is in operation and the tilting feature allows the barrel to be readily emptied or adjusted to give more or less violent tumbling. The sand blast barrel requires no large sand reservoir or conveying machinery. The sand is drawn by suction from the sand chamber and discharged against the work; it then drops through the perforations of the barrel into a sand chamber to be used over again. This barrel is not suitable for large castings, but for small work which can be readily tumbled. The outfit is inexpensive and has proved satisfactory in service. One man can easily operate from six to ten barrels.

Fig. 5, from *Canadian Machinery*, shows a small double emery grinder sketched in the Frog and Switch shop of the G. T. R. at



VARIOUS PNEUMATIC DEVICES.

Toronto. It is driven by a small air turbine or motor, mounted on the shaft, between two emery wheels. A reducing valve on the air line brings the pressure down to about 40 pounds per square inch, the pressure gauge being mounted where it can be easily read. It is not claimed that this is a highly economical method of driving an emery wheel, but where, as in this case, there is no belt or electric drive available, it serves the purpose admirably. For the sake of clearness, the emery wheels have been omitted in the end view. An idea of the scale of the drawing may be gathered from the fact that the thinner of the two wheels is 10 inches diameter, and that the centre of the spindle is 39 inches from the floor. There would seem to be here a possibility that the wheels might attain a dangerous speed when there was no grinding friction to act as a brake.

The air hoist device, Fig. 6, is also from *Canadian Machinery*, sent in by a contributor. When air hoists are carelessly operated the top cylinder heads are sometimes hit by the piston so hard as to break something. The coil spring shown in the cut is intended to check the piston before it strikes. The spring is made of 1-4 or 5-16 in. square steel. There should be a washer both above and below the spring and as big as the outside diameter of it.

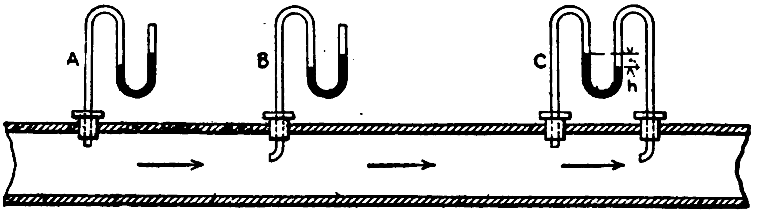
MEASUREMENT OF AIR VELOCITIES

By F. G. Hechler.

In heating and ventilating work it is often necessary to determine the amount of air supplied by a fan. The volume of air is expressed in cubic feet ,and as it is nearly always conducted from the fan through a duct either circular or rectangular, the cross-sectional area of the conduit and the velocity of the air through it should be known. The product of the area is square feet by the velocity in feet per minute gives the cubic feet supplied per minute.

The velocity may be determined in several different ways, though the most common method is by the use of an anemometer, a small-vaned instrument similar to a windmill wheel. The wheel is connected with a recording mechanism by the use of which in connection with a stop-watch, or even an ordinary watch, the speed of the air past the vanes may be determined. Its convenience is the only thing to recommend it as an anemometer, however, as its readings are subject to large and uncertain errors.

It is well known that the velocity of air in a pipe line is not the same at all points, being greatest at the center and least at the sides, where friction against the surfaces retards it. For a circular pipe the law of vari-



PITOT TUBE TO MEASURE VELOCITY OF AIR

ation is usually taken to be a parabola; the air moving in concentric layers with the average velocity at a point two-thirds of the radius from the center. This variation in velocity may partly account for the uncertain results obtained with an anemometer, and it is evident that an instrument properly calibrated may give too high a reading if held at the center of a large duct.

A better way to determine the velocity, and one which gives much more reliable results, is to use a Pitot tube. To make clear the principles on which the use of this instrument is based, its use for determining the velocity in a water main will be considered. Water is a more concrete substance than air and hence it is easier to deal with it; but exactly the same laws apply in regard to the velocity of air as hold for water.

A pressure gage connected to a pipe line will show a higher pressure with no flow than when the water is in motion, and the faster the flow the lower the pressure shown by the gage. When there is no flow the gage shows the total or static head; when the valve is opened and flow occurs a part of this head is used up in causing the water to flow: In other words, a "velocity head" is necessary to produce motion, the remaining head shown by the gage being the "pressure head." If the pipe were perfectly smooth and there were no friction losses, the sum of the velocity and pressure heads would always equal the static head shown when there is no flow. The friction losses are variable and not easily measured, but the Pitot tube gives a ready method for finding the velocity head, and from that the velocity, as shown later.

If a tube be inserted in a pipe line, as at *A*, Fig. 2, with its inner end parallel to the axis of the pipe and hence to the direction of flow of the liquid or gas, and the outer end connected to a U-tube filled with water or mercury (depending on the pressure to be measured), the difference in the height of the two columns represents the pressure head expressed in inches of water or inches of mercury. If a second tube be placed, as at *B*, with its end bent at right angles so that it is perpendicular to and faces the flow of the stream, its manometer tube will give both the pressure head and the velocity head. If then the difference between the readings of *B* and *A* are taken, the velocity head producing flow is obtained. For convenience, these two separate gages are usually combined into one, as shown at *C*. Here the tube at the left, similar to *A*, tends to show the pressure head; the tube at the right, similar to *B*, shows the pressure head and the velocity head. In other words, connecting the tubes in this manner automatically performs the above subtraction and the reading of this gage represents the velocity head.

After the velocity head is found, the velocity is calculated by the formula

$$v = \sqrt{2gh},$$

where

v = Velocity in feet per second;
h = Velocity head in feet;
g = Acceleration due to gravity in feet per second = 32.2 feet.

If the manometer contains water and the velocity of air is being determined, then the head must be changed from inches of water to feet of air by multiplying by the ratio of the density of water to that of air. To do this the temperature must be known, as the weight of a cubic foot of air and of water depends on the temperature. To illustrate, assume that the manometer reading *h*, in Fig. 2, is 1 inch of water and that the temperature of the water and of the air is 60 degrees Fahrenheit. From tables the weight of 1 cubic foot of water at 60 degrees is 62.37 pounds and of 1 cubic foot of air at the same temperature is 0.0764 pound, or the height of a column of air in feet to represent the same pressure as 1 inch of water would be

$$\frac{62.37}{0.0764} \times \frac{1}{12} = \frac{816.4}{12} = 68.03 \textit{ feet}$$

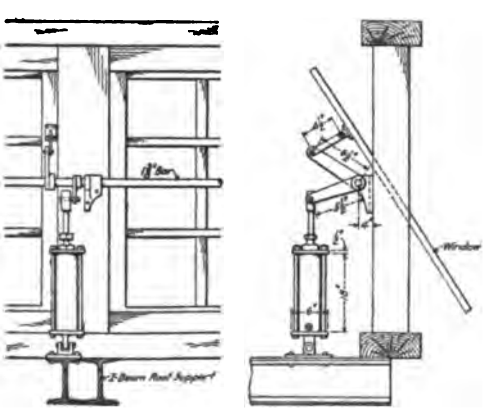
Using the equation

$$v = \sqrt{2gh} = \sqrt{2 \times 32.2 \times 68.03} = 66.2 \textit{ feet per second}$$

For any other temperatures, or if mercury is used in the place of water, the proper weights per cubic foot would have to be used. —*Power* (abridged).

THE WINDOWS WERE SUCKED IN

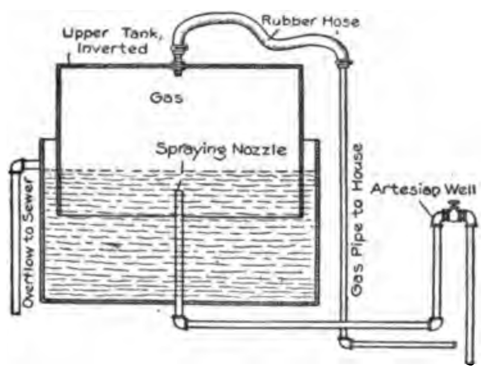
At a certain foundry a positive blower is used to supply draft for cupolas. It is located in a separate closed room, 12x16 feet, which has three glass windows 3x6 feet. The door is kept locked so that nobody can go into the room to loaf. The windows were the only way the room could be ventilated. One day the windows were closed tight. The man who had charge of the blower turned it on, thinking everything was all right, locked the door and went back to his work. In a short time there was a crashing of glass and everybody thought a terrible accident had happened. The man quickly opened the door and to his amazement the three windows were on the floor, all in pieces. After the blower had run a little while it produced a partial vacuum in the room; hence the windows were simply sucked in.—*American Machinist.*



APPARATUS FOR OPENING AND CLOSING SHOP WINDOWS

By T. M. Dryden.

An arrangement for opening and closing shop windows by compressed air is shown in the accompanying illustration. It consists of an air cylinder 18 in. long, made of 3½-in. pipe, a long 1⅜-in. bar and the necessary connections. The cylinder sets on a pin which allows it to swing when turning the rod. The rod extends the length of the shop, being connected to the windows by the lever arms as shown. There are⅜-in. air connections at the top and bottom of the cylinder to lower and raise the piston when desired. This arrangemen is used in the shop power house of the Central Railroad of New Jersey at Ashley, Pa. It operates sixteen windows, and without a doubt could handle three or four times as many. It was designed by Frank P. Meekins, foreman of the car wheel shop.—*Railway Age Gazette.*



GAS FROM ARTESIAN WATER WELLS

In the artesian basin of North Dakota there is a stretch, about 10 miles wide and 25 miles long, in which the water contains a quantity of natural gas varying from 20 to 50 cubic feet per hour, flowing out with the water at a pressure of from 25 to 65 lb. per square inch. Many farmers having an artesian well with gas are utilizing this gas to heat and light their homes. The separation of the gas from the water is effected by means of two tanks, one inverted into the other as shown in the sketch. The gas collects in the upper tank, and, as the pressure rises with accumulation, this upper tank rises until it can hold no more, the gas thereafter escaping around the lower edges into the air. When, however, the gas is used, the weight of the tank forces it through the hose at the top and the pipe connected therewith to the fixtures. One town in the artesian district has a well producing gas enough to run two 25 h. p. engines running a dynamo to light the whole town, besides furnishing water for all needs.

WONDERS OF WATER

The action of water is far more than a purely mechanical one. Water wets things and other liquids do not. Benzine, for example, although it may saturate a fabric, does not "wet" it. It has been found that most chemical reactions, in which apparently water is in no way concerned, will not proceed in the absence of water; so that water must possess some action peculiar to itself which is not yet thoroughly understood.

Water probably approaches closer to the universal solvent that the ancients dreamed or than most people suppose. There are very few things which will not dissolve to some extent in water, and distilled or rain water, which is free from any dissolved mineral matter, possesses remarkable solvent powers. If placed in a glass or earthenware vessel, it rapidly attacks the glass or the glaze of the earthenware, dissolving out the alkali. If placed in metal vessels or pipes, the metal, if it be iron, lead or zinc, is quickly attacked by the water, with probably the help of the dissolved air which it contains. This powerful solvent action of what is commonly called "soft" water, is alone a good reason for the launderer to use it as much as possible.

Another effect of this powerful solvent tendency of soft water is that as it passes through the soil, carrying, in addition to its own solvent powers, some carbonic acid from the air and some of the humic acid from the decomposing vegetable matter in the soil, both of which help it to attack the rocks, it dissolves out a large variety of mineral substances. The most common are sodium chloride (common salt), magnesium chloride and calcium chloride, calcium sulphate (gypsum), magnesium sulphate and calcium carbonate (chalk and limestone). In addition, some waters contain peaty matter derived from bog moss on the hills, and iron.

All or any of the substances just mentioned are undesirable in the washing machine, as, with the exception of the peaty matter, they combine with the fatty acid of the soap, rendering it useless from the launderer's point of view, and thereby causing a large waste, as well as the bad color, streaks and other blemishes due to the lime soap already referred to. Another objection to the presence of lime in the water used in the washing machine is that, although most of it goes into combination with the soap or is thrown out in a loose form by the soda, yet an appreciable amount very frequently is deposited in a crystalline form in the fibres of the linen, where it accumulates with every wash until the amount present is quite appreciable. These sharp crystals of carbonate of lime rapidly assist the ordinary process of wear and tear, and the life of the article becomes exceedingly short.—*National Laundry Journal.*

DYNAMITE DISAPPOINTMENTS

A young man employed on some road construction work in Virginia saw a pail standing by the road. Some one told him that the pail contained dynamite, so to show that he wasn't to be bluffed that way he kicked the pail. The dynamite exploded, and the unexpected happened, for the only injuries sustained by the young man was the loss of both shoes and the greater part of his pants. In another case three men were digging a well, and after they had got down about 5 feet, they struck some rock which required blasting. A charge of dynamite was put in, and the fuse touched off. For some reason the charge did not explode, and after waiting some time one of the men crawled up to the well to see what was the matter. Just as he had his head well over the hole the dynamite let go, the only result being that the man lost the skin from the very tip of his nose.

THE FRASCH PROCESS

The Frasch process, invented by Herman Frasch, of Cleveland, Ohio, and extensively employed in Louisiana, whereby practically pure sulphur is obtained directly from wells is as follows: A well is driven in much the same manner as a gas or oil well is sunk, and into it are placed several concentric lines of pipe. Superheated water, introduced through the outer pipe, melts the sulphur, which may be several hundred feet below the surface. Hot compressed air is then forced through the smallest of the pipes. This forms an aerated emulsion with the molten sulphur, which is forced out by hydrostatic pressure between the remaining pipes and discharged in a purified form into large vats where cooling, solidification, and feeding go on simultaneously. The sulphur is then broken up, shipped by rail to the Gulf coast, loaded on ships by machinery, and transported to Eastern coast ports.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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INDEPENDENCE IN MINE AND QUARRY

Independence is the unique ideal. It is a thing so desired and longed for that the most strenuous and protracted exertions of earnest men and the most sweeping sacrifices of all other things have from time immemorial been made to secure it. The value is in the thing itself, and is so intrinsic and enduring that too much can never be paid if necessary to secure it. Often it comes cheaply or for nothing at all, but the value inheres just the same.

Independence applies and has its value in business and industry just as much as in sociology, and ostensibly is as constantly sought for, but is not always recognized and appreciated and appropriated as soon as it comes in sight and reach. This is not to be wondered at just now, as the work of the most pronounced and efficient of modern industrial emancipators, which electricity surely is, has not been all and straigihtly for the fostering of general and permanent independence. Electricity is a wonder in power transmission, and by its alertness and adaptability has driven out some of the most established of old-time "facilities." Especially has it driven out, among other things, the small individual steam-operated apparatus, doing the same work of pumping and hoisting and hauling more readily, efficiently and cheaply.

Before, however, electricity began to show what it could do and how well it could do it, by actual performance in various fields, compressed air had become very firmly established in mines universally, and in quarries quite extensively, for the driving of the rock drills, so that in many cases in recent years it has happened that steam and compressed air and electricity have all found employment side by side where one of the agents could and should have done it all.

This is a kind of thing which is not to be tolerated in these days, and if there has not been a formal declaration of independence, the work of simplification, which is emancipation, has begun. One power transmitter instead of three is what we are to aim at. It has not been a difficult thing to supersede direct live steam for scattered and isolated service. Its wastefulness and inconvenience as compared with either air or electricity is conclusive at once against it, and it goes.

As between air and electricity the relative claims are not so easily settled, and circumstances may sometimes cause the retention of both. The one which apparently refuses absolutely to be ignored or rejected is electricity It must be had at least for lighting, and for long-distance transmission of power it has made the field its own. In many plants in these days it must be installed for these features alone, and if it could be also applied to the entire service in any particular plant, instead of employing also one or both of its chief competitors, that would be real independence for the proprietor.

For the driving of rock drills and allied reciprocating apparatus, especially the channeler for quarry work and the radial-axe coal cutter, which also is a channeler, air has, up to quite recently, monopolized the job. All at once comes along the electric-air device, which, by an adroit mechanical compromise, entirely changes the situation and makes the electric current fully competent for the last employment in mine or quarry which compressed air has claimed as exclusively its own. It is the independence which the electric-air device gives as to choice of motive power which constitutes its supreme excellence. It emancipates the employer as completely as may be from the tyranny of his servants and he may now make his arrangements with the one instead of the three. The electric-air drill or channeler, or the electric-air radial-axe coal cutter may still call itself an air-operated tool if it will, but only a wire connects it with the powerhouse.

THE DISAPPOINTING AIR RECEIVER

By Frank Richards.

In speaking here of air compressors, and more particularly of the air receivers which always accompany them, the writer has in mind those installed for service sufficiently permanent to warrant the provision of safe and economical working conditions. This includes air compressors which are installed in most of the plants of any considerable capacity. Compressed air is used as a necessity for operating rock drills, when sinking shafts, driving tunnels, and in general mining work, etc. It is also used as a time and money saver in still greater volume for a much wider range of service. Every extensive manufacturing plant must have its compressed air supply distributed throughout its works; for the larger engineering operations, such as dams and waterworks construction, and in the most extensive quarries, compressed air is superseding the isolated steam-operated pumps, hoists, shovels, stone crushers, concrete mixers, etc.

In all these extensive lines of air service, and, in fact, in all air practice, it makes a great difference as to the condition of the air when used, and especially as to the moisture which may be carried in it, much inconvenience and loss of time occurring when the air is not kept dry and clean. There is always a pretence made of attending to this necessity. Who would think for a moment of installing an air compressor without a good sized air receiver as close to it as possible? The man who would set up an air compressor without an air receiver would lose all his respectability among engineers. Respectability has, perhaps a good deal more to do with the installation of an air receiver than anything else.

SMALL STORAGE CAPACITY.

If you were to ask the whys and wherefores of an air receiver, you would probably be told that "everybody always uses them." If you pressed the matter still further, you would most likely be told that the receiver is needed for the storage of air and the steadying of the flow. Well, the total capacity of the air receiver usually installed with an air compressor does not exceed the output of the compressor for one minute. If the compressor is running continuously, and if the air is being used as fast as it is delivered, the apparatus driven by the air must come to a standstill within a single minute. So it can be readily seen that the air receiver as a storage adjunct is of little value.

RECEIVERS DO NOT COOL THE AIR.

Builders and sellers can afford to have you pooh-pooh the storage service of air receivers, but they will still assert the two-fold need of them for cooling the air and for getting rid of the moisture in it, the presence of the latter being the most serious objection to the air in use and the cause of the most trouble. Now as to the cooling of the air, how can the receiver do it? To cool the air as it comes from the compressor, there must be a cooling surface or material for the air to come in contact with, and to which it may impart its heat. The air receiver, however, is a plain cylindrical shell with no pretence of a cooling device or any arrangement of the sort within it, and the air merely passes through it hurriedly, emerging at the other end practically as hot as when it entered, giving up its heat more or less rapidly to the inner surface of the pipes through which it travels, for which cooling effect the pipes and not the receiver should have the credit.

COMBUSTION IN THE RECEIVER.

It is a curious fact that the air receiver, so far from being an air cooler, has often been transformed into a combustion chamber. Numerous authenticated instances are cited of receivers which have become red-hot while compression and transmission were going on, and flames have been emitted at the ends of the pipe at a considerable distance from where the air was "stored;" receivers have also sometimes exploded, which is much worse. When single-stage compressors are worked up to desirable service pressures, say 80 to 90 pounds gage, the temperature of the air discharged (water jackets having very little effect upon it) is high enough to volatilize the lubricating oil used; this oil-gas mingling with the air in such proportion as to form an explosive mixture, may be diffused through the receiver and into the pipe lines. Then if there is a sufficient increase of temperature to cause spontaneous ignition, or if there is a friction spark, disastrous and often fatal explosions result. It is well known that for the formation of an actively explosive mixture of oil-gas and air, the two constituents must be mingled in certain proportions, the limits of which, in either direction, have been quite precisely determined, and if either the oil-gas or the air be in excess when ignition occurs, there is no sudden explosion, but simply the active combustion which makes the recevier and air pipes hot. Although this is sufficiently alarming when discovered, it may be assumed that the danger of explosion is past.

If lubricating oil is used to excess in the air cylinder, it may accumulate in pockets or upon the horizontal surfaces for a considerable time, and when favorable conditions occur it may take fire and burn from the surface, just as the soot in a chimney takes fire. The activity of the combustion is not to be wondered at when it is remembered that on account of compression, the quantity of oxygen per unit of volume has increased six-fold or more, according to the pressure carried.

THE RECEIVER DOES NOT DRY THE AIR.

While the air receiver is not, thus, a cooler of the air, it also is not, for the same reason, an abstractor of the moisture in the air, this being the most desirable service which it could render, and which it has been too readily assumed to do. It is well enough understood that atmospheric air—free air—always carries moisture and also always has capacity, or as we might say appetite, for more, up to the point of saturation, when its avidity suddenly ceases. The moisture-carrying capacity of the air rises very rapidly with its rise in temperature, and diminishes, but not so rapidly, with rise of pressure. As the pressure must always be at the highest point just when the air is leaving the compressor, if we can then reduce its temperature to the lowest point, the air will be in a condition to surrender so much of its moisture that none will be found later to cause trouble, when lower pressures and perhaps higher temperatures are reached further along the line. It being thus sufficiently evident that the best place for drying the air is as near the compressor as possible, the first requisite is an efficient cooler or, rather, aftercooler for the air.

The air receiver, as has been said, has never been a cooler of the air, and the builders are now testifying to this fact by the number of aftercoolers they are offering. The best of these are highly efficient, and the air after going direct from the compressor and through the intercoolers is in the precise condition desired—that is, of high pressure and low temperature—for the surrender of its moisture. For the important service which the aftercooler may render, nothing could be expected to work more cheaply. There is only the first cost of the apparatus and connections, and then a sufficient supply—not large—of free running water.

Now, surely the air receiver is available for depositing the excess moisture which the aftercooler has liberated, and for sending forth the air sufficiently dry for all subsequent employment. Unfortunately, the typical air receiver still persists in its inefficiency, and the air passes through and out of it wet, or carrying a considerable amount of free moisture. It is to be remembered that when the saturation point is lowered by the lowering of the temperature of the air, and there is a relinquishing of the surplus moisture by condensation into water, that water still remains in the air, as mist or fog, and what is then needed is a separator. Any of the separators which are successful in drying steam are equally efficient in taking the liberated water out of the air, when it is in the condition here spoken of. The efficiency of such separators is due to the habit which water has, and which liquids like alcohol, benzine, etc., do not possess, of wetting or clinging to the surfaces with which it comes in contact. A constant repetition of this wetting process causes the water to drip or flow off and accumulate in pockets provided, from which it may at intervals be drawn off.

IMPROVE THE AIR RECEIVER.

An air receiver of the common type, preferably horizontal, if merely provided with a series of baffle-plates (which might be added without much additional cost) would be an efficient separator, provided that the air passing through it were in the prescribed condition of high pressure and low temperature. Indeed it would seem to be quite possible to combine in one apparatus the two functions of cooling the air and separating the freed water from it, and it might also be made large enough to constitute a storage capacity equal to that of the plain air receiver. It would seem to be almost an absurdity to be still installing the latter.—*Machinery,* with some additions by the writer.

CONSTANT COMPRESSED AIR VOLUME WITH VARYING PRESSURE

In general compressed air practice the usual requirement is the maintenance of a constant pressure while furnishing a varying volume, but it appears that the successful operation of water-gas sets depends primarily upon constancy of volume of air supplied the generator, and not upon constancy of pressure. By furnishing a constant volume at high pressure the blast period is cut down, permitting a longer "making period," which results in a material increase in the capacity of the gas generator.

If each gas generator had its own individual blower this would bring the task of governing it back to the ordinary method of governing the stationery engine by the maintenance of constant speed, this giving practically the volume required. When, however, generators take their air from a common blower installation the case is different. To maintain this constant volume under such conditions, regardless of the varying resistances of the fire, a gate or apertured disc will serve, although the Venturi tube is coming into general use. The constant volume is a result of maintaining a differential of pressure through the tube; in other words, if the drop of pressure is kept constant, the volume per any given unit of time will be constant, therefore a valve is placed in the tube to open or choke the pipe as much as is necessary to maintain the constancy in the pressure drop.

To operate the water gas blowing set for these conditions, the speed is maintained to deliver the maximum volume required at a pressure which will drive the desired volume through the fire, regardless of the existing back pressure due to clinkering, etc. To run a blower at such high speed requires in the case of steam driven set that the turbine be developed for this special service, capable of giving a blast pressure considerably over 30 inches W. G. In some recent tests with very large blowers, over 40 inches W. G. was maintained.

STEAM OR AIR FOR ATOMIZING FUEL OIL

By A. M. Hunt.

In order that petroleum may be burned with complete combustion, it is necessary that it be either gasified or injected in the form of a spray into the furnace in which it is burned. The general practice is to deliver the oil to the burner under head and then nebulize it, using air or steam for the latter purpose. Most fuel oils are of a viscous character and are generally preheated in a heater using the exhaust steam from the pumps which handle the oil; this greatly reduces the viscosity. The burners should be so designed that the relative areas of openings for oil and the atomizing medium can be maintained, or, if they become enlarged by scoring, that adjustment can be readily and inexpensively made. A considerable number of tests examined by the author show that an average of 4 per cent. of the steam evaporated by a boiler is required for atomizing the oil fuel (minimum, 2.39 per cent.; maximum, 7.4 per cent). In designing a plant a consumption of 5 per cent. should be assumed. In operation if the amount required is much in excess of 3 per cent., it may be concluded that the condition can be bettered.

In certain metallurgical and industrial operations, especially where high temperatures are desirable, the use of air under pressure for atomizing the oil is to be preferred. In a rotary cement kiln, 7½ ft. diam. by 125 ft. long, producing 500 bbl. of clinker daily with a single burner delivering 4 gal. oil per min., the air used—at 80 lb. pressure—was 25 per cent. of the weight of the oil atomized. A reverberatory copper matting furnace, hearth 80 × 17 ft., with roof arch 39 in. above the surface of the bath on the hearth, required 36,472 lb. oil for smelting 182 tons. The air was supplied by a Connersville blower at 9 lb. pressure, and 1 lb. air was required for each 2 lb. of oil burned. A manufacturer gives the following data: For marine boilers allow 0.2 cu. ft. of free air for each boiler H.P., the air being supplied at about 25 lb. pressure. In burning sewer pipe, about 5 cu. ft. of air per min. is required for each burner using 5 gal. of oil per hour. A 10-cu. ft. compressor running at 20 lb. pressure will supply air sufficient to atomize the oil fuel required by a boiler for heating a small apartment house by steam. A compressor for a 2500-H.P. boiler installation was designed to furnish, at full capacity, air weighing 55 per cent. of the weight of the oil atomized.—Condensed from *Journal of Electricity, Power and Gas.*

NOTES

Pittsburgh, Pa., is hereafter to have its name always spelled with the h as above, the feelings and wishes of the Pittsburghers being accounted of more weight than those of all the "simplified" spellers in the United States.

The firm of Krupp, in Essen, Germany, this year celebrates its hundreth anniversary. The firm was established in 1811, and for fifteen years only six persons were employed. Now the total number of employes is 70,000.

Machinery arrangement, artificial shop lighting and the advantages and disadvantages of concrete floors, composition floors and wood floors for manufacturing plants are to be made the special subject for a meeting Tuesday evening, October 10, of the American Society of Mechanical Engineers, at the Engineering Societies Building, 29 West Thirty-ninth street, New York City.

The Alexander Gibson, believed to be the last full-rigged American ship, is being dismantled for conversion into a coal barge. Her tonnage is only about one-twentieth of that of the biggest steamships of to-day.

More acetylene gas can be transported in the form of calcium carbide, and at less cost than in any other way. A can of carbide 13 by 23 inches weighs 100 pounds and will yield 400 cubic feet of acetylene. Transportation in this form is of course absolutely safe.

Old Sanly McPherson and young Aleck McDonald were working together over at the power plant, when Aleck says, "Sandy, what is this 'ere stuff they call vaakum?" Sandy replies: "It is naught, lad; it is nothing." Aleck says: "Sure it must be som'ot, Sandy, it must be something, for they keep it in pipes here."—*Power.*

Carbonic acid in the atmosphere arises from respiration of animals, from processes of combustion, from the decomposition of organic substances. Boussingault estimated that in Paris the quantities of carbonic acid produced every 24 hours were: population and animals, 11,895,000 cubic feet; combustion, 92,101,000 cubic feet.

A mixture of acetylene and air becomes explosive when there is 3.35 per cent. of acetylene present; while a mixture of coal gas and air does not become explosive until the amount of gas present reaches 7.9 per cent. Air may be added to coal gas and the mixture will not become explosive until the percentage of coal gas is reduced to 19.1 per cent. of the mixture; while if air is added to acetylene the mixture becomes explosive as soon as the acetylene has fallen to 52.3 per cent.

The use of stage compression of air at high altitudes is recommended by the fact that a larger percentage of saving is possible by this system than would accrue at sea level. The compressor must be larger for a given output than at normal atmospheric pressure, and the first cost, accordingly, greater. The ratio of compression is smaller at the high altitude, and the percentage loss from piston clearance larger, while the value of the inter-cooler is greater where the range of pressure through which the air must be carried is increased.

According to the Consolidated Gas Company of New York City, it requires 810,000 tons of coal per year to make gas for the boroughs of Manhattan and the Bronx. This means 20,250 cars of 40 tons capacity each, or a train about 130 miles long. With this coal, 90,000,000 gallons of oil also are used. Figuring this on its equivalent heating value in coal, and allowing 3.7 pounds of coal per horsepower-hour, this fuel would develop 80,000 horsepower for one year of 365 days of 24 hours each. For 300 days of 10 hours each, it would develop 234,000 horsepower.

The importation of needles at Chungking last year increased by 31,963,000 to 334,700,000. In many parts of the province these are put to a use that is not, perhaps, generally known. It is customary to ornament the center of the roof ridge of a Chinese house with an elaborate plaster decoration—usually in the form of a design embodying the character *fu*, meaning "happiness." To prevent this being damaged by the depredations of crows, large numbers of needles are stuck point outwards into the plaster while it is still soft.

M. Chaumet, the French Postmaster-General, has decided to offer a prize for the best pneumatic-tube system. The "petitbleu," or threepenny pneumatic post, which is often as speedy as a telegram, and enables a long communication to be cheaply sent, has become so popular in Paris that the service has recently been extended to all the nearer suburbs. A further extension is provided for in the 1911 Budget, and M. Chaumet is anxious to find out if some improvement cannot be secured by changing the existing plant. Three prizes are offered: $300, $200 and $150 respectively.

In probably the first accident of the kind, Philip Burrell was burned to death and "Pick" Mann was perhaps fatally injured when a threshing outfit exploded a gas pipe on a road two and a half miles north of Lawrenceville, Ind. Burrell had been operating the outfit for his father, William Burrell, and while going along the road the heavy traction engine ran over a high pressure gas line, breaking the pipe. Instantly the flames shot 50 ft. upward through the leak, enveloping the engine, separator and stacker of the threshing outfit. Burrell, who was the engineer, was caught between the engine and the separator and slowly burned to death. Mann, who was riding on the thresher, leaped to the ground, and, although flames enveloped him, he managed to get out of the zone of the fire, but not until he had been dangerously burned.

There is a great deal of discussion at the present time on the needless waste of using compressed air for atomizing purposes when superheated steam will answer, but in the small casting business one of the main difficulties is getting the metal hot enough to run the thin sections in the molds, and since, by its very nature compressed air, while atomizing the oil, furnishes at the same time oxygen for combustion, and that, too, very intimately mixed with the oil, it is quite evident that by using air we would get quicker combustion, a shorter flame and a somewhat hotter furnace.

"As drunk as a fish" is a common expression, but not many people ever saw a fish drunk. However, those who attended a temperance demonstration by E. F. Sutherland, of Columbus, Ind., were permitted to see intoxicated fish. Sutherland placed fish in a tank of water and added alcohol to the water. In a little while the fish began cutting capers that would have surprised any self-respecting members of the finny tribe. By and by the alcohol became too strong for the fish, and they started to turn on their backs. Sutherland saved their lives by transferring them to fresh water.

A peculiar mine-cage accident, Sept. 3, in the shaft of the Black Rock mine, near Butte, Mont., caused the death of six miners. A load of dull drill steels was being hauled to the surface on the cage, and the six men boarded the cage to ride up with the steel, in violation of the mine rules. According to press reports, the drill steels became dislodged during the ascent so that some of them projected from the cage and struck against the sides of the shaft. This caused their other ends to thrash about in the cage. The men were bruised and mutilated by the steels and, according to reports, were finally swept from the cage, falling 1,400 ft. to the bottom of the shaft.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 1.

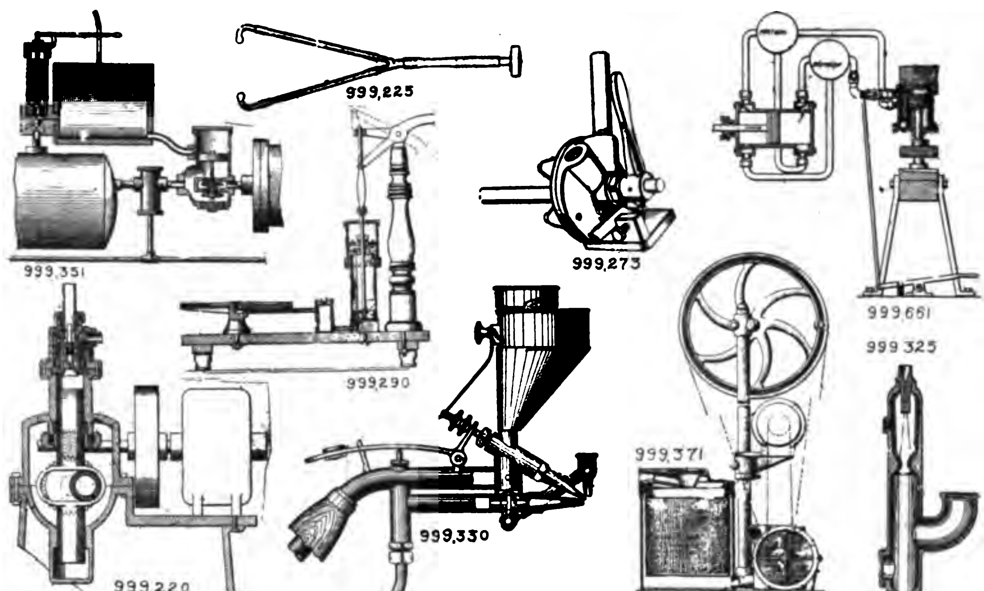
999,220. AIR OR GAS COMPRESSOR. CHRISTOPHER C. HARMON, Charlotte, N. C.
999,225. VIBROSCOPE. CHARLES F. HOPEWELL, Newton, Mass.
999,269. PNEUMATIC DUST-SEPARATOR. IRA H. SPENCER, Hartford, Conn.

AUGUST 8.

999,732. AIR-BRAKE FOR VEHICLES. CHARLES ANSPACH, Amherst, Nebr.
999,779. PNEUMATIC CLOCK. AUGUSTUS L. HAHL, Chicago, Ill.
999,870. ELECTRICAL APPARATUS. KARL C. RANDALL, Edgewood Park, Pa.

2. The combination with electric apparatus and an inclosing casing therefor, of a relatively high-pressure storage reservoir, a pump for supplying dry air thereto, and means for supplying dry air from the storage reservoir to the casing at a reduced pressure.

999,880. HOT-AIR PRODUCER AND BLOWER. AUGUST SCHAEFFER, Frankfort-on-the-Main, Germany.
999,985. OVERDRAFT-BLAST FOR FORGES. JOHN GEIST, Nashville, Tenn.
1,000,001. VACUUM APPARATUS FOR HYPEREMIC TREATMENTS. ROBERT A. C. HOLZ, Cleveland, Ohio.
1,000,021. PUMP. JOHN LEE LATTA, Hickory, N. C.
1,000,032. PNEUMATIC STACKER. WILLIAM RUSSELL MILLER, Hamilton, Ontario, Canada.



PNEUMATIC PATENTS AUGUST 1.

999,273. FLUID-PRESSURE VALVE. WILLIAM W. TEMPLES, Columbus, Ga.
999,290. VACUUM-PUMP. FRANK ARONSON, Evanston, Ill.
999,325. VACUUM CLEANING APPARATUS. GEORGE W. MACKENZIE, Ben Avon, Pa.
999,330. PAINT OR COLOR DISPERSER WITH MORE THAN ONE AIR-NOZZLE. HANS MIKOREY, Schoneberg, near Berlin, Germany.
999,351. AIR-BRAKE APPARATUS. JOHN H. WALLACE, San Francisco, Cal.
999,371. VACUUM-CLEANER. WILLIAM H. KELLER, Philadelphia, Pa.
999,506. AIR-TIGHT VALVE FOR PNEUMATIC TIRES. MORRIS LEVRANT, New York, N. Y.
999,604. PNEUMATIC DUST-SEPARATOR. IRA H. SPENCER, Hartford, Conn.
999,661. AUTOMATIC TOOL-FORGING MACHINE. LORENZA H. KUNKLE, Altoona, Pa.
1,000,075. TUNNELING-MACHINE. WILLIAM R. COLLINS, Georgetown, Colo.
1,000,130. ROCK-DRILL. JAMES A. THOMPSON and EDWIN M. MACKIE, Franklin, Pa.
1,000,169. WATER-ELEVATING APPARATUS. THOMAS W. GRAY, Woodville, Pa.

1. In a liquid-lifting apparatus controlled by a supply of compressed fluid, a liquid-holding chamber, an outlet pipe therefor, an inlet valve-seat between the compressed-fluid supply and the chamber, a valve actuated by differential pressure and seating in the direction of the flow of fluid through the seat and having its smaller area in contact with the fluid, an exhaust valve-seat for the said chamber, a valve therefor actuated by differential pressure and seating in the direction of the flow of the exhaust fluid from the chamber through the said exhaust valve-seat, a passage leading the compressed-fluid supply to the larger areas of the said valves, and means controlled by the liquid-level in the chamber for

exhausting the pressure on the said larger areas of the valves when the liquid is at a minimum low level and for closing the said fluid exhausting means when the liquid is at a maximum higher level.

1,000,182. AERATING - MACHINE. JOSIAH CHARLES FREDERICK LAWRENCE, Prahran, near Melbourne, Victoria, Australia.

1,000,193. REVERSING-VALVE MECHANISM. WILLIAM C. POST, Estherville, Iowa.

1. In an air pump for locomotives, the combination with opposed cylinders, of a reversing valve and a reciprocable valve operating stem arranged on one end of the cylinders, pistons respectively arranged within each of the cylinders and connected by a piston rod, one end of the piston rod projecting beyond the end of the cylinder opposite the reversing valve and its stem, a valve rod movably supported by the cylinders and arranged in parallel with the said piston rod, an arm connecting the valve rod and the valve stem, and means connecting the piston rod and the valve rod for moving the latter and thereby actuating the valve stem upon movement of the said pistons in either direction.

1,000,561. AUTOMATIC PIANO. FLOYD F. STAUFFER, Dallas, Tex.

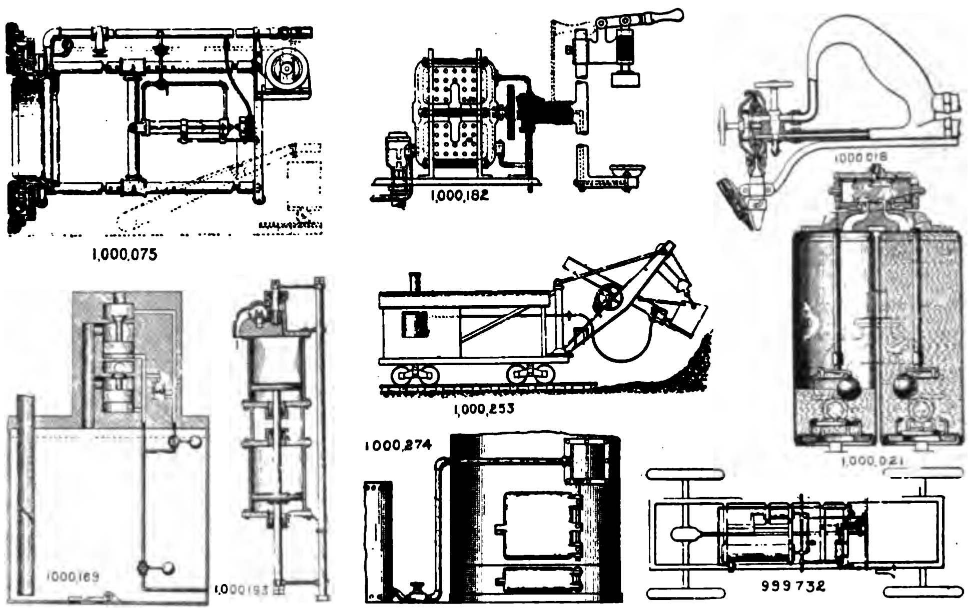
1,000,566. ROTARY PUMP FOR VACUUM SYSTEMS. AXEL WESTER, Minneapolis, Minn.

1,000,568. PNEUMATIC HAMMER. MELVIN ALBERT YEAKLEY, Kamms, Ohio.

1,000,615. AIR-PUMP. CHARLES W. MCGARY, Everett, Mass.

1,000,669. APPARATUS FOR OBTAINING GAS FROM WELLS. AUGUSTUS STEIGER COOPER, Los Olivos, Cal.

An apparatus for the recovery of gas from wells consisting of a well casing provided above the liquid column with a gas outlet, of a continuously open flow pipe extending down from the surface of the well to the vicinity of its bottom and closed at its lower end to the liquid of the lower portion of the liquid column in said well, a second continuously open pipe, the upper end of which is open to the liquid of the upper portion of said liquid column and thence extending down in the well, its lower end communicating with the lower end of the flow pipe to deliver thereto liquid only from the upper portion of the liquid column, a pipe extending from



PNEUMATIC PATENTS AUGUST 8.

1,000,253. DIPPER - TRIP FOR STEAM-SHOVELS. ALBERT H. GEDDES, Empire, Canal Zone.

1,000,274. FURNACE-DOOR OPENER. SHEPARD LYON, Sault Ste. Marie, Mich.

1,000,286. LIQUID-PISTON VACUUM-PUMP. MARCEL ANDRE MOULIN, Paris, France.

1,000,298. PREPARATION FOR SLOWLY LIBERATING OXYGEN. LEOPOLD SARASON, Hirschgarten, near Berlin, Germany.

AUGUST 15.

1,000,377. ACCENTING DEVICE FOR PNEUMATIC-PIANO-PLAYER ACTIONS. JAMES W. CROOKS, Mount Vernon, N. Y.

1,000,382. VACUUM CLEANING-MACHINE. ORA DRAKE, Cleveland, Ohio.

1,000,467. PRESSURE-REDUCING MECHANISM FOR MOTIVE-FLUID DRILLS. DANIEL S. WAUGH, Denver, Colo.

1,000,539. GASEOUS-FLUID COMPRESSOR. ERNEST NAUER, Chicago, Ill.

a source of air pressure down into the well and provided at its lower end with an upturned portion projecting into the lower end of the flow pipe and adapted to deliver a stream of air under pressure therein.

1,000,689. PULP-AGITATING APPARATUS. WILLIAM CAMPBELL PATERSON, Denver, Colo.

1,000,690. WINDMILL-ACTUATED AIR-COMPRESSOR. STEPHANE PICHAULT, Valenciennes, France.

1,000,713. COMPRESSED-AIR WATER-ELEVATOR. FRANK PETER CALLOW, Salt Lake City, Utah.

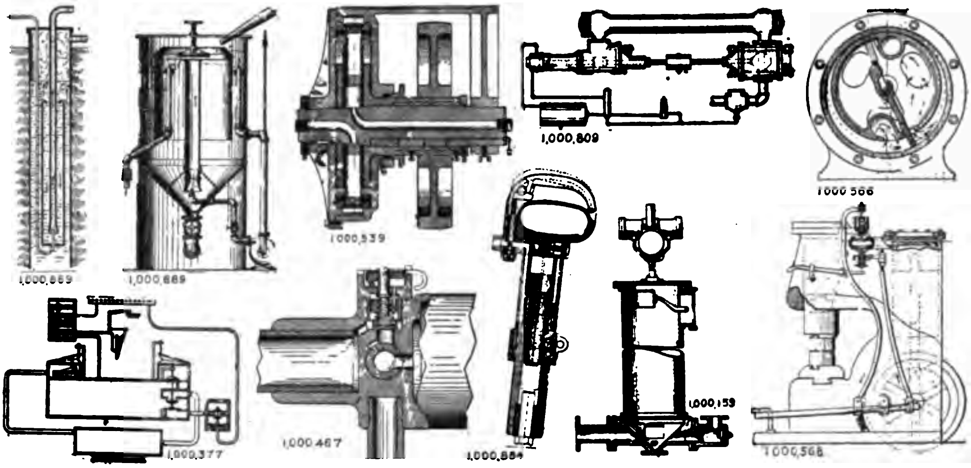
1,000,721. DIVING-HELMET. ANTON CYPRA, Worcester, Mass.

1,000,729. FLUID-PRESSURE REGULATOR. AUGUST GLOECKLER, Chicago, Ill.

1,000,759. AIR-PUMP. PAUL SCHOU, Copenhagen, Denmark.

1,000,809. AIR-COMPRESSOR. EBENEZER HILL, Norwalk, Conn.

1,000,858. VACUUM-CLIP. CHARLES B. ULRICH, Hancock, Mich.



PNEUMATIC PATENTS AUGUST 15.

1,000,884. PNEUMATIC TOOL. ALBERT BALL, Claremont, N. H.

1,000,905. PRESSURE-FED TOOL. GEORGE H. GILMAN, Claremont, N. H.

1,000,972. ELECTRO-PNEUMATIC PHOTO-EXPOSURE APPARATUS. KARL W. THALHAMMER, Los Angeles, Cal.

2. The combination in electro-pneumatic photo exposure apparatus of pneumatic mechanism for operating a camera shutter, an air-tank provided with an outlet, means to compress air in the air-tank, a tube leading from such outlet to said pneumatic mechanism, a valve to normally close the outlet, and electro-magnetic means to open the valve.

AUGUST 22.

1,000,979. PNEUMATIC-DESPATCH-TUBE APPARATUS. LOUIS G. BARTLETT, East Somerville, Mass.

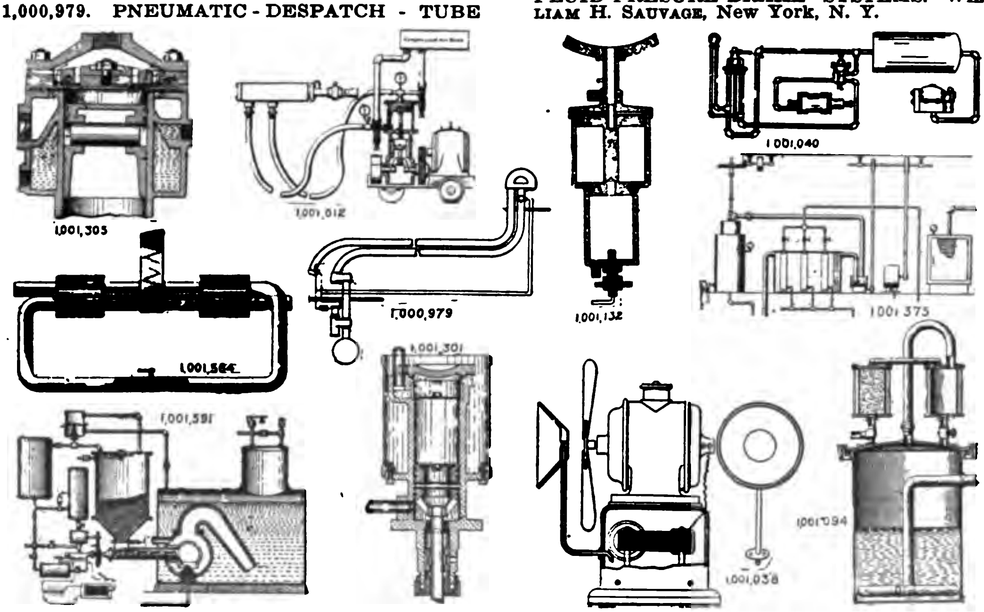
1,001,012. PNEUMATICALLY-OPERATED ROCK-DRILLING ENGINE. GEORGE A. FOWLER, Denver, Colo.

1,001,038. APPARATUS FOR PURIFYING AIR. FRIEDRICH GEORG JANICH, Rheydt, near Dusseldorf, Germany.

1. An apparatus for the distribution of ozone in the air comprising in combination a fan, an ozonizer with discharge conduit opening in front of the blades of this fan and a funnel-shaped screen with closed bottom arranged between the said blades and the discharge conduit.

1,001,040. AIR-BRAKE EMERGENCY-VALVE. LEE O. JOHNSONBAUGH, Lebanon, Ind.

1,001,084. SAFETY SIGNAL DEVICE FOR FLUID-PRESURE-BRAKE SYSTEMS. WILLIAM H. SAUVAGE, New York, N. Y.



PNEUMATIC PATENTS AUGUST 22.

1,001,094. AIR - FILTER. Harry Torchiani, Chicago, Ill.

1,001,132. APPARATUS FOR COMPRESSING AIR. Herbert H. Frey, Detroit, Mich.

1,001,297-8. PNEUMATIC HAMMER. Reinhold A. Norling, Aurora, Ill.

1,001,301. AIR OR GAS COMPRESSOR. Bernard Rathmell, Liverpool, England.

1,001,305. AIR-COMPRESSOR. Edward A. Rix, Oakland, Cal.

1,001,306. LUBRICATING SYSTEM. Edward A. Rix, Piedmont, Cal.

1,001,375. PROCESS OF PREPARING FOOD PRODUCTS. Thomas Edwards, Washington, D. C.

1. A process for preparing oysters, clams or smilar shell fish which consists in grinding them and placing the same in a heated receptacle, then agitating the mass to break it up into small particles and at the same time forcing heated air under pressure there through to expel the moisture therefrom and reduce the mass to a mushy consistency, then subjecting to an evaporating operation and finally pulverizing the mass.

1. The combination with a generator, of a combustion chamber therein communicating with the generator, a fuel receptacle protruding into the combustion chamber, means for regulating the supply of fuel to the combustion chamber, means for supplying the combustion chamber with fluid fuel and air under pressure, and means for igniting the fluid fuel under pressure, substantially as described.

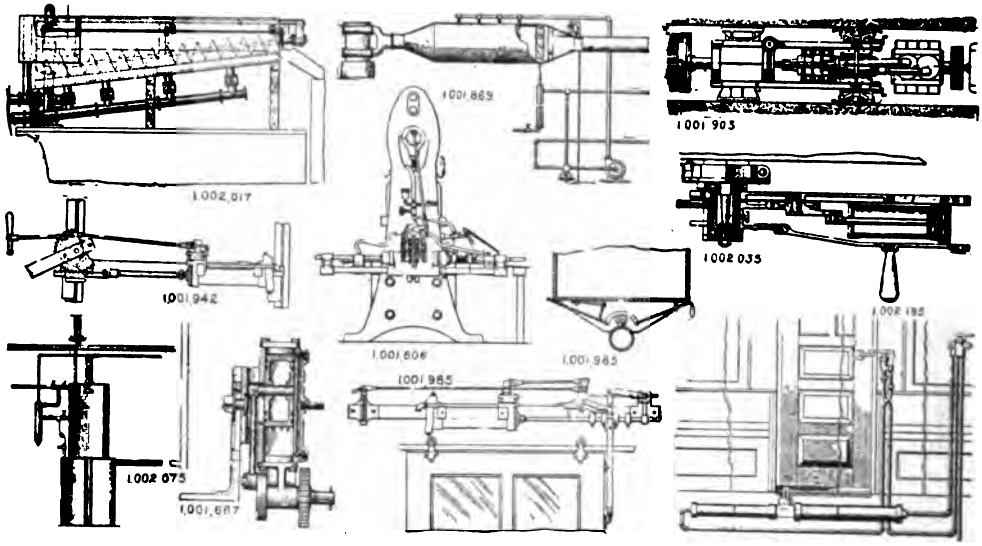
AUGUST 29.

1,001,606. AUTOMATIC PNEUMATIC FEED FOR PUNCH-PRESSES. Conrad Baumgartner, Schenectady, N. Y.

1,001,667. AIR-PUMP. John J. McIntyre, Hartford, Conn.

1,001,869. HUMIDIFYING APPARATUS AND MEANS FOR CONTROLLING SAME. Joel Irvine Lyle, Plainfield, N. J.

1. Means for humidifying and cooling compressed air including means for varying the temperature of the air as the pressure thereof varies, and compensating means for proportion-



Pneumatic Patents Auugst 29.

1,001,429. PNEUMATIC CONTROL SYSTEM. Lawrence S. Nash, Detroit, Mich.

1. In an automobile, change speed and reverse drive transmission mechanism, brakes, pneumatically operated means connected to the change speed and reverse mechanisms and to the brakes for throwing said mechanisms into action and for applying the brakes, and manually operable means for admitting air selectively to said pneumatically operated means adapted to automatically set the brake applying mechanism into action by admitting air thereto when shifting the air supply from the change speed to the reverse drive mechanisms.

1,001,564. ATTACHMENT FOR COTTON-GINS. James L. Standard, Hamburg, Ark.

1. In a device of the kind described the combination with a plurality of seed boxes of a plurality of valves one of each arranged immediately below a respective seed box, and a pair of blow pipes adjacent each other arranged below each of said valves and in communication therewith, said valves adapted to direct the seed into one or the other of said blow pipes and means to direct a current of air into one or the other of said blow pipes, substantially as shown and described.

1,001,591-2. APPARATUS FOR GENERATING MOTIVE FLUID. George B. Hayes, Denver, Colo.

ing between the temperature and pressure variations to maintain a constant weight ratio between the moisture and air.

1,001,903. ROCK-CUTTING APPARATUS. Robert Temple, Denver, Colo.

1,001,923. PNEUMATIC FOR AUTOMATIC PIANOS. William G. Betz, Steger, Ill.

1,001,942-3-4. PNEUMATIC DOOR-OPERAT-

1,001,985. AIR-BRAKE-RELEASE DEVICE. Alex Woods Rollings, Montgomery, Ala.

ING MECHANISM. Paris R. Forman, Chicago, Ill.

1,001,988. CUSHION MECHANISM FOR PNEUMATIC DOOR-CONTROL DEVICES. Harold Rowntree, Chicago, Ill.

1,002,017. VACUUM STOCK THICKENING AND WASHING MACHINE. Thomas Edwin Warren, Ticonderoga, N. Y.

1,002,035. AUTOMOBILE AIR-PUMP. Antoine M. Clement, New York, N. Y.

1,002,075. VACUUM-PUMP AND CLEANING APPARATUS. Leal L. Montgomery, Superior, Wis.

1,002,195. PNEUMATIC DOOR-OPERATING MECHANISM. Thomas R. Brown, New York, N. Y.

1,002,088. FURNACE-DOOR OPENER AND CLOSER. Thomas E. Smythe, Bellefontaine, Ohio.

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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FIG. 1. GENERAL VIEW OF CHANNEL WORK IN THE HUDSON NEAR MECHANICVILLE.

SPECIAL DEEP-HOLE DRILLS AND WORK ON THE BARGE CANAL

By Lucius I. Wightman.*

In these drills, called "autotraction drills," the drill truck or carriage consists of a heavy timber frame mounted on flanged steel wheels running on a track of wide gage. Chain-and-sprocket and gear drive between the forward truck wheels, and an independent reversing engine on the rear of the frame, provide for the movement of the machine along its track from hole to hole. Over the forward wheels is a turntable about 8 ft. in diameter, which is rotated by means of a hand crank operating a pinion and outside gear on the circumference of the turntable. Clamping screws lock the turntable in any position desired. Built up on the turntable is the drill mounting or frame, of steel angles and channels

*29 Broadway, N. Y. City.

rigidly braced. The base of this frame, made of two channel irons, extends forward beyond the turntable about 3 ft., and carries a heavy jack-screw which is run down to a block on the ground, giving rigidity to the drill rig when at work. The vertical members of the frame are channel irons which serve as guides for a heavy cast-iron block to which the drill proper is bolted; and this block is raised or lowered, with the drill, by means of steel cables passing over sheaves at the head of the frame to a drum below geared to a small reversing engine. In the particular drills here described, the weight, with the drill, has an up-and-down travel of about 16 ft. This travel or length of feed can be altered, when a machine is built, to suit the conditions under which it is to operate. In the present case it was necessary to provide only for holes 12 to 15 ft. deep.

The drill proper is a standard Ingersoll-Rand rock-drill, of "H-61" submarine type. Its cylinder diameter is 5½ ins., the stroke 8 ins. At 75 lbs. pressure it has a speed of about 250 blows per min. The machine has the standard features of "Sergeant" release rotation, cushion back-head spring, and U-bolt chuck. Air is supplied through a length of hose leading to a throttle valve placed within easy reach of the operator's hand, close to the lever controlling the feed engine. The drill and frame are so placed on the turntable that when the turntable is resolved the steel describes the arc of a circle 10 ft. in diameter, swinging to both sides of the machine.

A small water pipe about 15 ft. long, with a hose connection, is swung from a block-and-tackle at the head of the frame, and gradually fed downward into the hole, as the steel descends. In the Barge Canal work, water at 20 lbs. pressure is piped all over the ground, and the drill pipe takes its supply from these mains. But a small direct-acting pump is mounted on the truck, by means of which water can be drawn from any pool or other source at hand and forced through the water pipe into the hole. Compressed air for the drill and engines is taken from air mains, laid over the work.

The work on which these drills are engaged is in Sections 68 to 72 of the New York State Barge Canal, on the Champlain Branch, running northward in the Hudson Valley from Troy through Waterford, Mechanicville and Stillwater. The contract at Waterford is in the hands of the Merion Construction Co. The Shanley-Morrissey Co., Inc., is the contractor for the divisions at Mechanicville and Stillwater. The canal construction in these sections consists in the deepening of a portion of the Hudson River channel to form a waterway for barge traffic 200 ft. wide and 12 ft. deep in the clear.

In the greater part of these sections, excavation has been carried on by a method calling for the construction of cofferdams shutting off portions of the river channel, the space within being pumped out by centrifugal pumps. These portions vary from a quarter of a mile up to a mile in length, and in many cases the cofferdams extend from the shore to islands in mid-channel. The exposed river bed is removed to the proper depth and width by drilling and blasting, loading the muck by steam shovel, and hauling away the waste in dump-car trains by steam locomotives. In some places this method could not be applied, and the river bed has been drilled and blasted and dredged on to barges, by means of a combined submarine drill scow and dipper dredge. The completed work will afford a clear channel paralleling the river, adapted to the heavy-draft vessels contemplated for the Barge Canal service. At Stillwater a tying-up basin or harbor is being excavated between two islands, beside the canal channel.

The rock encountered in these sections is a black Hudson shale, hard and brittle in its bed but crumbling under the atmospheric action when exposed. It lies at an acute angle so that the river bottom, when exposed, presents a jagged, hummocky appearance with a surface so rough and irregular as to make transportation of any kind over it impossible without laying track or building roadways.

At the time of the writer's visit to the work, drilling operations were temporarily suspended on all sections except one at Stillwater. Between Mechanicville and Waterford, the bursting of a cofferdam had flooded the bed and forced the removal of all drills and steam shovels, while the dam was being repaired and the water pumped out. At Stillwater, below one of the completed locks, there were in operation two of the auto-

FIG. 2. TWO AUTOTRACTION DRILLS AT WORK.

traction drills, two steam shovels, and one well drill. At this point the autotraction drills were working on the bench about 100 yds. ahead of the shovel. They were running on a single track, one about 50 ft. ahead of the other. The working gang consisted of a drill runner and two helpers for each machine, with two or three extra men for laying track ahead.

The method of operation may be briefly defined as follows: The turntable of each drill is swung with the drill frame at right angles to the track; the jack-screw is set and a hole is drilled. The steel is withdrawn, the turntable swung until the frame is parallel to the track and another hole drilled midway between the rails. The turntable is then swung to the opposite side and the third hole drilled. Thus three holes are put down from each position of the machine, two on a line at right angles to the track, 10 ft. apart, and one 5 ft. in advance of the others and on a line midway between them. The drill is then moved forward on its track 5 ft., bringing the center of the turntable over the last hole between the rails, and three more holes are drilled in the same arrangement. When the following drill has caught up with the first holes of the leading drill, both are moved forward 50 ft. and started anew. This gives a triple row of holes 5 ft. on centers each way. When the needed length has been covered, drills and track are moved and another triple row of holes paralleling the first is put down. The steel used is solid, 2 ins. in diameter, 15 ft. long, terminating in a 4-in. cross bit. It makes a 4-in. hole 12 to 15 ft. deep as required. The water jet in the hole flushes out the cuttings and gives the bit a clear face to work upon.

One hole was timed and was put in 15 ft. deep in 12 min. The drill-runner stated that his regular performance with his machine was from 160 to 200 ft. of 4-in. hole per 8-hr. shift. The best record on the work, under test conditions, was 165 ft. of 4-in. hole drilled in 4 hrs.

In operation, the drill-runner stands on the turntable, with the throttle valve and feed engine lever before him. The hole is started on short stroke in the usual way. The runner watches the drills and feeds the weight, with its drill, downward just enough to give full stroke without striking the heads. The weight of the cast-iron block absorbs the recoil of the drill. One man tends the water jet, lowering the pipe with the steel. The third man keeps the mouth of the hole clear, watches the jack-screws, and otherwise assists. As soon as a hole is finished, a wood plug is dropped in to keep it clear until ready for loading.

It will be observed that the 15-ft. hole is put down without change of steel, and three holes are drilled from a set-up. The number of holes which can be drilled with a steel varies with the tempering the smith has put in the bit. A poor bit may last only one hole. Well tempered steels will put in seven or eight holes. The average was three or four holes drilled per steel. The trouble is less in the dulling of the steel than in its loss of gage, so that later holes are of smaller diameter. This emphasizes the importance of careful attention to the smith shop when rapid, economical drilling is sought.

The view of Fig. 2 shows standard tripod drills working near the autotraction drills. A large number of these are employed on portions of the work. They are of the "Sergeant F-24" type, with 3½-in. cylinders, and in the illustration are putting down 15-ft. holes. But they suffer under the handicap of steel-changing and loss of time in moving, which limits the tripod drill; and it has been found that one autotraction drill does the same work per day as seven of the tripod drills. A well drill machine working nearby was averaging 80 to 85 ft. of 4-in. hole per day. It was the only machine of the type on the work.

While the performance of the autotraction drills has been eminently satisfactory, it is believed that better results still we be secured by the adoption of the Locher pump drill-steel.

Mr. C. H. Locher, of Thorice, Michigan, who invented this steel, is also the pioneer in the development of the deep-hole drilling machine of the general type here described. On the work of the contracting firm of Grant, Smith & Co. & Locher on the Livingston Channel of the Detroit River, he devised an autotraction drill capable of putting down a 5-in. hole 50 ft. deep at a rate far better than any realized up to that time.* This machine was of course experimental and somewhat crude, requiring changes of steel every 8 ft., but it contained the proper idea, and Mr. Locher has developed it through successive models to now show remarkable speed and efficiency. The inventor's later work was carried on in connection with the Ingersoll-Rand Co., and the perfected auto-drills just described were produced under collaboration of Mr. Locher and the company's engineers, the inventor having licensed the company under his patents.

The Shanley-Morrissey Co. has eight of these autotraction drills on their work at Mechanicville and Stillwater, and four additional machines are on order. The Merion Construction Co., at Waterford, use one autotraction drill.

It is to be understood that the machines here described were specially designed and built for these local conditions. These drills can be made for all classes of work. The depth and diameter of hole, character of rock to be drilled, spacing of holes, etc., all have vital bearing upon some features of construction. They may carry an air reheater, or be fitted with a steam boiler where necessary. The general design and method of operation, however, are as here described, in all the autotraction drills built by the Ingersoll-

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*See a description by Frank Richards in Compressed Air Magazine, Jan., 1910.

Rand Co. Patents are either issued or pending on the essential features of these machines, in favor of that company. Several deep-hole autotraction drills of this general type have been built for Mr. Locher's own work, and are in operation at Gross Isle. Others are on order for use on some sections of the Catskill Aqueduct of the New York Water Supply, and on the Barge Canal.

MINE VENTILATION ON THE RAND

By Frederick H. Hatch.

In the early days of the Rand, and, indeed, up to quite recently, it was not found necessary to employ any artificial system of ventilation, the numerous shafts and outlets to the surface of the outcrop mines having sufficed to maintain an ample supply of fresh air. But with deeper levels (the Village Deep mine is already working at a vertical depth of 4,000 ft.), fewer communications with the surface, and an increased rock temperature, artificial ventilation is destined to play an increasingly important part. Stuart Martin gives it as his opinion that it will be impossible to work the deep levels economically without carefully thought-out schemes of ventilation; and that for the success of these, it will be necessary to have shafts with small frictional resistance and large air space, and to carry the air current through special ventilating roads.

The quantity of pure air to be supplied per minute, per man employed underground is fixed by law at 70 cu. ft. This being a standard difficult to enforce, the South African Mining Regulations Commission, whose report was pubilshed in 1910, prosposes as a substitue, the quality standard, based on a maximum of 20 parts by volume of carbon dioxide per 10,000 parts of air. Of this, four parts is an allowance for the CO_2 normally present in the atmosphere; three parts are allowed for the CO_2 produced by the burning of candles, and there is a further allowance of five parts for the CO_2 possibly given off from the country rock, leaving eight parts per 10,000 as a legal limit for the noxious CO_2 due to the vitiation of the air by blasting, human emanations, etc. Under the proposed regulations provision is to be made at each mine for a permanently up-cast and a permanently downcast shaft, by the use of ventilating fans, or otherwise; and the current of fresh air so produced is to be split by regulating doors at every level where work is carried on, in proportion to its requirements. Further, the courses of pure supply and foul return are to be kept distinct by bratticing, and short circuiting is to be prevented by stopping disused drives, stopes, etc.

The ventilation problem has already been seriously attacked on the Rand, and already ventilating fans, varying in capacity from 50,000 cu. ft. per min., at 1-in. water gage, to 250,000 cu. ft., at 4-in. water gage, have been installed at the East Rand Proprietary mines, at the Simmer Deep, at the Village Deep, at the Langlaagte Royal Shaft of the Crown mines, and at several other mines of the Eckstein Rand mines group. In splitting the air current the numerous dikes of igneous rock that traverse the Witwatersrand mines in a north and south direction (i. e., across the strike) can be made to serve as natural brattices, since they cut up the mines into air-tight compartments. The levels that penetrate these dikes must be permanently closed, or, if used for tramming, closed by double swinging doors.

The ventilation of the mines is hampered by the small air space and large frictional resistance of the rectangular timbered shafts at present in use on the Rand. For this reason many of the deeper shafts of the future will, no doubt, be of the circular type, with either brick or concrete lining, as is the common practice in the collieries of South Africa. Already a large circular shaft is being sunk at the New Modderfontein mine.

Main levels and underground inclined shafts will also be driven in the foot wall. These will serve as intakes for the air current, and, being in solid ground, will reduce the loss of air by short-circuiting to a minimum. Since these main ventilating roads, instead of following the regular course of the reef plane, are driven straight, they will be admirably adapted for cheap mechanical transport.

When the foundations of a New York skyscraper are completed and the erecting of the steel skeleton is about to begin the fact is indicated by a change in the color of the derricks. At the Woolworth building, which is to make a new record for height, the derricks have changed from green to orange.

BOTTOM HEADING DRIVING ON THE HUNTER BROOK TUNNEL

By Arnold Becker, E. M.*

Because of the very notable success achieved by the builders of the Loetschberg tunnel, in Switzerland, much has been written of late concerning the methods used by them. Mr. W. L. Saunders and Mr. Eugene Lauchli, particularly, have contributed valuable and highly instructive papers on this subject, and they have been ably answered by advocates of the more ordinary tunnel method. The discussion has lacked a certain definiteness, however, because the comparison has been between Swiss and American tunnels, driven by the new and the old methods respectively, and in countries where the costs of labor, material, power and all things that go to make up the grand total of costs in such enterprises differ so widely that an intelligent comparison is difficult.

It is my purpose herein to give facts and figures concerning the Hunter Brook tunnel of the Catskill Aqueduct, now being completed for the city of New York by the Glyndon Contracting Company, at Yorktown Heights, N. Y. This tunnel is 6150 ft. long, 276 sq. ft. (minimum) cross-section and has, except for the first few hundred feet, been driven by a method that is similar in the chief essentials to that used in the Swiss tunnels. As all records of cost have been most exactly tabulated for seven months past, it is possible to show definitely the economies of the method in this country and to state the reasons therefor. The change in method has resulted in a reduction of labor cost from $6.63 to $2.55 per cubic yard, and an increase of average progress from 126.5 ft. to 270.5 ft. of completed tunnel per month. This rock is mica schist and hard, close grained gneiss. The faulting is complicated and in places the ground is very treacherous and difficult to drive through, as described in an earlier issue of the *Engineering Record.*

THE MINING METHOD OF TUNNELING.

As a preliminary, it should be pertinent to point out the reason for the wide differences of opinion as to this so-called Alpine method, which is really a mining method. It is a curious thing that such great underground works as railway tunnels, whole series of aqueduct tunnels and subway systems costing scores of millions should have been built by various adaptations of surface methods which have been uneconomical and usually very slow; while mining methods, the results of many centuries of evolution toward the truest economy in underground excavation, have been ignored except in the most recent Swiss tunnels and in two aqueduct tunnels in this country (Hunter Brook and Elizabeth Lake) now under construction. Undoubtedly the reason is that such works have usually been parts of larger surface systems that have fallen to the lot of surface men to build. The result is that there are two absolutely opposed methods of underground excavation; the one directly evolved from surface methods and almost universally used for large tunnels and subways, which is unnecessarily costly; the other a purely underground method, developed in the metal mines through many generations of labor-saving and cost-saving effort.

The essential difference lies in the use or neglect of gravitation as a force. The surface man habitually excavates from the top downward. This is the natural and proper thing to do in outdoor work. The American tunnel man has taken this inherited principle underground, wherefore he excavates his top heading first and then digs down to grade (Fig. 1). All of the excavated material must, by this method, be shoveled into cars, which is a misuse of the force of gravitation, in that this force is made to work against the operation instead of for it.

The miner, whose business it is to excavate ore bodies which almost always exceed in depth and very often exceed in width and length the greatest tunnel ever driven, always gets below the ore to be excavated with the smallest workings possible, ordinarily a shaft and a series of levels that are 100 ft. or more apart, and then excavates or stopes upward, from level to level, dropping the ore through loading pockets and chutes into cars for transport to the surface. The stopes usually represent over 90 per cent. of the total excavation in a successful mine and shovels are unknown in them unless the vein be too flat for the ore to run. The greatest item of labor, the actual handling of the ore, is thus avoided by a proper use of the force of gravitation.

A miner, when called upon to drive a tun-

*President Glyndon Contracting Company.

nel of large cross-section, instinctively drives a bottom heading on grade and, by the use of simple devices, stopes out the top, handling the excavated material into cars by gravity By application of this and other mining methods it is not only possible to handle over 50 per cent of the excavated material at minimum cost but to increase speed far beyond anything that has been accomplished by the ordinary method. In the case of subways the application of well-tried principles of lode mining should be even more important, not only for the economy in actual excavation but because, in very many cases, all tearing up and relaying of streets, interfering with traffic, disturbance of water and gas mains and endangering of foundations could be avoided and the great expense of these factors in the ordinary method of subway building saved, without sacrifice of speed or economy of construction. Subway building by the open-cut method involves, in the initial stages, destruction of valuable property which must be replaced. This is seemingly unavoidable where the proposed subway is so close to a street surface that mains and conduits (other than sewers) occupy any part of the space actually required for the subway, its walls and roof; but, with this exception, the work could be done by mining methods, and a serious economic waste avoided.

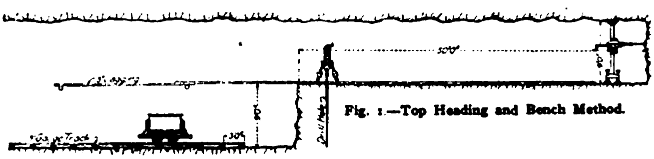


Fig. 1.—Top Heading and Bench Method.

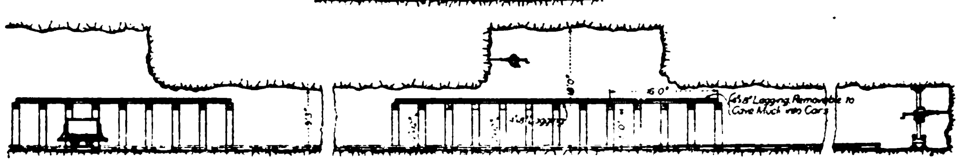


Fig. 2.—Bottom Heading and Stope Method, Showing Multiplication of Stopes.

BEGAN IN THE OLD WAY.

The Hunter Brook tunnel was started at the north portal on October 6, 1909, and at the south portal on December 15, of the same year. The top heading and bench method (Fig. 1) was used with heavy loss. I was called in consultation late in May, 1910, and a few days later was retained as chief engineer and manager. At that time the north tunnel had been driven 677 ft. and the south tunnel 716 ft., the average progress having been 84 ft. and 126.5 ft. a month respectively.

Th problem was to complete the tunnel within the contract price and without adding more in the way of equipment than could be helped. Economy rather than speed was the requirement. Also, there were 5295 lin. ft. of outside concrete conduit to be built, requiring 25,000 cu. yd. of crushed rock, the only source of supply for which was the south tunnel, and months of preparatory work were needed before this outside conduit could be started. It was apparent that if the south tunnel were completed ahead of the outside conduit we should have to rehandle our concrete rock at considerable expense. Therefore the tunnels were run with two 8-hour drilling shifts only and three small mucking shifts; and for the same reason the north tunnel was closed down on April 15 last, 1956 ft. from the portal. The south tunnel will hole through in October, 1911.

The first method tried was to drive a bottom heading on grade 8 ft. wide and 9 ft. high; then to stope in the top and finally the sides. This permitted only one link of track in the heading, as all cars were 36-in. gauge. As we had to rely on mule haulage we were unable to take away the muck fast enough on one track. It became necessary to use two tracks and consequently to widen the heading, which was, thereafter, driven full width, 15 ft., a procedure which was unavoidable in this case, but which would not be advisable where proper equipment and electric haulage for a small heading could be provided.

BOTTOM HEADING.

The bottom heading (Fig. 2) is driven on grade, with four Ingersoll-Rand 3.5-in. drills mounted on two columns. The round varies from 16 to 28 holes, according to the rock. Cut holes and lifters are driven between 6 and 7 ft., and breakers 5 ft. Steel slick-sheets are laid from the breast for at least 20 ft. back before blasting. The round is shot with 60 per cent. forcite and invariably with fuses and caps, in rotation. By this method the holes almost always break to bottom, which they do not do with battery shooting.

Immediately, after the blast four picked muckers muck back the heading They work a split shift and are paid from $2.50 to $3.00 per day. They get a bonus for quick work and go home as soon as the heading is cleared for the drill columns. They usually do this in three hours, making their actual working day six hours. With the heading cleared twice a day, in this way, the drill shifts easily set up, drill and shoot their rounds within the eight hours allowed each of them. The regular mucking gangs, shoveling off slick-sheets, usually finish ahead of time and then lay track and extend pipes for the next shift.

The powder consumed averages 7.5 lb. per cubic yard in the bottom heading. The rock is very tough, but, owing to the method of shooting and the quantity of powder used, is broken fine enough to be easily shoveled—though the same rock, when broken from a bench, is so blocky as to require handling by power into cars. An effort was made to cut down the quantity of powder used, but this soon proved to be a false economy. The muck broke larger and more labor was required to handle it.

The regular heading drilling shifts are each made up of

1 shift boss, at	$5.00
4 drill runners, at	3.50
4 helpers, at	2.25
1 nipper, at	2.00

The regular mucking shifts are each made up of

1 muck boss, at	$3.50
8 muckers, at	2.00

The five months from March 15 to August 15, 1911, afford representative figures; the tunnel was shut down during the winter and the force was not fully reorganized until early in March. During these five months there were excavated from the bottom heading of the south Hunter Brook tunnel 6916.685 cu. yd. at a total labor cost, including blacksmithing, but not including haulage, of $23,476.86, or $3.40 per yard. From July 15 to August 15, 1911, bottom heading progress was 289 ft., at a total labor cost of $3.29 per cubic yard. Overhead charges, power and haulage are not included in the above, as these items vary with each locality. The salaries of the tunnel superintendent and the night superintendent are carried in overhead.

TOP HEADING OR STOPE.

A timber gang, consisting of a foreman, two timbermen and two helpers, working on day shift only, puts up the temporary sets required for the stope (Fig. 3). These are of 10x12-in. posts with 12-in. round caps, placed at 3-ft. centers and heavily lagged over the top. A gap of 30 in. in the first layer of lagging is left continuously above each track, and this is covered by short cross-lagging, which can be removed, piece by piece, with a pinch bar, whereby the stope muck pile is caved progressively into cars.

The top of the temporary platform, so provided, is 7.5 ft. above the tunnel floor. The bottom heading having been driven 9.25 ft. high, there is left a free space of 21 in. above the temporary timbering to break to. This space is necessary for the success of the operation. Without it the timbers would be broken by blasts above, and the only alternative would be to adopt the underhand stoping method of the Simplon and Loetschberg tunnels, which is more costly. No timbers have been broken in the Hunter Brook tunnel since round caps were substituted for square ones last winter.

In the stope two Ingersoll-Rand 2.5-in. drills are used on an 8-ft. cross bar (Fig. 4). The round varies from 12 to 16 holes, which are all breakers. These are shot with fuse entirely, the bottom holes being shot first, lightly, then the next row above, and so to the top. The timber caps are supported by extra temporary posts during shooting (Fig. 4), and the muck is all held on the timber platform. It is then rapidly caved into cars, through the lagging, as above described, by two men. Battery shooting would be impossible in the stope. It would break the timbers, inevitably.

This operation leaves the stope incomplete, as shown in Fig. 4. One drill runner, using an Ingersoll-Rand telescope feed stoping drill, which is the fastest tool yet devised for upholes, follows and drills trimming holes to a line given him by the survey crew. These are shot with the next regular round. The same man drills and shoots any trimming holes that may be necessary to perfect the lower half of the tunnel, as indicated by the surveyor.

The bottom heading and stope are checked, as to line and grade, each day by the company's surveyor and no trimming is left undone. The temporary sets and lagging are regularly moved forward from behind the stope, to be reused. Such pieces as are injured are used up for blocking.

In order to facilitate the work of stoping, it has been found expedient at times to separate the drilling, mucking and trimming operations in the top. This is completely accomplished by putting up a raise about every 300 ft., as shown in Fig. 2. By this system three stopes are always in operation. Drilling is going on in one, mucking in another and trimming in the third. This avoids any interference by the various gangs with each other's work and greatly facilitates progress. All the equipment used in stoping is light and can readily be moved. The chief advantage is that the drill runners always have a clean breast to work at, with no muck to hinder them. The top crew consists of:

2 drill runners, at	$3.50
2 helpers, at	2.25
2 muckers, at	2.00
2 car handers, at	2.00

From March 15 to August 15, 1911, there was stoped from the top of the south Hunter Brook tunnel a yardage almost exactly equal to that of the bottom heading, but at a labor cost, including blacksmithing and all cost of temporary timber platform and maintenance thereof, of $1.69 per cubic yard, making the average labor cost per yard for the completed tunnel $2.545 in the cars. The powder consumption in the stopes, for the same period, was 2.5 lb. per cubic yard.

When the ground requires timbering a regular timber crew follows closely after the trimmer, placing permanent sets. If the

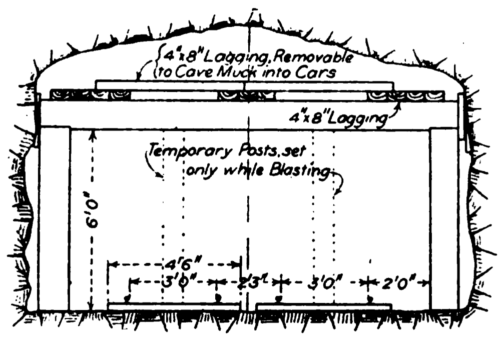


Fig. 3.—Bottom Heading and Temporary Timber Platform.

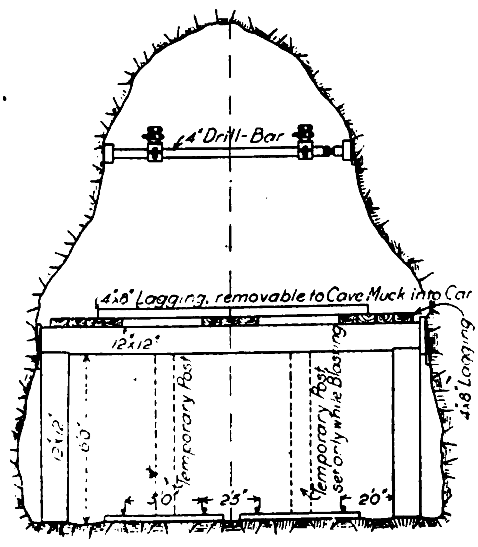


Fig. 4.—Method of Stoping Out the Top.

ground is very treacherous, the permanent timbering can be kept within 3 ft. of the stope breast without danger of shooting out the timbers, since all holes in the stope break downward and do not require heavy charges. No cut holes are ever needed or used in the stope. Where permanent timbering is required it is always best to run three or more stopes.

ECONOMY AND ELASTICITY.

The advantages of this method are several. The most important is that 50 per cent. of the muck is handled from the stopes directly into cars, by gravity, at a minimum of labor and cost. By the old method all of the muck in the top heading is shoveled into wheelbarrows and wheeled the whole length of the bench and beyond, to be dumped into cars. This requires a large crew of muckers and wheelbarrow men for the top heading, besides an equally large crew to muck the bench.

Timbering is a much more simple process by the mining method. It can be kept close to the breast without injury to timbers and wall plates are unnecessary, each set being built up from grade; neither need there be any delay. By the old method wall plates must be placed first, which is a slow operation; then the arches are placed and later, when the bench has been blasted out at considerable risk to the upper timbering, posts are set under the wall plates. Very frequently timbers are blown out by the heavy blasts of the cut in the top heading; and I have known six or eight such sets to be brought down by an unlucky round in the bench. All of this is avoided by the mining method.

Finally, there is more elasticity. The greatest effort for progress is concentrated in the bottom heading, to which everything else gives way; for here there is only one point of attack possible. If for any reason the top falls behind, it does not greatly matter. Progress of the bottom is not thereby impeded and the top may be attacked from as many new raises as may be required to make up lost time, whenever it is convenient to do so. By the old method, however, if the bench falls behind, work in the top heading is immediately made more difficult and costly.

Tunnel driving is an industry wherein speed and economy are equivalent terms, unless because of some outside and conflicting factor. In most lines of endeavor it is possible to spread out, to divide the work into sections, particularly in railways, canals and similar surface undertakings, which can be attacked at many points simultaneously. In deep tunnels, however, the space is confined, the number of men that can be advantageously worked is strictly limited and the points of initial attack are never more than two, unless shafts be put down to provide more headings. As shafts involve hoisting and usually pumping, they are to be avoided unless in long tunnels, the early completion of which may justify considerable extra cost.

Manifestly, then, speed in the heading should be the first consideration. The number of men being limited by the working space the crew is constant in a heading of given size and the cost per foot may be said to vary in inverse ratio to the speed.

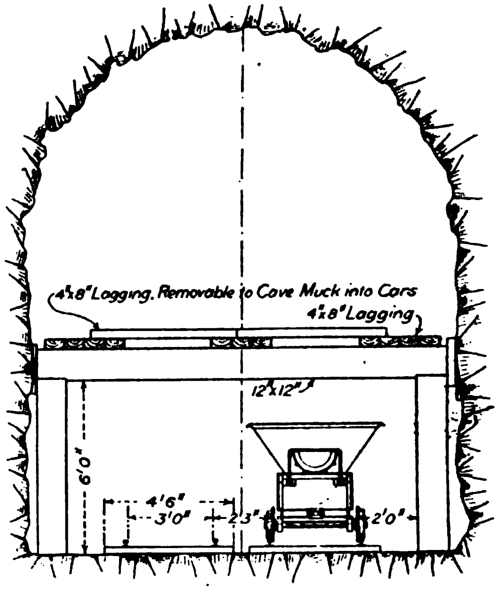


Fig. 5.—Completed Tunnel, Timbers to be Moved Forward.

It is also manifest that the heading is the most expensive part of tunnel excavation. Since the rock is exposed on one side only, it must be torn out. All other rock to be removed, after the heading has passed, is exposed on at least two sides and may be broken inward to a free space with fewer drill holes and less explosive. It follows that the heading should be as small as may be practicable, and that transportation facilities should be fully adequate for removal of all the rock to be excavated from bottom heading, top and sides at the speed required. This means good track, electric haulage, plenty of quick dumping cars of narrow width, empties delivered as rapidly as needed at the heading and hauled away as soon as loaded, no interference with main line traffic by top and side excavation, and proper terminal arrangements outside.

If the traffic facilities be inadequate for removal of all excavated rock at the required speed on a single track, then the heading must be widened to permit double track. The heading yardage is thereby nearly doubled, the expense is increased and the speed of the heading and, of course, of the whole tunnel is reduced. Money loss is in two directions: The proportion of most expensive excavation is materially increased and the period of overhead cost is as materially lengthened, whereby the cost of the excavation per unit increases proportionally.

An interesting comparison, showing the marked difference of results by different heading methods, is that of the Bergen Hill (Pennsylvania R. R.) Hunter Brook and Simplon headings.

Tunnel.	Head.	Size. Sq.Ft.	Crews	Best Month, Lin.Ft.	Equivalent. Yardage
Bergen Hill*	top	210	2 10-hr. shifts	145	1127.77
Hunter Brook.	bot	138	2 8-hr. shifts	289	1477.11
Simplon† ...	bot.	60	3 8-hr. shifts	685.5	1523.33

*F. Lavis, *Trans.* Am. Soc. C. E., Feb., 1910.

†W. L. Saunders, *Trans.* Am. Inst. M. E., Feb., 1909.

The comparison shows quite clearly that speed increases in inverse ratio to the size of the heading.

Provided that equipment be suitable, there can hardly be serious question as to the advantages of the small bottom heading. Moreover, the Ingersoll-Rand drill carriage can be used in a narrow, single-track heading, but not in a wide heading with double track. The use of this carriage and all details of the Swiss bottom heading method seem admirable and highly practical. If one were inclined to criticize at all, it would be the Swiss method of stoping the top, which seems unnecessarily complicated, first, because small drifts are run from the top of each raise, after which the rock below is taken out by underhand stoping, which costs more than overhand stoping and has long been obsolete in American mining practice; second, because work in the stopes seems to be divided into more separate operations than would be resorted to in this country. Such details are overshadowed, however, by the wonderful heading records made in Switzerland.

Those records could, without any reasonable doubt, he duplicated in this country if the proper method were adopted and suitable equipment provided. The saving, in money alone, would be tremendous. The saving in time, especially where long tunnels are to be driven, would often be of paramount importance.

The mining method of tunneling requires very perfect organization, for more operations are going on at the same time than in an ordinary heading and bench tunnel. It is necessary to divide the work very closely and to train each man to proficiency in the particular work he has to do. The degree of organization will generally show in comparisons of monthly costs and progress. The record of the Hunter Brook tunnel, for the five fiscal months previous to this writing, is as follows:

	Progress, Completed. Tunnel.	Labor Cost. Ex. Haulage.
March 15, April 15...	278.5 ft.	$7096.39
April 15, May 15.....	*263.5 "	6851.01
May 15, Jun 15.......	278.5 "	7304.01
June 15, July 15....	†259 "	6676.65
July 15, Aug. 15......	283 "	7183.63
July 15, Aug 15, head.	289 "	

*Easter holidays, April 16 and 17.

†Two holidays, July 4 and 5.

For the successful driving of this tunnel by a method which was entirely new in this part of the world much credit is due to Mr. Harry A. Leeuw, general superintendent of the entire work; to Mr. Peter Bachels, tunnel superintendent, and to Mr. Joseph Goodman, night superintendent.—*Engineering Record.*

THE AIR PUMP VALVE FROZE

I once had occasion to use a double-acting pump for mine purposes, using air at 90 lbs. gage pressure. But I was continually bothered with the valves freezing, which stopped the pump.

Then it was the old story of burning a piece of oily waste to thaw them out and get the pump started again. This method, however, has often caused cracked and broken pumps, due to the unequal expansion.

I finally tried the scheme of tapping a ⅜-inch connection on the discharge pipe, near the pump, and leading the same around and over the air chest, branching off over each chest. Then I put in a ¼-inch pet cock about 4 inches above each chest so as to get a small stream of warm mine water to flow over the top of each valve chest while the pump was working. This ended the trouble.—W. Cooke, Chignecto, N. S., in *Power.*

EXPANSION VALVE GEAR FOR STEAM OR AIR-HAMMERS

Fig. 7., here reproduced from *The Engineer,* London, shows a hammer designed to be operated with either steam or air—the latter being employed with increasing frequency—and provided with an improved valve and valve gear, enabling the operating fluid to be used expansively. The object of the makers, Messrs. B. and S. Massey, Openshaw, England, in designing this gear has been to reduce the consumption of the working fluid without the introduction of complicated mechanism, and without sacrificing ease of manipulation. Figs. 1 to 6 show sectional views of a hammer of the arch form, the piston valve being in section in four different positions. Fig. 7 represents a steam hammer of the Rigby type to which the mechanism has been applied.

The chief feature of the gear is that the hand worked movement and the automatic cut-off are entirely separate and in different directions. The hand movement of the piston valve for the ordinary control of the hammer is vertical, whereas the automatic cut-off movement is rotary, the valve being turned through a small arc of a circle by levers and tripper mechanism actuated by the tup. Referring to the sectional illustrations it will be observed that when the valve is in the position shown in Fig. 3 steam is admitted to the under side of the piston, and simultaneously the space on the top side of the piston is opened to the exhaust. The result is an upward movement of the working piston, and in rising the tup comes in contact with the tripper, clearly shown in Fig. 1, and rotates the valve by means of the roller mechanism, cutting off the steam below the piston and closing the exhaust above—Fig. 4. During the remainder of the stroke the steam below the piston is used expansively, and the compression of the entrapped steam above the piston produces a cushioning effect which brings the hammer quietly to rest and prevents the possibility of blowing off the cylinder cover which is liable to accompany the operation of steam hammers by inexperienced persons. Although the valve mechanism is thus arranged to cut off the supply of live steam at a certain position of the stroke, the valve is so designed that when the hammer is at the top of its stroke a small port is uncovered which admits just sufficient steam below the piston to keep it suspended for "holding up" purposes.

FIG. 7. HAMMER WITH EXPANSION VALVES

On moving the valve into the position shown in Fig. 5 the bottom of the cylinder is opened to exhaust and steam is admitted above the piston for forcing the hammer down. As the tup descends the valve is rotated back again until at a predetermined point in the stroke steam is entirely cut off—as shown in Fig. 6—and the steam is therefore used expansively during the remainder of the stroke. For "holding down" supplementary ports are provided which come into operation when the hand lever is placed a little below mid position. These ports also serve to produce short strokes, but are closed when a longer travel is given to the valve for ordinary working.

The makers claim that the expansion gear gives a considerable economy of steam consumption compared with ordinary valve gears, as the steam is used expansively on both strokes. They also claim that "after flow"—the useless and wasteful flow of steam into the cylinder after the blow has been struck—is prevented; that clearance loss is

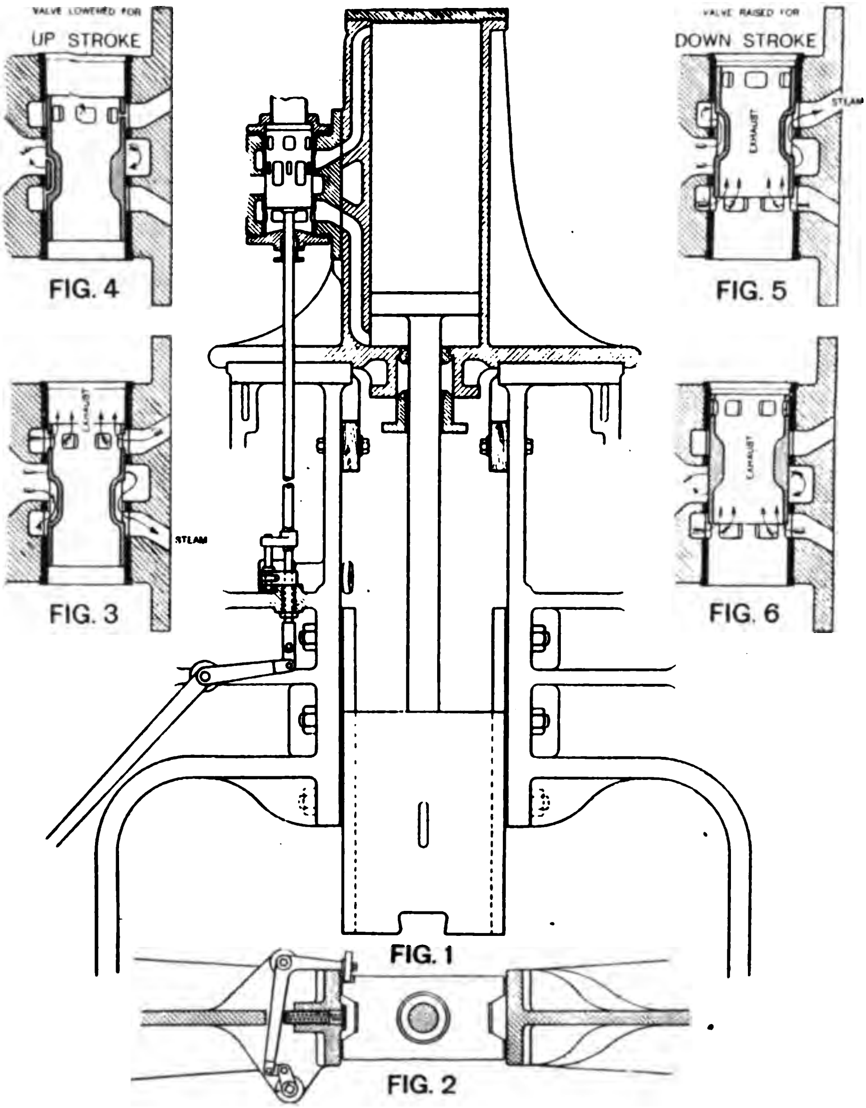


FIG. 4 FIG. 5 FIG. 3 FIG. 6 FIG. 1 FIG. 2

largely avoided owing to the automatic compression at the end of the up stroke; and that direct leakage of steam past the valve when the hammer is holding up is prevented. During the latter operation the valve is arranged to occupy the position in which the lap is at its maximum. With regard to the control, this we found most simple, enabling an unskilled person to use the hammer without danger. Owing to the operation of the tripper and roller mechanism on the valve no shock to the attendant's hand is possible, and a further advantage is that the hammer can be held up at the extreme top of the stroke.

Air under pressure, whether at 2 lb. or 150 lb., has come to be regarded not as an elusive, intangible quantity, but as a commercial commodity, the handling of which requires judgment. This is a subject to which a great deal of attention is being devoted at the present time, attention that has lately been reflected in the purchase or planning of equipment. Similarly, apparatus that is pneumatically operated finds increasing application, and is bought more than formerly on the basis of demonstrated efficiency.—*Iron Age.*

TYPES OF MINE-RESCUE BREATHING APPARATUS

By James W. Paul.*

The types of breathing apparatus used by the Bureau of Mines carry a supply of manufactured oxygen. The purpose of these types of breathing apparatus is to supply the wearer with oxygen, and to absorb the carbon dioxide and the moisture exhaled in his breath. To accomplish this purpose, the apparatus are so made as to permit the wearer to use the oxygen that is exhaled in his breath, and to permit him to breathe over and over again the nitrogen that is in his lungs and any that is inside the apparatus.

TYPES OF BREATHING APPARATUS.

There are a number of types of breathing apparatus. Those in extensive use are of European make, and several of them, including the Draeger, the Westphalia and the Fleuss, which have been tested and used at the mining experiment station of the Bureau of Mines, seem to be about equal in merit.

Draeger, 1907 Type.—The Draeger breathing apparatus, 1907 type, has a knapsack, a pair of breathing bags, and either a helmet or a mouth-breathing device. The knapsack holds two steel cylinders charged with oxygen to a pressure of 1764 lbs. per square inch; a pressure gage (finimeter); a reducing valve; two regenerators containing caustic potash (ordinary lye); and a cooling cylinder.

The helmet incloses the wearer's face and top of his head, and is made to fit closely about his face by means of a rubber tube that may be inflated by pressing a small rubber bulb. The front of the helmet is closed by a circular disk of mica, protected by a wire frame. From the helmet are suspended two breathing bags, protected by a leather apron. The apparatus is so arranged that the mouth-breathing device may easily be substituted for the helmet.

The circulation of the air and gases within the apparatus is controlled by an injector that keeps a pressure in the supply or inhalation tube and a vacuum in the return or exhalation tube equivalent to 10 cms. (3.94 ins.) of water column. The reducing valve is so regulated as to furnish 2 liters (122 cu. ins., or about 2 qts.) of oxygen per minute. The injector causes the air within the apparatus to pass through the supply and return tubes at the rate of 50 liters (1.77 cu. ft.) per minute, so that the exhaled breath is quickly carried through the regenerator, where the carbon dioxide is absorbed, and then to the cooler and the supply tube. A relief valve attached to the helmet allows air to escape when the breathing bags become too full. The circulating system of the Draeger 1907 helmet-type apparatus is shown in Fig. 1.

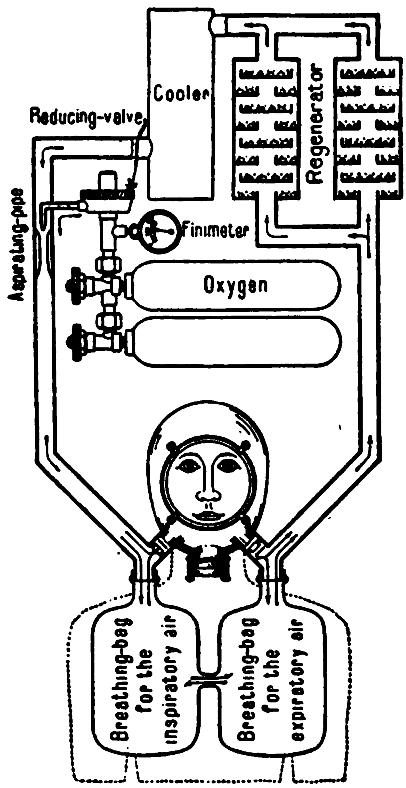


Fig. 1. Circulating System of Draeger 1907 Helmet-Type Apparatus.

Draeger No. 2, 1910 Type.—The 1910-type Draeger apparatus (Fig. 2) works on the same principle as the 1907 type, but is differently built. The 1910 type has the following parts: A knapsack with one oxygen bottle which contains, at a pressure of 2205 lbs. per square inch, oxygen enough for 2 hours' service; a reducing valve which regulates the supply of oxygen from the oxygen bottle; an injector nozzle which makes the air circulate; a pressure gage, readable by the wearer, which indicates the length of time the oxygen in the

*From Miners' Circular, No. 4, Bureau of Mines.

cylinder will last; a chest union to which are attached the circulating tubes and one breathing bag; a helmet or a device for mouth-breathing; a regenerator can (or cartridge), which contains potash grains arranged on shelves to absorb the carbon dioxide exhaled in the wearer's breath; and a tube for cooling the purified air.

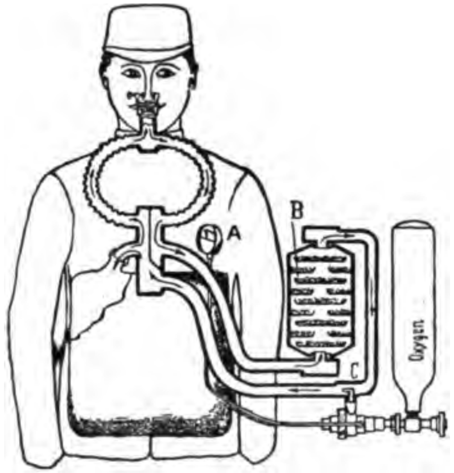


Fig. 2. Circulating System of Draeger 1910-Type Apparatus.

A relief valve on the chest union permits air to escape from the breathing bag when the bag gets too full. There are no valves in the circulating system. The helmet is of leather and has a mica window fastened in a metal frame. The facial tube is made to press against the forehead, the cheeks and the under side of the chin; it should not cover the temples. A more recent model of the 1910 type has two breathing bags, mica valves in the circulating system, and separate tube connections with the helmet for the inflow and outflow of air. A mouth-breathing attachment may be substituted for the helmet.

Westfalia.—The Westfalia breathing apparatus (helmet and mouth-breathing types) has, like the Draeger, a knapsack that is suspended from the shoulders and rests on the back. This knapsack has a frame supporting two oxygen cylinders, a regenerator, a pressure gage, a reducing valve, and an injector. Resting on the breast of the wearer are two breathing bags; one is connected to the oxygen supply tube and the helmet, and the other to the exhalation tube and the regenerator. The helmet, like that of the 1907-type Draeger apparatus, covers the front half and top of the head. A flexible rubber lining fits about the face and keeps out the external air, but for greater safety a rubber tube around the edge of the lining may be inflated by an attached rubber bulb. The mouth-breathing device may easily be substituted for the helmet.

The circulating system of the Westfalia helmet-type apparatus is shown in Fig. 3.

Fleuss or Proto.—The Fleuss (or Proto) breathing apparatus (Fig. 4) consists of a pair of steel cylinders or bottles, containing oxygen at a pressure of 120 atmospheres (1764 lbs. per square inch); a reducing valve

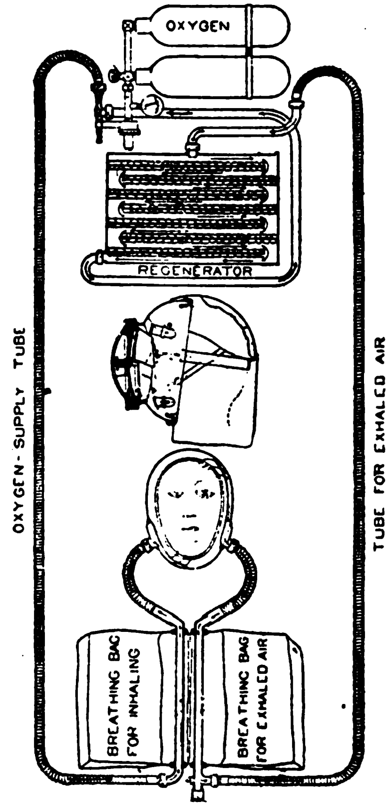


Fig. 3. Circulating System of the Westfalia Helmet Apparatus.

equipped with a by-pass valve; a breathing and regenerating bag that contains, when ready for use, 4 lbs. of caustic soda in sticks, a saliva trap, a cooler, and a relief valve; and mouthpiece, nose clip, goggles, and skull cap. A face mask that covers the nose and

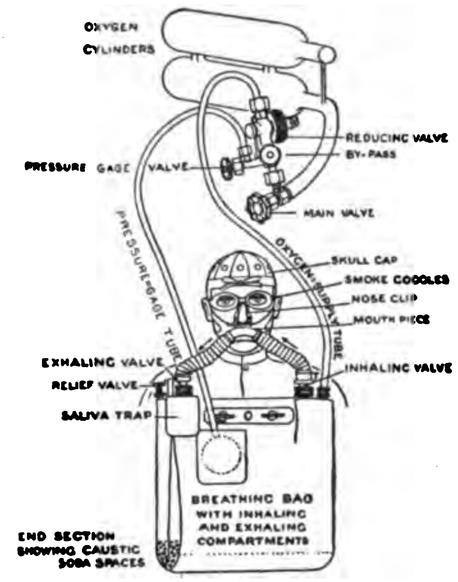


Fig. 4. Circulating System of the Fleuss Apparatus.

mouth may be used instead of the mouth-piece.

GOGGLES AND NOSE CLIP.

Goggles are used with the mouth-breathing patterns of apparatus only when a man has to work in smoke or in gases that affect the eyes. In the use of the mouth-breathing patterns of apparatus a clip is worn on the nose to close the nostrils. This clip has adhesive plasters which make it fit the nose firmly.

HELMET VERSUS MOUTH-BREATHING TYPES.

Men who have had much experience with breathing apparatus have different opinions in regard to whether masks, helmets, or mouth-breathing devices are the better. The writer thinks the helmet is not necessary for safe and effective service in unbreathable gases.

In an atmosphere that contains smoke or fumes that irritate the eyes, nostrils, or throat, the helmet may be worn with safety by one who has been thoroughly instructed and trained in its use, for the reason that any leakage may be readily detected, but in an unbreathable or poisonous atmosphere that contains no irritating fumes or gases a leak is not detected and the wearer may be overcome. The above disadvantage does not apply to the mouth-breathing form of apparatus, which the writer believes should be used for mine work in an atmosphere that will not support life and which does not contain irritating gases. In addition, the wearer of the mouth-breathing type can examine the roof more easily than can the wearer of a helmet. Some men who have used both helmets and mouth-breathing devices prefer the former, because they can breathe through the nose more easily than through the mouth. An objection to mouth-breathing devices is that they make it more difficult for men to talk to each other when working in a poisonous atmosphere, but audible signals may be used with success by men properly trained.

JAPANESE PEARL DIVERS

The pearl divers of Japan are women. Along the coast of the bay of Ago and the bay of Kokasho the thirteen and fourteen year old girls, after they have finished their primary school work, go to sea and learn to dive. They are in the water and learn to swim almost from babyhood, and spend most of their time in the water, except in the coldest season from the end of December to the beginning of February. Even during the most inclement of seasons they sometimes dive for pearls. They were a special dress, white underwear and the hair twisted up into a hard knot. The eyes are protected by glasses to prevent the entrance of water. A boat in command of a man is assigned to every five or ten women divers. When the divers arrive on the grounds, they leap into the water at once and begin to gather oysters at the bottom. The oysters are dropped into tubs suspended from their waists. When these vessels are filled the divers are raised to the surface and jump into the boats. They dive to a depth of from five to thirty fathoms without any special apparatus and retain their breath form one to three minutes. Their ages vary from thirteen to forty years and between twenty-five and thirty-five they are at their prime.

RESTRAINING THE USE OF COMPRESSED AIR

Perth Amboy, N. J.—The police have begun to enforce orders from Chief Burke, putting a stop to the use of putty blowers by the boys of the city. The chief has instructed his men to warn and later arrest on sight any boy or girl who blows putty through tubes of any sort.

PORTABLE, AUTOMATIC, OIL-BURNING COMPRESSED AIR HEATER

The heater shown in the half tone and sectional cut herewith marks a new departure and a distinct advance in the working out of one of the most important problems in connection with the employment of compressed air for general industrial purposes. The considerable increase of volume resulting from the heating or reheating of air after compression and transmission, and the slight fuel cost of such reheating are generally understood and many heaters have been devised for the purpose, but various objections have prevented their extensive adoption. Perhaps the most frequent deterrent has been in the intermittent character of air employment. Heaters which would give very good results when the current of air was flowing constantly through them, as in the driving of a pump, have not proved so satisfactory in connection with rock drills or other intermittently operated tools.

The heater here shown, recently placed on the market, has sufficient capacity to supply one drill, and automatically maintains the desired temperature of the air passing through it. This is accomplished by the burning of gasoline or kerosene directly in the compressed air as it is passing through the heaters. The fuel is injected into the combustion chamber in the required quantity by the current of air passing through, so that the heating is automatically kept up while the tool is in operation and is discontinued when the tool is stopped. The mixture of fuel and air is ignited by an electric resistance coil or by a hot tube. It is stated that the only attention required is in the initial adjustment of the fuel valve to give the temperature desired.

The half tone, Fig. 1, shows a heater of

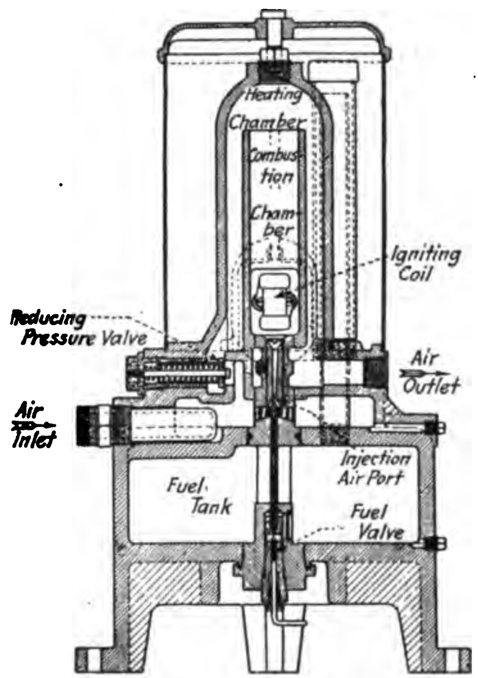


FIG. 2. SECTION OF LARGER HEATER.

small size, weighing only about 40 pounds and capable of heating air at the rate of about 75 cu. ft. of free air per minute. This would be enough for one rock drill up to, say 2½ in. Fig. 2 is a sectional view of a larger heater, having a maximum capacity of 250 cu. ft. of free air per min., enough for a 5½-in. drill. Its weight is about 150 lbs. The internal arrangement of both models is substantially the same. The supply line from the compressor is connected to the air inlet (Fig. 2) and the tool is connected with the outlet by a flexible steel hose. The metal hose is necessary, instead of rubber, to withstand the high temperature (350 degrees F.) of the reheated air. The hose is insulated to reduce the loss by radiation. The entering air fills an annular chamber just above the feed tank at the base of the heater. From this space most of the air passes into the heating chamber through the pressure reducing valve set to maintain a pressure difference of a fraction of a pound. Due to this pressure difference, some of the entering air is by-passed up through the injection port, carrying with it oil from the tank below. A combustible mixture is formed and is lit by the igniting coil (or the hot tube) upon entering the combustion chamber above. The products of combustion mingle with the main body of air in the heating chamber and the heated air then passes from the outlet to the tool.

The heater is being put on the market by the maker, the Sterling Equipment Company, People's Gas Building, Chicago, under the name of the Sterling Air Economizer. It is claimed by the Sterling Company that 100 cu. ft. of air per minute can be heated from 50 degrees to 350 degrees during ten hours of continuous running with about 2½ gallons of gasoline or kerosene.

DETERMINING THE SPECIFIC GRAVITY OF GASES

The following account is the description of an apparatus for the determination of the specific gravity of gases. The same follows the well-known Bunsen method, and depends on the law: That the squares of the velocities of two gases, flowing through a small orifice at the same pressure, moisture and temperature, are directly proportional to the specific gravity of the two gases. If

s_1 = specific gravity of air;
t_1 = velocity of the air flow;
s = specific gravity of the gas;
t_2 = velocity of the gas flow, then

$$t_2^2 \div t_1^2 = s_1$$

And if the specific gravity of air equals one (1), then

$$s = t_2^2 \div t_1^2$$

In this new apparatus the flow of gas is in a vacuum whose height can be regulated accurately and kept within wide limits. It is therefore possible to determine the relation of the velocity of dry gases and get more accurate results. The apparatus is of glass, and consists of an upright cylindrical body, with manometer attached near top, the intake tube at bottom, the thermometer in the inlet pipe, the suction cock on the manometer exit, and cock on the manometer exit, and cock at the top of the cylinder. In the inflow pipe is a cock split in two chambers by a diagonal section. One of these chambers has a platinum sheet with a very fine orifice; the other is open and has no obstruction. The former serves to allow the test gas to enter. The manometer has a mercury column, and thermometer is attached in such a way that the mercury is enveloped by the inflowing gas or air. To use the instrument a vacuum is created in the vertical cylinder by means of a suction pump attached to the manometer cock. The mercury column in the manometer gives the height of the vacuum. When the vacuum is complete and the cock at the side of the cylinder is closed, the cock on the inlet is set properly, and air is admitted through the platinum sheet into the cylinder and the fall of the mercury column is watched to see when the vacuum shall have reached a certain lower value. The time of the inflow of air is determined by a chronoscope. Then the vacuum is again raised to the previous height, and the same process is repeated with the gas. The specific gravity and molecular weight are determined by the formula: Spec. grav. $= t_2^2 \div t_1^2$ and molecular weight $= 28.76 \times (t_2^2 \div t_1^2)$ (air = 1). If the gas to be tested is under pressure, the mouthpiece of the intake tube, as also the mouthpiece of the manometer, are connected to the gas main, so that there shall be a balance or equilibrium of pressure with the interior of cylinder. The excess pressure of gas over the atmosphere will be balanced in this way. A large number of tests were made with this inaccurate. The apparatus was tested with anthracite coal gas, oxygen, water gas, mixed gas, etc. An accurate even temperature of the gas is one of the necessities for a successful test. The apparatus can of course be made of metal as well as of glass.—Herr Gülich, *Journal für Gasbeleuchtung.* Translated by the *Progressive Age.*

The city of Rio Janeiro has a long distributing plant which employes three twin gas compressors of 2900 cu. ft. per min. capacity working at a pressure of 6 lbs. gage.

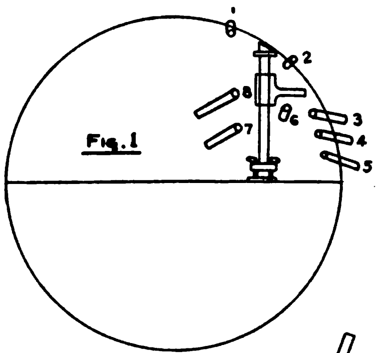


Fig. 1

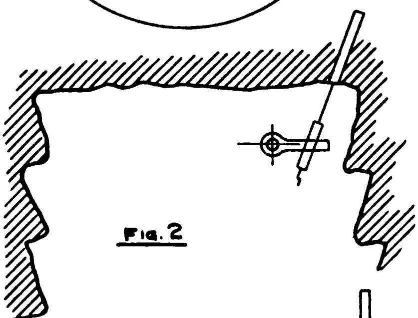


Fig. 2

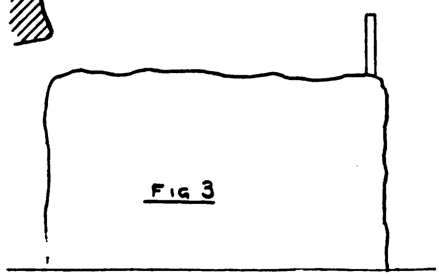


Fig 3

LONG COLUMN ARMS IN TUNNELS

In driving tunnel headings of oval or semi-circular cross section, ranging from 10 or 12 up to 18 or 20 feet in width on the floor, a customary method is to employ two columns, each carrying two drills. In order to complete the round and break the ground to the best advantage it is necessary either to move the columns or to set up a third column. A device for obviating this delay has been used recently with success in tunnels on the line of the New York City water supply aqueduct. It consists merely of a column arm of unusual length, 30 or 36 inches. This is set near the bottom of the column, and gives the drill a much wider range in placing the holes than the arm of ordinary length.

With this long arm a tunnel wall or rib may be carried straight, instead of as a series of offsets, with the resulting roughness, which must be reduced by filling or trimming. In the sketch, figure 1, is shown a column with a short arm. It must be set far enough from the rib to permit the arm to swing between the rib and the column when the arm is placed for drilling the holes at the top of the tunnel.

Hole No. 1 is drilled with the arm on the left side of the column. The arm is then swung to the position shown in the cut, and holes Nos. 2, 6, 7 and 8 drilled. If this arm or bottom arm of the same length is used for the lower rib holes, Nos. 3, 4, and 5 would be drilled as shown in figure 2, leaving an offset.

The use of a long arm on this column allows holes Nos. 3, 4 and 5 to be drilled as shown in figure No. 3, and the difference in appearance of the rib when the two arms are used is shown in figures Nos. 2 and 3. These are, of course, made of extra strong material to withstand the strain placed on them when the drill is working at the outer end.—*Mine and Quarry.*

DETERMINING VERTICAL MOVEMENTS OF AIRSHIPS

To determine his precise position at any time the marine navigator has only to know his latitude and longitude. The aerial navigator, for personal safety as well as for successful voyaging needs also to know not only his altitude, which the aneroid barometer will tell him approximately, but also on the instant he should know whether he is rising or falling. Engineer Philip Lens, of Gross-Lichterfelde, Germany, has recently produced a device for this purpose. His signal apparatus consists of a rectangular wicker basket, in which a wind wheel is placed vertically. By means of a lever connected with the axis of the wind wheel, two sounding mechanisms are set in motion as soon as the little wheel revolves. The bottom and top of the complete instrument are provided with openings so that the air can enter either way. As soon as the balloon changes its altitude, an air current flows into the signaling instrument, setting the wind wheel in motion, and with it the sounding mechanism. In order to render the device useful for motor airships, the top and bottom of it are provided with a wire gauze as shields against the vertical current caused by the propeller.

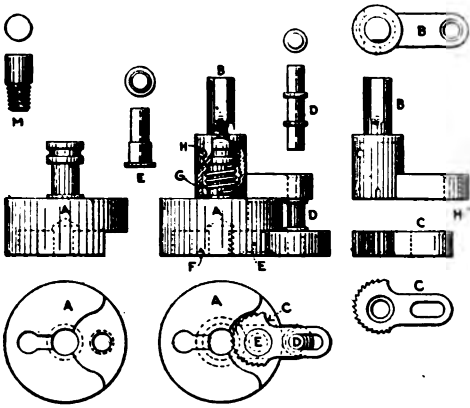


Fig. 1
THE CHUCK FOR DRILLING

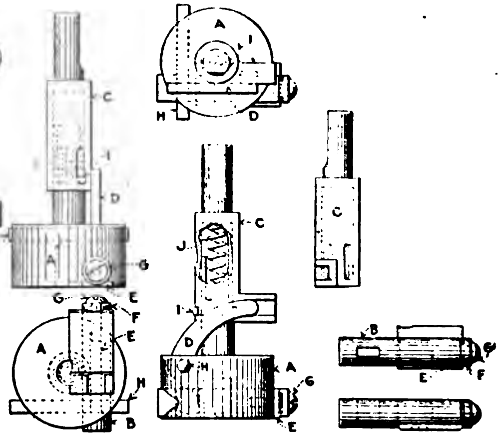


Fig 2
THE CUTTING-OFF TOOL

SPECIAL TOOLS FOR ROTATING AIR DRILLS

In the accompanying cut, reproduced from the *American Machinist,* are shown in complete detail some special tools invented by Mr. William D. White and used with great success in the Montreal shops of the Canadian Pacific Railway.

At the time of their production this road was engaged in the work of replugging the numerous gas tanks carried underneath its passenger cars. Each tank contained from fifty to seventy-five ⅜-inch holes, which were formerly filled with lead as a preventive of explosion in case of fire. On the introduction of a new nonexplosive gas, the lead-plugged holes in the tank had to be replaced with brass plugs.

This represented no small amount of work, as there was a large number of cars with two tanks each.

The lead was first drilled out of each hole by means of the air drill, and tapped with a ¼-inch pipe tap. The plugs, made of 7/16-inch diameter brass bar cut off 1 inch long and threaded one-half their length, were next inserted in the holes by one man, while the second followed with an air drill and the chuck, Fig. 1.

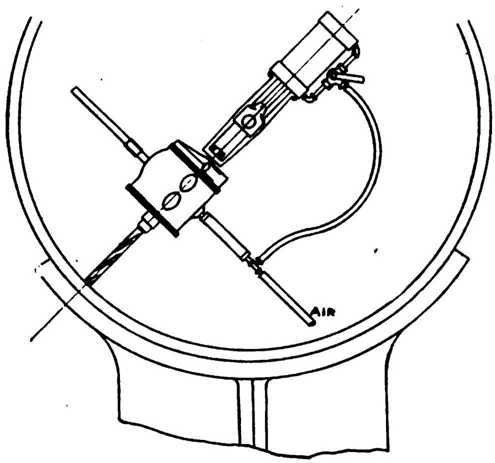
In Fig. 1, *A* is the body proper, and *B* the shank with a proextension at the side, into which is fastened the post *D*. The eccentric gripping piece *C* is made of cast steel and hardened. Pin *H* holds the shank *B* to the body of the chuck by engaging the groove cut on the proextension of the body *A*.

The spring *G,* being fastened at one end to the shank, *B,* and at the other to the post on the body of the chuck, causes the shank *B* to be carried to the left and the eccentric gripping piece *C* with it by means of the post *D*. Thus the chuck is always held open to receive the end of the brass plug *M*. In operation, the shank *B* is carried to the right, thus causing the eccentric gripper to grip the end of the plug inserted in the chuck. The hardened-steel piece *F* also assists in gripping and holding the work.

After the plugs are screwed in, the projecting end is cut off by means of the tool shown in Fig. 2. This is accomplished by a downward pressure on the air drill as the tool is driven by it and revolves around the end of the brass plug. The cutter held in the sliding bar *B* is forced against the plug until the corner of the cutter reaches the center, when the plug is cut off flush with the tank. The lever *D* serves to engage the shank *C* with siding bar *B*. Thus a vertical reciprocating movement of the shank *C* causes a horizontal reciprocating movement in sliding bar *B*.

The spring *J* serves to hold the tool open to receive the work. The pin *I* holds the shank *C* on the body of the chuck and also prevents it from turning on its pivot.

Two men turned out 16 tanks a day with these tools, whereas four men without the tools turned out only four tanks per day.



PNEUMATIC FEED FOR AIR DRILLS

By F. G. Goddard.

This device was designed for drilling locomotive saddle bolt holes in the erecting shop after the boiler is in place, at as high a rate of speed as could be obtained in the machine shop on a radial drill. A small air cylinder fitted with piston, guide-bars and crosshead is attached to an air motor by means of a coupling, Fig. 2, screwed into the motor in place of the usual feed screw. This coupling is also attached to the end of the guide-bars in such a way that the motor is free to rotate on its axis, this condition being necessary to relieve the guide-bars of all twisting strain when drilling

When in operation, a 2 inch round bar or pipe of extra heavy section is rigidly stayed in the centre of the smokebox by means of two spiders, Fig. 3; the motor and cylinder being suspended between the spiders on the bar which passes through a 2 inch hole in the crosshead. The air supply to the cylinder is tapped off the motor supply by means of a tee and short length of hose to a three-way cock on the cylinder. It can be manipulated to give exactly the requisite amount of pressure to feed the drill; or on being reversed, backs the drill out of the hole. As the crosshead and piston are attached to the 2 inch bar, they remain stationary when air is applied; but the cylinder moves either up or down, and with it the guide-bars and air motor. It will be noticed that every hole thus drilled is perfectly radial from centre of the smokebox. The apparatus was so designed that drills of average length could be used in smokeboxes of the smallest diameter; consequently in those of larger diameter drill sockets or extensions must be used to make up the length, so that the point of the drill swings 1 or 2 inches clear of the inside of the smokebox when in the back-up position.

When drilling, the motor should be at its full speed before any feeding pressure is applied, and a chalk mark should be put on the drill to show when it is about to point through the outside of the saddle, at which juncture the air feed must be shut off and the drill allowed to go through by its own weight, otherwise it is liable to jam or break the point of the drill. If properly handled and using high

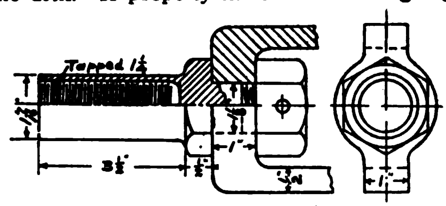


FIG. 2

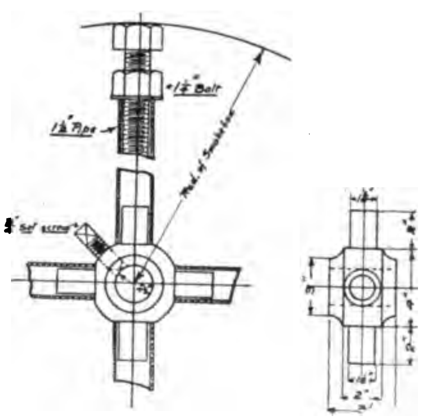


FIG 3

speed drills, saddle-bolt holes can be drilled in this manner at the rate of one every 1½ to 2 minutes, and the time required to change from one hole to another is but a few seconds. The device was originally intended for use in the case of new cylinders being applied to a repair engine, but it was afterwards found that a great saving in time could be effected in the case of new engines, by punching the holes in the smokebox, before rolling, and then drilling the saddle as described after the boiler is in place on the cylinders. It has also been used to advantage for drilling out old saddle-bolts when stripping boilers.

The correct size of cylinder was only arrived at after one of two trials. Finally, a diameter of 5 inches, with an air pressure of 70 to 80 pounds was found to give a fairly heavy feed to high speed drills up to 1½ inches diameter. The stroke of the cylinder is 8 inches.—*Canadian Machinery.*

THE PULLMAN PORTER DERANGES THE AIR BRAKE

The following is taken from a collection of "Old Line Railroad Reminiscences," by S. J. Kidder, in *Railroad and Locomotive Engineering*:

On several occasions an express train had been stopped by an apparently unexplainable application of the brakes, the brakes releasing after the stop and giving no further trouble during the trip. Three times this had occurred on the same railroad and train before it had come to my attention, and I at once started out on a still hunt during which it was learned that Pullman car "Wyoming" had been in the train each time the trouble was experienced and with the same porter accompanying the car.

This was in the early days of employing the water raising system on Pullmans, the air for the system being taken direct from the air pipe, the control of the air passing from the brake pipe to the large air reservoir being governed by a globe valve located in the washroom, under the basin. To avoid possible interference with the air brakes a notice addressed to porters was posted in the room, this notice being to the effect that the water system should never be charged, except when the train was making a long stop, such as a station where the passengers were taking a meal. Believing I was on the right trail, I accompanied the "Wyoming" on its next trip. Getting along quite late in the night others deserted the smoking room, leaving me the sole occupant, and after a time the porter came in with his shoe-shining outfit, when I began making inquiries regarding the water system. What made the water flow from the faucets so freely, etc., all of which the porter explained, and, among other things, he stated if the water did not come out fast enough he just opened up the valve and filled everything with air.

"Don't you porters ever have that hungry feeling when the train is standing at an eating station, as well as the passengers," I asked.

"Sure, I does, boss; I always carries my appetite along with me," he replied.

"I should think you would want to reach the lunch counter when meals are being served as well as the others."

"I don't go without my feed, no Sar. I just sneaks out here when there ain't no smoking gentlemen, and turn that wheel, and no one don't know anything about it. I has just done been in this business too long to lose my fodder."

"If no one knows anything about your fixing up the water outfit, why is it that the train sometimes stops when you open that valve?"

"That's the funny thing about it, boss. When the train stopped, I done shet up that wheel and got off, and while we was hunting for the trouble the brakes all blowed off."

I then called his attention to the notice, explaining to him that the opening of the valve was the cause of the train stopping and, of course, would have to make out a report to that effect.

Upon making this statement his eyes bulged, and throwing up his hands, he exclaimed, "For the goodness sake. Was that me making that train stop?" Then he began supplicating that he would lose his job, saying if I would not report him he never again would disobey the rules governing the manipulation of that globe valve, a promise I gave with the proviso that he should explain to the other porters the danger of charging the water raising system when the train was in motion, a promise he faithfully carried out.

For reasons such as the one here recited the development of valves to automatically maintain the desired pressure in the water distributing system resulted, thus removing any liability of interfering with the action of the air brakes.

A simple muffler for a gas engine may be made by leading the exhaust pipe into the bottom of a barrel, filling the barrel with scrap tin, and putting in the head, through which a hole is cut for the outlet pipe. The tin breaks up the sound waves, and thus the noise is muffled.

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CONTENTS

PNEUMATIC TOOL PROGRESS

A "pneumatic tool," taken individually, is nothing very formidable to look at, and hardly suggests the revolutionary effects following the general introduction of the class of devices which it represents. Only a few years ago lists were being made up of the various tasks which compressed air was undertaking and most successfully accomplishing in practically all lines of human activity, but the list became so large and was growing so rapidly that the enumerators could not keep up with the times and the sport was dropped. It would now be almost as discouraging to try to mention all the employments of the pneumatic tool alone, although it is only a single item of the compressed air kit.

The pneumatic tool is transforming the old-time trades so that the highly developed skill of the workman so requisite in many of them is now a thing of the past, and the workman himself is displaced by the operator. One of the most tedious and constant of the tasks of the machinist of the olden time was the chipping of iron, generally cast iron; this the pneumatic tool now does so much quicker and cheaper, also smoother and better, that the knack of doing it by hand is likely to be forgotten. The rolling up of long, unbroken chips or shavings of soft steel, which the pusher of the pneumatic chisel often can show, is a new art to replace some one of those sentimentally lamented as "lost." Requiring more muscle but less skill, perhaps, was the pulling of the ratchet drill and the tap-wrench, which also the machinist is now pneumatically released from.

The trade of the boiler maker has been entirely transformed by the pneumatic tools which have been put into his hand until there is scarcely a straight hand-work operation surviving. Probably few realize the skill of the expert boiler maker in "driving" the hot rivets by hand and producing the beautiful, smooth, symmetrical, conical heads. Such skill may become a tradition and then a myth. The machined or pneumatic-tooled rivets are better to look at, after all.

The noise of the hammer has not been eliminated, but little else survives, and we hear it constantly as the skyscrapers are going up. The rapidity with which the steel skeletons grow is due to the pneumatic riveters, as well as to the derricks.

Hand hammering throughout the trades, from the driving of nails to the forcing into place of heavy pins and bolts in machine erecting, is becoming a "has been," and the mutilating dents of the hand hammer need no longer be tolerated.

The pneumatic hammer is not more efficient, and ultimately is not more a necessity in the metal trades, than in the other industries where skillful or merely persistent applications of force to cutting tools in detail is required. Stone carving is one of its greatest successes, the most delicate and difficult designs of the sculptor being reproduced in granite or marble with a facility which the ancients could not have dreamed of. The stone-cutting ability is now found just as handy and valuable in cutting asphalt, concrete or macadam where street pavements are to be torn up for any of the modern "improvements."

The percussive pneumatic tool follows in principle the hand operation, the chisel or other bit being held tight against the work and the hammer blows being showered upon the head of it. It is curious that the first, and now established, pneumatically-operated rock drills radically departed from this idea, the cutting bit and the hammer all reciprocating and striking the blow together. These drills, as we know, have been a success the world over; but later the pneumatic tool, embodying the primitive idea, has been replacing them among the miners, and none can say what will be the end of it.

AMERICAN BLOWING ENGINE PROGRESS

Twenty years ago the simple vertical, long crosshead type of blowing engine was installed at a group of four blast furnaces. About eight years after, half the group of engines were replaced by larger machines with large steam cylinders, so as to operate them as disconnected compound units. In fifteen years' time from the start they were superseded by improved forms of compound engines. About two years ago the new engines were assisted by gas-driven blowing engines using blast-furnace gas, with the implied intention of displacing all steam blowing engines. Now arises the specter of the turbine-driven blower. Fundamental changes in the iron and steel business imposed these changes and not the mere "obsolescence" of the elements of the power plant. Other lines of industry, not excepting the business of furnishing electric current, have exhibited similar crises in their development.

INCREASE IN USE OF COAL MINING MACHINES

According to E. W. Parker, of the United States Geological Survey, 174,012,293 short tons, or 41.7 per cent of the total output of bituminous and lignite coals, was mined by machines in 1910. This was an increase of 31,515,415 short tons over the amount so mined in 1909. The number of machines operated in 1910 was 13,254. The use of machines not only makes the miners' task easier but, according to Mr. Parker, reduces the tendency, too prevalent in many coal-mining districts, to "shoot from the solid," a practice that not only increases the liability to accident but produces an inordinate quantity of undesirable and unmarketable fuel. It is gratifying to note, says Mr. Parker, the steady increase in the proportion of coal mined by the use of machines, for it indicates a larger proportion of coal undercut before being shot down.

SOUTH AFRICAN DRILL CONTEST

The following letter in the latest-to-hand issue of the South African Mining Journal, with the appended note by the editor of that publication, seems to be entirely self-explanatory and will be read with interest.

To the Editor South African Mining Journal:

Sir—I enclose a small circular, entitled "Results of the Stope Drill Contest," which from its appearance was published by your journal, and quoting from your issue of June 14th, 1910, this being circulated in the United States as an advertisement of the Holman rock drill. This was no doubt unintentional, but the general impression is very misleading. It would give one the impression that there were 4,000 Holman prize-winning drills in use on the Rand. The truth is that of all the various drills that entered the Stope Drill Contest there are probably few in actual use on the Rand to-day, including the Siskol and Holman drills, between whom the prize money was divided. These drills were all small, the Holman only 2⅛ in. diameter of cylinder, and only weighed 100 lbs. The smallest drills being installed on the Rand to-day have cylin- to 200 lbs. Furthermore, this circular does ders 2½ in. to 2¾ in., and weigh from 140 lbs. not mention that some of the largest of the drill manufacturers did not enter the contest, as they considered that 100 lbs. was too light a weight for a stoping drill, and therefore did not enter the contest at all. Again, the fact that very few of these drills are in operation here now, proves conclusively that this contest accomplished nothing more than proving that a 2⅛ in. reciprocating drill of the Holman type and weight, though it shared the prize, was *not* the ideal stope drill for the gold mines of South Africa. I have taken the liberty of calling this to your attention, as I do not think that a journal of your standing would care to mislead any mining men in so important a case as this is. Yours, etc.,

"ENGINEER."

September 12, 1911.

[The foregoing letter refers to a pamphlet being circulated in the United States, claiming to consist of extracts from the South African Mining Journal of 4th June, 1910. This pamphlet was not issued from our office, does not quote us correctly and has been published without our knowledge.—Ed. S. A. M. J.]

SMALL MOTORS

We have received the first issue of a neat little monthly publication bearing the above title put out by the Westinghouse Electric and Manufacturing Company, its scope being clearly indicated by its title. It is devoted to the innumerable and widely diverse applications of small electric motors, for industrial and domestic purposes with information and advice as to installation, operation, upkeep, etc. It is to be destributed to central stations and dealers the first of every month.

OUR DIMINISHED ATMOSPHERIC PRESSURE

The following curious and rather interesting line of speculation is to be credited to *Cosmos*:

Among the animals which people the earth we find representatives of all sizes, from the microscopically small animalcule to the great elephant. But within the limits of any one species the scale upon which the individuals are built does not differ very materially; we do not, for example, find specimens say ten times larger than their adult congeners.

It is easy to show good mechanical and physical reason why this should be so. Consider two birds, geometrically similar, such as two swallows for example, and imagine the second to have ten times the normal size. This bird will then have all its linear dimensions ten times as great as the normal bird, while the surfaces will be one hundred times as great. In this way all the cross sections, the thickness of the muscles, especially of the wing muscles, being increased one hundred fold, we may safely take it that the strength of the bird will also be increased in the same proportion. But on the other hand, it must be remembered that the volume, and hence the weight of the body, will be increased one thousand fold. Thus this large swallow, built on ten times the normal scale, would find itself quite unable to rise into the air or to sustain itself there, for it is relatively ten times less strong than its congeners; with muscles one hundred times as strong as theirs it is called upon to perform one thousand times the work.

As a matter of fact, an examination of the flight of different kinds of birds having approximately the same form shows that flight becomes more and more difficult as the weight increases; large birds substitute as far as possible sailing flight (which is the characteristic motion of our aeroplanes) for flapping of wings. Thus the size of animals capable of flight has an upper limit, and this seems to be reached, in the present state of nature, by the large birds, so far as sailing flight is concerned, and by the large insects, so far as flight by wing vibration is concerned.

And yet in past ages much greater animals have flown. One reptile of the group Pterodactyl had a span of over thirty feet, which exceeds that of a racing Blériot; this creature lived during the cretaceous period and flew as far as 90 miles inland. Certain dragon flies of the carboniferous era measured over three feet from tip to tip of their outspread wings. Under present conditions it would be quite impossible for these creatures to fly. The most natural supposition is that in the times when these creatures flew through the air, the atmosphere had a greater density than it has at present. This is the conclusion reached by Mr. Harle. In the estimation of this paleontologist, the existence of these great flying animals during cretaceous and carboniferous times indicates that atmospheric pressure at that time was greater than at present.

A POLE PRESERVING APPARATUS

The life of wooden poles for telephones, telegraph and transmission lines is shortened by their rapid decay at or near the surface of the ground, and if this local decay can be prevented or even retarded, the life of the pole is proportionally lengthened. Effective preservatives have been found for the wood, but painting the surfaces or even dipping the ends of the poles is not sufficient and a portable apparatus has been devised which secures a certain and effective penetration of the fibre.

The machine as constructed comprises a platform about 19 ft. long and 6 ft. wide, mounted upon wheels for drawing about, and upon this platform are placed a steam boiler, an air compressor and air storage tank, a closed oil tank with steam coils, and an airtight canvas band or belt 3 ft. wide to enclose the portion of the pole which is to be treated. There are also the necessary devices for wrapping the band about the pole and making it tight. A pole to be treated is rolled onto the platform and rests upon two horizontal beams fixed at the proper height, and two segmental stationary rings have their upper halves closed over the pole. Then a spindle carrying the canvas strip is revolved on the rings about the pole, and a clamping bar converts the belt into a closed bag. Air pressure is applied to the edges of the band to close it around the pole and then the oil is forced through a pipe connection into the bag and around the pole, pressure being held on for any desired length of time. Should any oil leak by the ends of the bag, through cracks or checks in the wood, it would drip into a catch basin and might later be drained into the oil tank. By reversing the above operations, the pole may be released and taken away on the other side of the machine. Where a large number of poles have to be treated, a platform may be built on either side of the machine, or any desired construction made for ease in bringing poles to the machine. For a small number of poles in any one place, inclined skids may be placed on each side of the machine. The capacity of the machine is claimed to be about 50 poles per day. The cost of treating, including labor, oil, fuel and fixed charges, is something less than $1 for a 35-ft. pole, with a 7-in. top.

At a demonstration of the process and apparatus, which was given recently in Chicago, three 35-ft. Michigan cedar poles, cut last winter, were treated 7, 10 and 15 minutes, respectively, with hot creosote oil, under an air pressure of about 5 lbs. With the 10 minute treatment an initial penetration of 3/16 in. was obtained, and in a few days this had increased to over ½ in. The treated belt was 3 ft. wide, and 1 gallon of oil was absorbed.

It is stated that both the process and the equipment are patented, the latter being manufactured by the B. & E. Pole Preserving Machine Company, 2014 Fisher Building, Chicago.

A WEATHER FORECASTING COMPETITION

The Société Française de Navigation Aérienne has decided to organize a competition in weather forecasting, which will extend over a period of two weeks about the time of the vernal equinox of next year. This season was selected because it is supposed to be characterized by generally unsettled weather, and therefore likely to afford a servere test to the competitors. An elimination contest, the particulars of which have not yet been announced, will precede the principal competition, its object being to shut out the cranks and charlatans who might be disposed to participate in such an event.

The idea of a public contest in weather forecasting is not new. In the autumn of 1905 a competition of this sort was held by the Société Belge d'Astronomie for a prize of 5,000 francs. The competitors were first required to make daily forecasts based on the current weather maps published at the various meteorological centers of Europe; these were submitted by telegraph and registered mail to the jury assembled in Belgium, the members of which were all well-known meteorologists, viz., Messrs. Teisserenc de Bort, Rotch, Polis, Brunhes, and Vincent. From the twenty-four contestants the seven who submitted the most accurate forecasts were summoned to Liège to take part in a further test. Each of them was required to make a series of forecasts for a twenty-four hour period based upon seven weather maps selected at random from those published by the French meteorological service between the years 1880 and 1902. The jury, having at hand the maps for the days succeeding those selected, was able immediately to verify the accuracy of the predictions.

This second test resulted in the further elimination of four competitors, and the remaining three were then required to furnish a statement of their methods of forecasting. The jury unanimously awarded the prize to M. Gabriel Guilbert, of Caen, France, both for his successful forecasts and for his method, which was then first made known to the scientific world, and attracted wide attention. —*Scientific American.*

SAND SPECIALLY MANUFACTURED FOR THE SAND BLAST

There are, as they say, sands—and sands. Not all sands are effective with the sand blast, and, indeed, some would be perfectly worthless for the purpose. The use of the sand blast is constantly increasing and its specific applications are becoming more numerous. One of its most extensive fields of activity is in the cleaning of castings in the foundry. Fabricators of structural material are installing the system for cleaning sections before painting so as to insure a clean surface and to thereby further retard corrosion. Tank works and similar manufacturing establishments are likewise installing this equipment and with the growing use of this device there has been a correspondingly increased demand for sand blast sand.

Heretofore much of this sand has been shipped from the east, where it is dredged from the Atlantic ocean. A large deposit of silica rock, which is unusually well-adapted for sand-blasting purposes has been uncovered in Portage county, Ohio. This deposit is owned by the Portage Silica Co., Youngstown, O., and consists of practically 900 acres. The rock is now being mined by this concern and a large crushing and disintegrating plant, as well as washer and dryer, have been installed.

The sand blast sand can be furnished in six grades adapted for various classes of work, the coarser grade being specially suitable for use in cleaning castings which are to be subsequently enameled. The finer grades are adapted for cleaning aluminum and brass castings, and other grades are suitable for gray iron and steel castings and rolled steel products of all kinds. The company's mines and sand-preparing plant are located on the Erie railroad and the present output averages from 400 to 500 tons daily. The dryer installation permits of the shipment of dry sand at any time of the year, thus precluding the necessity of foundries carrying a large stock of sand during the winter months.

PNEUMATIC CAISSONS FOR DRY DOCKS IN QUICKSAND

The dry-dock construction in the Brooklyn navy yard is one of those complicated pieces of work which deserve to be described by a literary master like Kipling, for the struggle that is going on there between the treacherous quicksand and the men in charge of the work is something wholly outside the ordinary run of engineering undertakings. Every dry-dock in the yard has caused its builders constant worry, but the new one has a particularly cantankerous record of disaster. Those who are unacquainted with the site can hardly imagine the difficulties. The place is underlaid by very fine material possessing most of the characteristics of quicksand, although some engineers have hardly classed it as such. Whenever a large excavation is made in it subsidence occurs in the vicinity. The earlier contractors on the dock conducted the work in the open, and before they retired a number of buildings in the vicinity were injured by the settlement of their foundations. Attention has been called from time to time of the warning against such methods given years ago by the builder of the first dry-dock in the yard, the late William J. McAlpine. His experience showed him that it was impossible to execute more than a small piece of the structure at a time, but that the concrete could be put in piecemeal by concentrating the work on small areas. The new dock, after a long record of disappointments and tribulations, is now being executed in just this way, but by means which were outside the resources of Mr. McAlpine. The construction of such a dock is essentially a foundation problem, and the work is now being executed successfully by employing that most important resource of foundation specialists, the pneumatic caisson. This is essentially a means for concentrating construction on a small area under the most favorable conditions, and the work in progress in the Brooklyn navy yard is a singularly vivid exemplification of the progress in such matters since the first dock was constructed. That the troubles have by no means been wholly overcome is very probable, but enough of them have been encountered and bested to indicate that the new dock can be constructed without any more serious results to adjacent structures.—*Engineering Record.*

NOTES

Politeness may be only "hot air," but an air cushion makes a mighty good "shock absorber."

Tarred-paper gaskets will be found effectual when an air or oil paint persists in leaking. They may also be used on the flange joints of an air compressor. They are much better than lead gaskets.

The cost of a loft building of reinforced concrete, recently completed on Forty-second street, New York City, is reported to have been 11 cents a cubic foot, including the ornamental front, the heating plant, lighting, elevators and plumbing.

In round numbers a stream having a flow of one cubic foot per second will generate one theoretical horse-power for every 10 ft. of fall it has. Thus, a stream flowing 4 cu. ft. per second, and having a fall of 30 ft., could generate 12 theoretical horse-power.

The lung capacity of the average woman who does not wear corsets is about 2800 cubic centimeters or 171 cubic inches; of one who is in the habit of wearing corsets only 2,200 cubic centimeters or 134 cubic inches.

A feature of the mine safety demonstration at Pittsburgh this month will be a parade of miners, with 19,927 men in line. This is the number of men killed in America coal mines during the last 20 years, and the parade was designed both as a mark of respect to the dead and to add impressiveness to the figures of mine fatalities.

A jet of compressed air directed against the heated ends of work that is being forged will revive the heat and also blow off all dirt and scale.

An English report says that the use of pitch as a binder in the briquetting of coal has developed a disease known as epithelioma (pitch cancer), from which an alarming percentage of the briquette workers suffer. A government inquiry is to be held, the result of which will be published as a special report.

Screw connections may be made tight by using powdered shellac dissolved in 10 per cent. ammonia. The mucilaginous mass is painted over the screw threads, after they have been thoroughly cleaned, and the fitting is screwed home. The ammonia soon volatilizes, leaving behind a mass which hardens quickly, makes a tight joint, and is impervious to hot and cold water.

The condition of iron in lime concrete after a period of more than 200 years was determined when an opening was made recently in the concrete of the dome of St. Paul's Cathedral, London. A large chain used for reinforcement at the base of the dome was found to be as bright and perfeet as when new. One reason advanced in explanation of the condition is that the oxide of iron chemically combines with the cement, forming a covering of ferrite of calcium, which is a protective agent.

It has been shown that oil with a flash point of 239 deg. Fah. will not ignite if fired into with a shell, and if dynamite is exploded in a reservoir of this oil, it only throws up jets of oil which do not ignite. The only dangerous liquid fuel oils are those which have not parted with their volatile, inflammable gases, such as absolutely crude oils. In all ordinary commercial fuel oils these portions are removed, and the oil is safe and contains no power of spontaneous combustion. Oil with a fire test of 180 deg. to 200 deg. Fah. is as safe as coal, and it will not ignite when stirred with a red-hot poker, nor when hot-coals are thrown in it.

One ton of refrigeration is the amount of heat absorbed by the melting of 2000 pounds of ice at 32 degrees Fahrenheit into 2000 pounds of water at 32 degrees Fahrenheit, or the amount of heat that must be extracted from 2000 pounds of water at 32 degrees Fahrenheit to reduce it to 2000 pounds of ice at 32 degrees Fahrenheit, or $2000 \times 142 = 284{,}000$ B.t.u.

It is proposed to hold a Smoke Abatement Exhibition in London next spring. It is the outcome of the success achieved by recent exhibitions in the country, many manufacturers having expressed a desire that steps should be taken to hold in London an international exhibition of a more comprehensive character than is possible elsewhere. The exhibition, which is being arranged by the Coal Smoke Abatement Society, will be held at the Royal Agricultural Hall, and will last a fortnight.

An efficient air filter should be considered a necessary part of the equipment of every motor car. That a large amount of dust does actually enter the air inlet pipe has been proved by an experimenter who purposely refrained from using a duster anywhere inside the bonnet. As a result, the whole of the mechanism within the bonnet—cylinder, magneto, carbureter, piping, etc.—was thickly covered with dust; and as the inlet pipe draws its air supplies from within the bonnet it is obvious that a large amount of this dust becomes mixed with the lubricating oil inside the cylinders, where it is acting as a grinding material for destroying the bearings and the accurate fit of the pistons in the cylinders.

The possibilities of Spitzbergen are attracting. considerable attention since the Arctic Coal Co., owned by American capitalists, has achieved some success in exploiting the coal resources of the island, which is located within the actic circle and is uninhabited save by those engaged in the mining operations. It is stated that the Arctic Coal Co. shipped some 30,000 tons of coal from the island during the open season of navigation which is now about to close, and expeditions have recently been sent to Spitzbergen by Swedish and English capitalists to study its coal deposits and other resources. It is a no man's land, claimed by no government and without an owner of any kind.

The Nepton tunnel, now being driven in the Pachuca, Mex., district will be one of the longest mining tunnels in the world. It will be over 6 miles long when finished, and lies at a depth of about 1,400 ft. below the surface of the city of Puebla. Though started 18 years ago, only about 2 miles of the length has been finished. The tunnel is to drain the Pachuca mining district and afford an outlet for the ores of the different mines.

In the suction pumping of water not only should variations of altitude and, consequently, of air pressure be taken into consideration, but the engineer should take account of any decided variations in the temperature of the water. With the volatilization of water the vapor overcomes the vacuum condition upon which the elevation of the fluid by suction is dependent and materially reduces the possible head at which the pumping is carried on. It has been computed that at a water temperature of 180 degrees F. at sea level a safe suction head is less than 13 ft., while with the same temperature of water at an altitude of 5,000 ft. the safe head is 8.2 ft., compared with a head of 20.5 ft. at 60 degrees F. and an altitude of 5,000 ft.

In breathing ordinary air a man consumes from 10 to 35 per cent. of the oxygen that passes into his lungs; the rest he exhales with the nitrogen he inhaled and the carbon dioxide produced in his lungs. The exhaled breath contains 2.6 to 6.6 per cent. of the suffocating gas carbon dioxide, or an average of about 4 per cent. The percentage does not change much, whether the air breathed contains a high or a low percentage of oxygen, so long as a man breathes freely. But when a man breathes air that contains as much as 5 per cent. of carbon dioxide, even if it contains a high precentage of oxygen also, he begins to breathe with effort, his head aches, he feels dizzy, and he may have pains in the chest. The same difficulty in breathing may be felt when a man breathes air containing as little as 14 per cent. of oxygen. Air that contains 10 per cent. of oxygen is extremely dangerous, for it will quickly suffocate anyone breathing it.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 5.

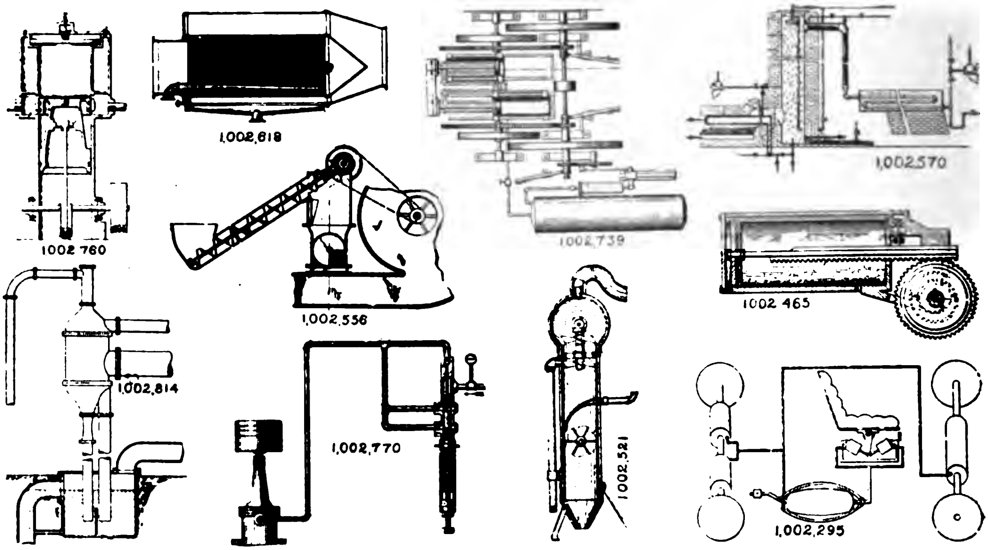
1,002,249. ELECTRICAL OXIDATION OF NITROGEN. CARLETON ELLIS, Montclair, N. J.
1,002,295. AIR COMPRESSOR AND DISTRIBUTER. MICHAEL G. MCGUIRE, Chicago, Ill.
1,002,324. VACUUM CLEANING DEVICE. GEORGE JAMES SHEPPARD and HENRY FRANKLIN ADAMS, Montreal,, Quebec, Canada.
1,002,465. ENGINE-STARTING DEVICE. GREGORY J. SPOHRER, Franklin, Pa.
1,002,521. VACUUM-CLEANER. FRANK KENNEY, Portland, Oreg.
1,002,556. PNEUMATIC ELEVATOR. GEORGE BERNERT and JACOB BERNERT, South Germantown, Wis.
1,002,570. TREATMENT OF PETROLEUM. JESSE A. DUBBS, Santa Monica, Cal.

The method of treating petroleum to dry, and free the same from water, distil or produce asphalt therefrom, consisting in continuously causing the petroleum to drop, *in vacuo*, in the presence of ascending currents of combustion gases to drive off the lighter products from each of said drops while in suspension and collecting the asphaltic residuum below the heat zone, the size of the drops being varied according to the ascending heat and to the product desired.

1,002,576-7-8. APPARATUS FOR DRYING AIR BY REFRIGERATION. JAMES GAYLEY, New York, N. Y.
1,002,618. AIR-FILTER. HUBERT WINKLER, Moscow, Russia.
1,002,739. COMPRESSED-AIR ENGINE. DICK H. MURRAY, Houston, Tex.
1,002,760. AIR-COMPRESSOR. EDWARD A. RIX, San Francisco, Cal.

1. In an air compressor, the combination with a cylinder having an eduction valve at its upper end and two annular series of inlet ports at an intermediate point, spaced apart longitudinally of the cylinder, of a crank shaft, a connecting rod and a piston movable downwardly to open the upper series of inlet ports above the piston and having a peripheral air chamber open to the inlet ports in all positions of the piston when the inlet ports are not open to cylinder, whereby the inlet ports are never closed by the piston, and an upwardly opening valve in the piston through which air passes from the peripheral chamber to the cylinder.

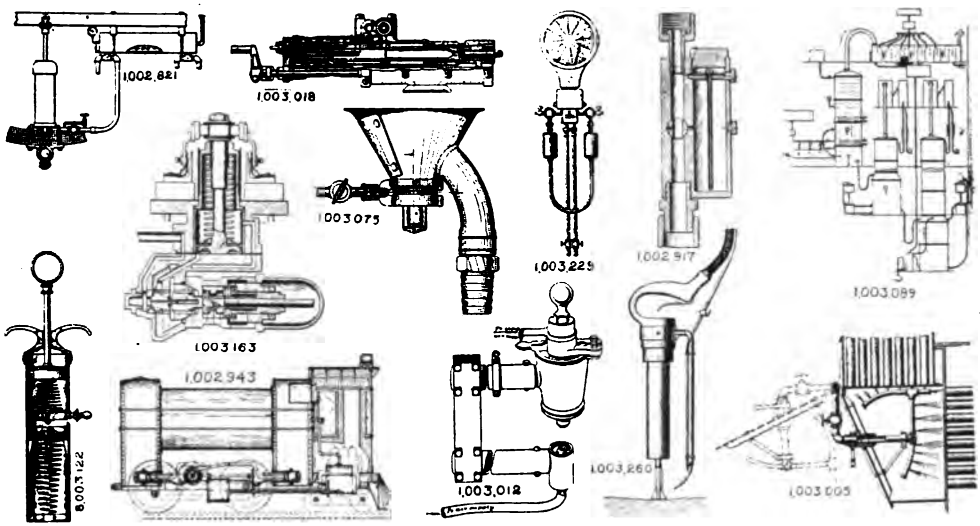
1,002,770. UNLOADING DEVICE FOR COMPRESSORS. CARL G. SPRADO, Milwaukee, Wis.
1,002,814. BAROMETRIC CONDENSER. ROYAL D. TOMLINSON, Milwaukee, Wis.



PNEUMATIC PATENTS, SEPTEMBER 5

SEPTEMBER 12.

1,002,821-2-3. PNEUMATIC SPRING DEVICE. IRVING COWLES and ERNEST H. MACDOWELL, South Haven, Mich.
1,002,905. HUMIDIFYING APPARATUS. ALBERT J. DRONSFIELD, Providence, R. I.
1,002,917. LUBRICATOR. STARKY DANIEL JONES, Georgetown, Colo.
1,002,943. AIR-ENGINE PLANT. MAGLOIRE THIBAULT and MICHAEL SAMWOLD, Ottawa, Ontario, Canada.
1,002,971. COMBINED SPEED-REGULATING AIR-CUSHION AND EMERGENCY JARRING DEVICE. ROBERT M. DOWNIE, Beaver Falls, and JAMES L. DOWNIE, Downieville, Pa.
1,003,005. BLOWER FOR BOILERS. ALFRED G. MATTSSON, Detroit, Mich.
1,003,012. RIVETING AND CALKING MACHINE. CLARK J. SMITH, Ottumwa, Iowa.
1,003,018. DRILLING-MACHINE. DANIEL SHAW WAUGH, Denver Colo.
1,003,075. DUST-COLLECTOR FOR ROCK-DRILLS. CHARLES SOLOMON WAHLSTROM, Wallstreet, Colo.
1,003,089. APPARATUS FOR RECOVERING SOLVENT VAPORS FROM AIR, &c. AN-



PNEUMATIC PATENTS, SEPTEMBER 12

TOINE COLLARD, Molenbeek, near Brussels, Belgium.

1,003,122. AIR-PUMP. IRA PASLEY, Olds, Alberta, Canada.

1,003,129. AIR-COOLING APPARATUS. FREDERICK WITTENMEIER, Chicago, Ill.

1,003,154. PNEUMATIC HAMMER. ROBERT T. SCOTT, Chicago, Ill.

1,003,163. PRESSURE-GOVERNOR FOR PUMPS. WALTER V. TURNER, Edgewood, Pa.

1,003,229. DIFFERENTIAL-PRESSURE GAGE. WILLIAM H. BRISTOL, Waterbury, Conn.

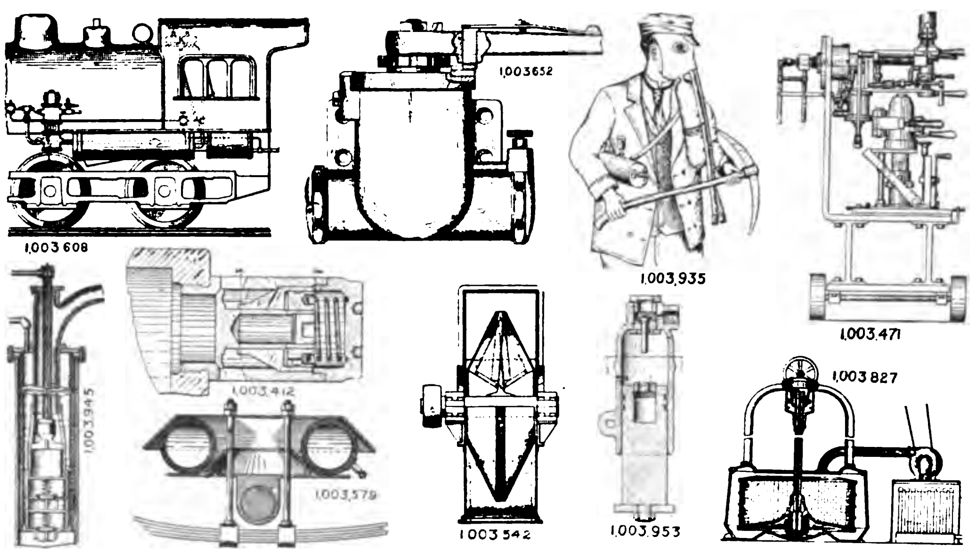
1,003,260. DUST PREVENTER FOR STONE-WORKING-TOOLS. WILLIAM H. HOLDEN and EDWARD M. TOBIN, Barre, Vt.

1,003,279. PNEUMATIC PIANO-PLAYER. WILLIAM GIFFORD MCARTHUR, New York, N. Y.

SEPTEMBER 19.

1,003,312-3. VALVE. CHARLES R. BALLARD, Midway, Pa.

1. A self contained valve for compressors, pumps and the like, comprising a casing provided at its inner end with a valve seat and with means for attachment to the cylinder and having ports in its side walls and provided with an internal shoulder, a valve co-operating with the valve seat and provided with an outwardly extending stem, a bushing rotatably adjustable in said casing and provided with an axial bore in which the valve stem is slidable and with an enlarged part contacting directly with the shoulder in the casing, a valve cap threaded into



PNEUMATIC PATENTS, SEPTEMBER 19

and closing the outer end of said casing and bearing directly against the bushing and clamping the latter against the internal shoulder in the casing, and a spring arranged to hold said valve to its seat.

1,003,471. MACHINE FOR MANUFACTURING GLASS BOTTLES, JARS AND THE LIKE. FREDERICK WILLIAM KNOWLES and GEORGE WILLIAM INMAN, Thornhill Lees, near Dewsbury, England.

1. A glass blowing machine comprising a rotatable frame, a divisable parison mold and an air cylinder mounted on the frame, mechanism operated from the cylinder for separating the mold, an air supply pipe connected with the blowing shell of the molds, a pressure pipe communicating with an annular passage formed in the journal of the frame, and conduits connecting the annular passage with the air cylinder.

1,003,542. CENTRIFUGAL PUMP OR BLOWER. JOSEPH J. STOETZEL, Chicago, Ill.

1,003,579. PNEUMATIC CUSHION FOR VEHICLES. GEORGE J. BANCROFT, Denver, Colo.

1,003,603. TRAIN-HEATING SYSTEM. WILLIAM JOHN HATCH, Montreal, Quebec, Canada.

1,003,651-2-3. DOOR-CHECK. JOSEPH CHARLES REGAN, Stamford, Conn.

1,004,020. GLASS-BLOWING MACHINE. LUDWIG GROTE, London, England.

1,004,043. AUTOMATIC AIR-TORPEDO. OTTO A. LANGOS, Chicago, Ill.

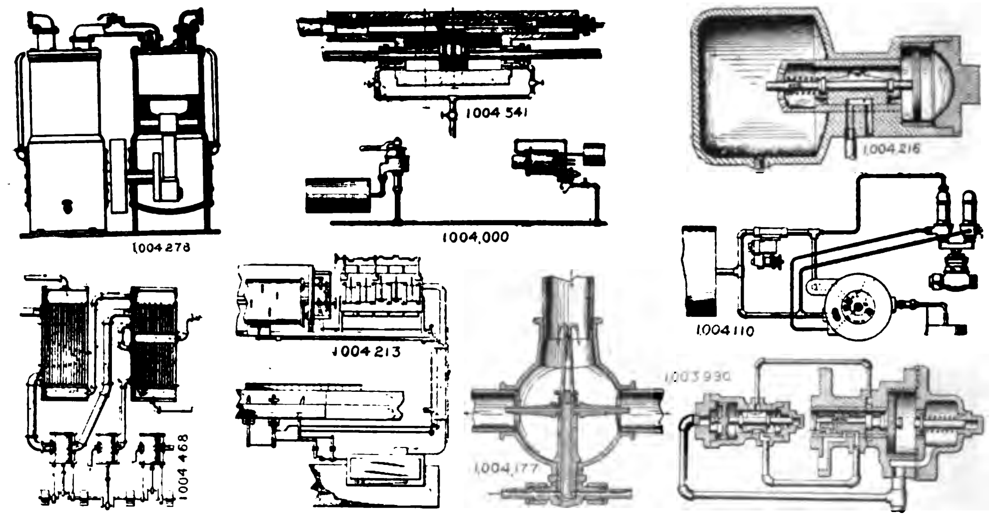
1. An automatic air torpedo, comprising a cylinder having an outlet port, means adapted to clamp the ribbon onto said port, means adapted to compress air in the cylinder and burst the ribbon above the port, and means for automatically feeding the ribbon across the port.

1,004,110-1. PRESSURE-CONTROL APPARATUS FOR FLUID PRESSURE BRAKES. WALTER V. TURNER, Edgewood, Pa.

1,004,177. TRACK-SANDER FOR LOCOMOTIVES. RICHARD KETT, Denver, Colo.

1. In a track sander, the combination with a sand receptacle, means for supplying air to the receptacle under pressure, and a tube in communication with the source of air supply and extending upwardly into the receptacle and having its upper extremity bent downwardly for initially discharging air into the receptacle for sand agitating purposes, and conduits connected with the receptacle for delivering sand to the track rails, substantially as described.

1,004,213. DEVICE FOR REGULATING THE SPEED OF PNEUMATIC MOTORS. LOUIS W. SOTHGATE, Worcester, Mass.



PNEUMATIC PATENTS, SEPTEMBER 26

1,003,661. WIND-MOTOR. CHARLES E. SHAFFER, Morrill, Nebr.

1,003,827. ART OF DRYING AND POLISHING. FREDERICK A. TOLHURST, New York, N. Y.

1,003,935. COMBINED RESPIRATOR AND PRESSURE EQUALIZER. WILLIAM F. MERRYMAN, Denver, Col.

1,003,945-6. PNEUMATIC WATER-ELEVATOR. BENJAMIN R. PILCHER, Dothan, Ala.

1,003,953. BELL-RINGER. FRANK SIMONS, St. Louis, Mo.

SEPTEMBER 26.

1,003,990. RETARDED-RELEASE VALVE. JOHN S. CUSTER, Pittsburgh, Pa.

1,004,000. FLUID-PRESSURE BRAKE DEVICE. EDWIN A. EMERY, St. Louis, Mo.

1. In a fluid pressure brake, the combination with a brake cylinder and means for charging the air in the brake system with a lubricant, of means for conveying the exhaust air from the brake cylinder to the chamber at the non-pressure side of the brake piston.

1,004,006. RAIL-LUBRICATOR. FRANK S. FREEMAN and FRED L. DOKE, Corsicana, Tex.

1,004,016. PNEUMATIC CONTROL DEVICE. LELAND F. GOODSPEED, Milwauke, Wis.

1,004,216. AUTOMATIC RETAINER. EDWIN M. SWIFT, Seattle, Wash.

1,004,257-8-9. PROCESS OF MANUFACTURING GLASS VACUUM-WALL BOTTLES. ORLANDO J. W. HIGBEE, Pittsburgh, Pa.

1,004,278. AIR-PUMP. DANIEL KLEIN, Spokane, Wash.

1,004,468. METHOD OF DRYING AIR. IRVING H. REYNOLDS and FRED E. NORTON, Youngstown, Ohio.

1. The method of extracting moisture from air, which consists in compressing the air; bringing the same while in its compressed state into contact with a surface the temperature of which is materially lower than that of the air and thereby causing the contained moisture to condense; permitting the dried air to expand and by reason of its expansion to lower its temperature; and finally employing the cold air thus obtained to lower the temperature of the medium employed to cool the aforesaid cooling surface.

1,004,504. VACUUM-CLEANER. LUTHER VAN NETTE, Bradford, Pa.

1,004,541. FLUID-PRESSURE CONTROL. FREDERICK E. MARTIN, Bonami, La.

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COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

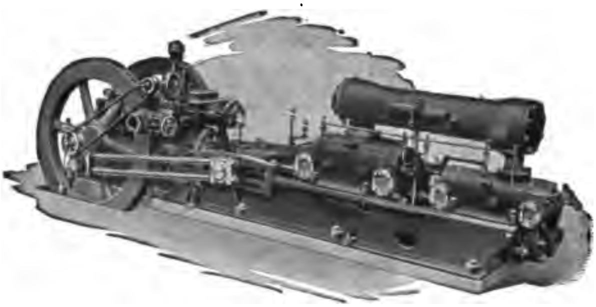
Vol. XVI DECEMBER, 1911 No. 12

Published by THE COMPRESSED AIR MAGAZINE CO., Easton, Pa.

NEW YORK, Bowling Green Building LONDON, 165 Queen Victoria Street

Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

TURN ON THE AIR!



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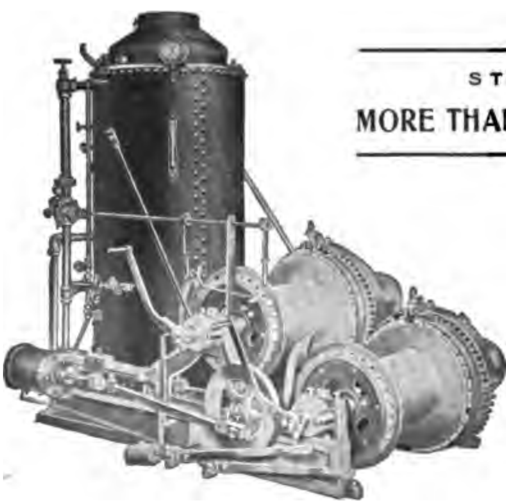

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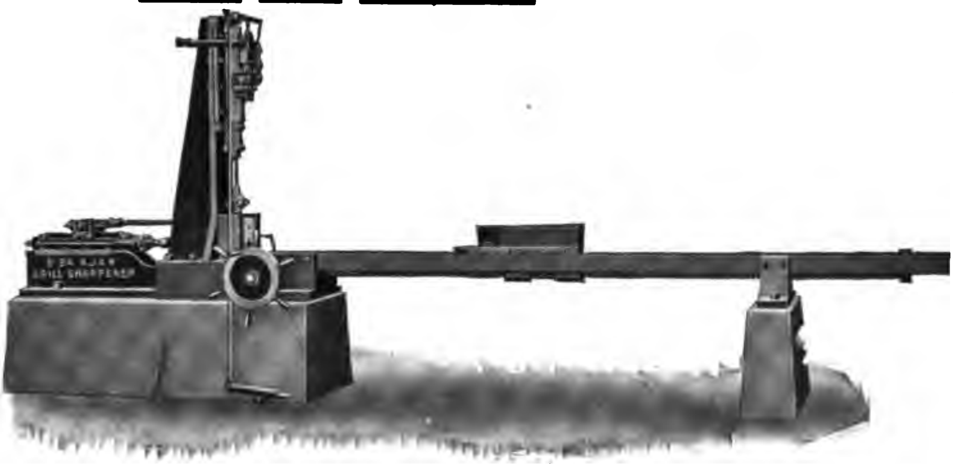

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV DECEMBER, 1911 No. 12

FIG. 1. ENTRANCE TO COLLEGE OF CITY OF NEW YORK.

SMALL DRILLS FOR A SMALL TUNNEL

The half tones here shown illustrate one of the minor or incidental compressed air jobs of which there are so many constantly coming on in New York City. The fine buildings of the College of the City of New York cover a large area upon ground a hundred feet or so above the normal city level but still with the cellars so low that they will not drain by gravity into the Washington Heights system of sewers. There is therefore a tunnel being driven to form a connection with the sewer in St. Nicholas Avenue. From the mouth of the tunnel here shown, which is in St. Nicholas Park, the sewer will be a cut-and-cover construction, all in rock, to St. Nicholas Avenue.

The plant for the job comprises an Ingersoll-Rand NF-1 steam driven compressor automatically maintaining a working pressure of 80 pounds and two Ingersoll-Rand B-104, 2½ inch drills, each weighing 116 pounds, mounted on double-screw columns.

The tunnel is 6 feet square, unlined. The average progress is 50 feet per week of six days. There are two working shifts, the first going on at 1 A. M. and finishing at 9 A. M. and the second starting at 11 A. M. and working until 7 P. M. Each shift consists of 11 men: 2 drill runners, 1 engineer for compressor, 1 blacksmith and helper and 6 muckers. The actual drilling time for each shift is 4 hours, during which time each drill accomplishes an average of 50 feet of holes 6 feet deep, starting with a 2 inch bit and finishing with 1¼ inch. While designed for a depth of 6 feet they will easily do 8 feet. The contractor for this work is the Thomas Crimmins Company, of New York.

efficiency all through the details of machine-shop practice that there might be some question at the moment as to what most requires to be castigated for its delinquency, although I have little doubt about it.

FIG. 2. COMPRESSOR HOUSE RUNWAY AND DUMP.

COMPRESSED AIR THE LAST* DUCK OF THE MACHINIST

By Frank Richards.

The simile of the last duck was used by a writer in the *American Machinist* many years ago in connection with some other matter. You know that in the big rivers of China there are many who live in boats and who keep lots of ducks. These ducks are allowed to swim away in the morning and to be gone all day, picking up their living, but they are all sure to return with a rush when night comes or when the owner calls them, because the last one is sure to get a whipping.

The *American Machinist,* without any formal or conscious recognition of the function, has kept up the whipping of the last machine-shop duck through all the years of its existence. The thing which has been most incorrect or inefficient in practice has constantly been set right and urged forward, until now there is such a general uniformity of

In very recent years it has come in my way to offer a word or two here and there about compressed air, and usually in advocacy of its general and more extensive employment. My present breaking out is decidely in the same line. There may be those who, when they have read thus far, will think they have enough, but there really is something which ought to be said, and which should be heeded and acted upon for the good of all.

If, at the present time, compressed air is not the last duck in general machine-shop practice, and requiring the treatment which a last duck should receive, where else is that duck? Knowing in a general way the capabilities of compressed air, machinists still have not fully acquired the compressed-air habit. They don't *think* compressed air. They do not look upon it as a working companion, a constant helpmeet. When they do employ compressed air for any specific purpose, it is too apt to be as a last resort. There are some things, as we know quite generally, which only compressed air can do, but there are many other things which compressed air can

---

**American Machinist.*

do better or quicker or more cheaply or with less fuss and muss than they can be done by any other agency, but this we do not so fully appreciate.

THE COMPRESSED AIR MISSIONARY.

In speaking here of the general machine shop, including its close ally the blacksmith shop, and of its too frequent lack of proper appreciation and its too infrequent employment of compressed air, both the manufacturing and the jobbing shops are included, and from the biggest down to those which are quite small, but practically all railroad shops are excluded from this category, for in all those the compressed air missionary has been located and has done its beneficent work so thoroughly that it can never be undone. There compressed air has come into its own and can never be dispossessed.

This missionary is, of course, the air-brake pump. With these pumps or compressors always hanging around ready for a job in all railroad shops, it has been the simplest thing in the world to pipe one up and to use the air for any of the primitive compressed air devices, as likely as not for an air hoist of some type, and then the handy air has at once made its way for other uses and has soon become indispensable. In the growing use of compressed air thus begun, it has frequently happened that one air-brake pump after another has been added, until sometimes a battery of eight or ten or a dozen has accumulated. The air-brake pump, as is conceded by all, is an extravagant and costly means of producing compressed air, though admirably adapted to the conditions of its normal employment. The steam or power cost of operating several of these pumps together has led to their replacement by standard and up-to-date compressors, so that railroad shops are now among the best customers of the compressor builders.

FIG. 3. MOUTH OF TUNNEL.

There has recently appeared a book of railroad-shop kinks of about 300 pages, each larger than the page of the *American Machinist,* and crowded all through with devices which have originated in railroad shops. Among these is an astonishing lot of air-operated conveniences and contrivances, all in established and successful use. These are devices which have all originated in railroad shops, have been first thought of and worked up and applied there. Most of them are equally applicable in all other machine shops, numbering, perhaps, four times as many as the railroad shops alone. These devices generally are not in the habit of being born, so to speak, in the shops other than railroad shops, because the air they breathe is not so free and plenty there.

The railroad man regards compressed air with confidence from the beginning, for he has constantly before him one of the world's greatest mechanical successes—the air brake. As a consequence he need not waste his time in hesitating as to the feasibility of any compressed-air application which may occur to him. Generally speaking, no experimenting is required. As soon as the thing is thought of it speaks for itself that it will work, and the only thing to be done is to determine the strength and sizes required and the general arrangement and adaptation of details.

COMPRESSED-AIR LEAKAGE.

With the air brake so well known, and with a general knowledge of its operation which every intelligent mechanic must possess, it remains an inexplicable mystery that there should be such a persistent impression, among those who have had little directly to do with compressed air, that in the general use of it there is a considerable and constant leakage. In the presence of a modern railway train it is impossible to discuss the matter. Take a train of, say, a dozen passenger cars, or, more trying still, forty or fifty freight cars with the air pipes coupled with a snap between each pair of cars by a not over-careful trainman, with valves and joints and fittings in each car. The pressure is maintained when the train is running and rattling along with the little air-brake "pump" working less than half its time, less than a quarter of its time, probably, and working not to keep up this constant pressure but to replace the air which is used each time the brakes are set. If there is so little loss by air leakage on railway trains, or on the miles and miles of piping in the switch and signal service, the possible losses in an ordinary machine shop are not worth talking about.

I have referred here only to the incidental uses of compressed air which develop in shops wherever a supply of air is constantly and freely usable. Compressed air is not primarily brought into shops for this service. It has its regular line of business in driving pneumatic tools, hoists, sand blasts, etc. Many of the most highly developed and most efficient machine tools call for air under pressure to operate feed motions and automatic devices, so that no shop can be uptodate, or can avail itself of the most advanced and most profitable of modern facilities without providing and maintaining an air supply. In the matter of providing this air service it is not a question of meeting the initial expense involved; the question rather is how the greater cost of operating without the air facilities can be longer submitted to.

The shop which is not a railroad shop has a great advantage to begin with, in that it is not tied to the steam gormandizing air-brake pump. The compressor manufacturers are now putting out machines in such great variety as to satisfy closely all requirements as to capacity, and the most suitable drive for the given conditions. Perhaps the most important thing of all in getting the first compressor is to provide one larger than the requirements in sight would suggest, for additional uses for the air will certainly develop. But, after all, it will be surprising how many air-operated devices a small compressor will drive where they are only intermittently operated. Compressed air is unique in that while it may be always standing ready to do its work it costs nothing except while actually doing it.

THE WORK OF THE HUMAN HEART

The average human heart is a suction and force pump of remarkable capacity and dura-antiquated diving methods employed on har-bility. Each of its two chambers contains, on an average, 75 cubic centimeters, or 4.575 cubic inches; the total contents of 150 cubic centimeters or 9.15 cubic inches being discharged 81 times a minute, corresponding to a delivery of 12,150 cubic centimeters, or 741 cubic inches per minute, or 25.73 cubic feet per hour. Expressed in U. S. gallons, the average human heart pumps through it each hour 192.6 gallons; each day, 4,622.4 gallons; each year, 1,687,176 gallons; and in the adult life time of a man living to the age sung by the Psalmist 8,435,880 gallons. The pressure against which this fluid is pumped is equivalent to that of a water-column 2½ meters or say 8 feet 2.42 inches high; otherwise expressed, about 0.242 atmospheres or 3.55 pounds avoirdupois per square inch.—*Scientific American.*

THE METERING OF COMPRESSED AIR

By J. L. Hodgson.

Until comparatively recently the metering of compressed air has been looked upon as a problem involving considerable practical difficulties. At the present time, although it is not possible to assert that all these difficulties are removed, it is possible to say that practicable instruments are available by means of which the metering of compressed air may be effected with an accuracy of plus or minus one per cent.

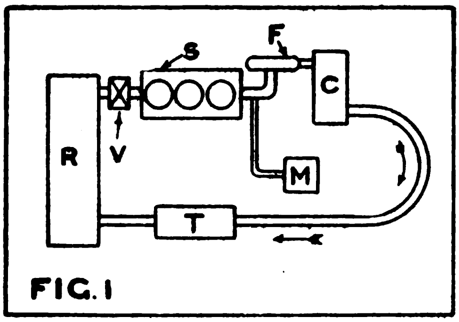

FIG. 1

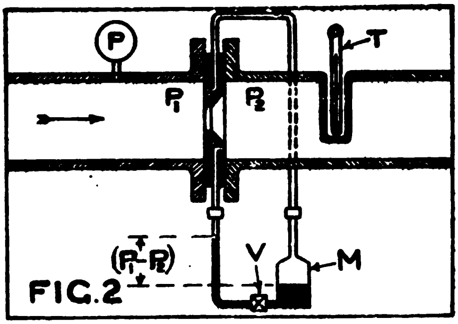

FIG. 2

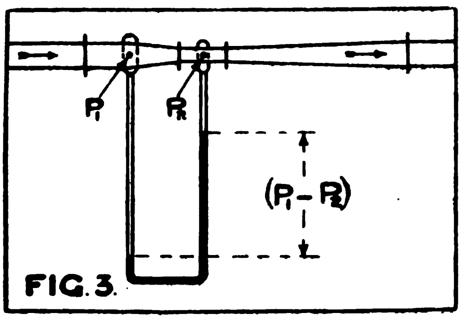

FIG. 3.

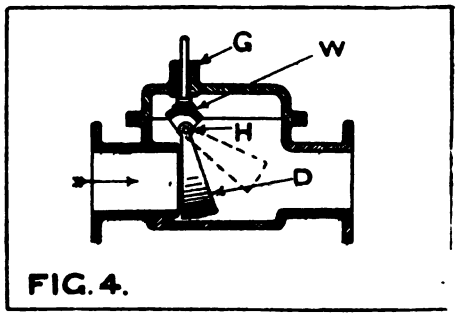

FIG. 4.

METERING COMPRESSED AIR.

Our confidence in the accuracy of the measurements is mainly due to the calibration plant belonging to Messrs. Eckstein, which was first erected to suit the author's requirements at Fraser & Chalmers' works at Erith, Kent. By means of this plant the various metering devices constructed to the author's designs by Messrs. Geo. Kent, Ltd., of London, were tested and calibrated. The plant is now re-erected at Ferreira, and serves as a permanent air standard for the Rand.

As this plant forms the basis of all the more recent measurement work, a brief description should not prove uninteresting. The air to be measured is passed through a large displacement meter, which is built somewhat on the lines of a steam engine. It has three cylinders 36 inches in diameter and the stroke is 27 inches. The air is admitted to and discharged from the cylinders by means of piston valves which are set to cut off exactly at the top and bottom of the stroke.

The stroke volume of the meter is 95.156 cubic feet. It therefore passes 50 lbs. weight of air per revolution at 100 lb. per square inch abs. and 513 degrees F. abs. The drop of pressure across the meter at full load is only about 1 lb. per square inch. For this reason, in designing it, no attempt was made to secure very small clearance volumes.* Owing to the small pressure drop across the meter, the leakage past the piston and valves is a minute percentage of the total weight passed.

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*South African Institute of Engineers (Abstract).

*If the clearance volume is 10 per cent. and the pressure of the air is 100 lbs. per square inch (abs.), a 1 lb. per square inch pressure drop across the meter will only cause an error of 1-10th per cent.

Referring to Fig. 1, the air which passes through the meter to be tested T, and the standard meter S, is not allowed to discharge to atmosphere, but is circulated round and round in a closed air circuit by means of a single-stage Rateau fan F, which is capable of producing about 2.5 lb. per square inch difference of pressure at 4,000 revs. per min. with the air at 100 lb. per square inch. This arrangement enables a meter capable of measuring 2,000 h. p. to be calibrated with an expenditure of some 90 h. p. only.

The air, after leaving the Rateau fan, passes through a cooler C, by means of which its temperature is brought approximately to that of the surrounding air. A small compressor M is employed to compress the air in the circuit to any desired pressure and to maintain it at that pressure. A large receiver R was placed between the standard meter and the meter to be tested, in order to damp out the pulsations caused by the standard meter. It, however, proved entirely ineffective, and the pulsations were finally damped out, as far as possible, by placing the top valve V, by means of which the air following round the circuit was controlled between the two meters.

SIMPLE ORIFICE AND MANOMETER.

One of the simplest modes of measuring air flows in actual practical work is by means of an orifice and a manometer. This arrangement is show diagrammatically in Fig. 2. The air pipes are sprung apart and an orifice O, about 5/8 in. thick, is placed between the flanges. Upstream and downstream pressure holes are provided in the orifice, as are also provisions for a pressure gage P and a thermometer T. The difference of pressure between the upstream and downstream sides of the orifice are measured on a manometer M, and from its readings and the pressure and temperature of the air the flow may be determined. In order to facilitate reading, one limb of the manometer is made in the form of a large reservoir, so that almost the whole of the change of level of the liquid takes place in the other limb. A contracted scale is employed to enable the true change of level to be read directly on the one limb. A throttle valve V is placed between the two limbs to damp down pulsations and to prevent the liquid being blown over when the manometer is being connected up. In arranging the pipes between the manometer and the orifice it is best to avoid U bends in which water may collect. If these are unavoidable, blow-out cocks must be fitted at the lowest points.

The discharge formula for any particular orifice is of the form:—

$$Q = K\sqrt{\frac{P_1 \ (P_1 - P_2)}{T_1}} \text{ lbs. per sec.}$$

where K is a numerical constant.

P_1 and T_1 are the absolute pressure and temperature of the air at the orifice.

$(P_1 - P_2)$ is the difference of pressure across the orifice.

It will be noticed that the orifice O is sharp edged instead of being rounded or curved. It was found that if the orifices were made with rounded edges, slight variations in the curvature caused very considerable alterations in the value of the co-efficient K. As it was necessary to be able to calculate the discharge, a sharp-edged orifice, which can be reproduced with ease and precision, was adopted. The tests have shown that the discharge through these orifices can be calculated to within ½ per cent.

Orifices of this type have been installed for metering the compressor discharges at the Rosherville and Robinson Central Stations of the Victoria Falls and Transvaal Power Company. In this case they measure the discharge through air mains 12 inches in diameter. They are, however, equally applicable for measuring the air supplied to single drills which passes, say, through a 1 in. pipe. If orifices are installed at various points in a compressed air distribution system, the discharges can at any time be determined by means of a portable manometer.

A CHEAP COUNTER METER.

A cheap form of counter-meter, with automatic pressure correction, is also being designed for use in conjunction with these orifices, so that a continuous measurement of the air supplied to the various levels in a mine may be made. By tabulating the air used per drill per shift for each level, inefficient drills and wastage due to bad joints and open cocks can be detected.

THE VENTURI METER.

The principal disadvantage of the orifices just described is that only a small proportion of the pressure difference $(P_1 - P_2)$— which is used as the basis of the measurement

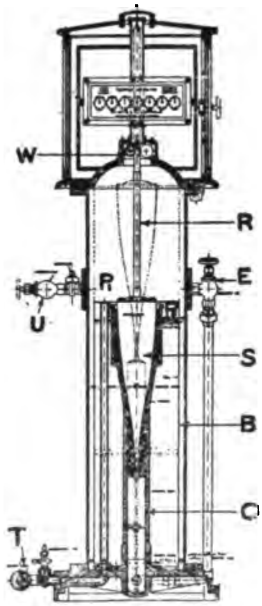


FIG. 5. VENTURI TUBE METER.

—is recovered. The Venturi tube (Fig. 3) effects the measurement in essentially the same manner, but owing to the long, tapering case on the down stream side, the formation of eddies is avoided, and a very much larger proportion of the pressure drop (P_1—P_2) is recovered.

The discharge formula for the Venturi tube is of the form:—

$$Q = KA_1 \sqrt{\frac{P_1 (P_1 - P_2)}{T_1 (N^2 - 1)}} \text{ lbs. per sec.}$$

where K is a numerical constant.

A_1 is the cross-sectional area of the air main.

P_1 and T_1 the absolute pressure and temperature of the air at the Venturi tube.

(P_1—P_2) the drop of pressure between the full diameter and the throat.

N the ratio of the area of the upstream to that of the throat—called the "throat ratio."

The value of the co-officient K was determined experimentally on the calibration plant for all diameters of Venturi tubes between 3 ins. and 20 ins., and for all the throat ratios that commonly occur in practice. As a result of this work the discharge through these tubes can now be calculated with extreme accuracy, and they form a very simple and reliable secondary standard for air measurement. The meters at present supplied to the Victoria Falls and Transvall Power Company all involve the use of the Venturi Tube, but owing to it being possible to simplify the erection and installation of the meters by adopting an entirely different method of measuring the air flow, meters of this new type will in future be supplied for air mains above six inches in diameter, instead of those involving the use of an Orifice or a Venturi Tube. The Venturi Tube meters have, however, a permanent sphere of usefulness in the measurement of the large volumes of coal gas used for town supply. Messrs. Geo. Kent, Ltd., of London and Luton, have already installed several of these meters in England and in Australia with very considerable success.

The main practical difficulty with regard to the gas has been the deposition of tar or napthelene in the Venturi Throat. This difficulty has been successfully overcome by putting a steam or hot-air jacket round the throat; thus keeping the surfaces warm and so preventing the condensation of the various impurities in the gas.

In the Venturi Tube meter the difference of pressure (P_1—P_2) is measured by means of a light inverted bell B (Fig. 5) immersed in an oil-seal, the throat pressure (P_2) acting on the underside of the bell, and the upstream pressure (P_1) on the outside. An increase of flow causes the bell to sink. The weight of the bell is taken by a carrying float C, made of vulcanite and slate (in order to compensate for changes in temperature), which is always totally immersed in mercury. The amount of movement of the bell is determined by the shaped float S, the bell descending until the difference in pressure (P_1—P_2) is balanced by the buoyancy of the immersed portion of the shaped float. The bell carries a rack R, by means of which its motion is transmitted to a wheel W, and from thence through a gland to a cam placed outside the bell chamber. Owing to the shaped float being made long and tapering, the arrangement is extremely sensitive at low values of (P_1—P_2): giving an inch of motion when (P_1—P_2) changes by 1-1,000th lb. per square inch, and being perfectly sensitive to variations of pressure of less than 1-10,000th lb. square inch. The upstream throat and equalizing cocks are shown at U., T., and D.

A drawing of the Venturi Tube as supplied

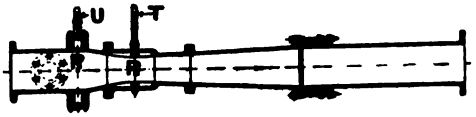


FIG. 6.

to the Victoria Falls and Transvaal Power Company is shown in Fig. 6.

A SIMPLE DIAGRAM RECORDER.

A small diagram recorder which can be used in conjunction with either the Orifice or the Venturi Tube is shown in Fig. 7. A

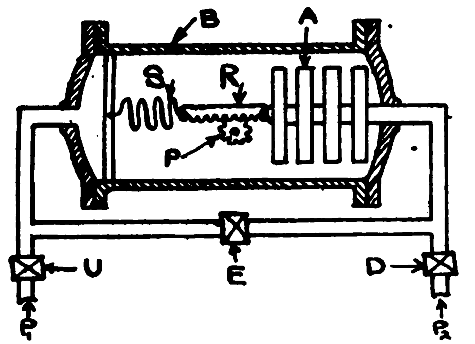


FIG. 7.

battery of aneroid diaphragms A (Fig. 7) are enclosed in a pressure-tight box, B. They are kept in tension by the spring, S, and any movement is transmitted by the rack, R, to the pinion, P, to which a pen arm is attached. The inside of the diaphragms is in communication with the downstream pressure, P_2, while the outside is subjected to the upstream pressure, P_1. An increase of $(P_1—P_2)$ therefore causes the diaphragms to collapse. The intrument is provided with upstream and downstream and equalising cocks, U, P, and E respectively. By closing U and P and opening E the accuracy of the zero can at any time be tested. The instrument may also be arranged to correct automatically for variations in pressure. It forms a very simple and reliable diagram meter for measuring air or steam flows.

THE "WEIGHTED DOOR" METER.

The type of meter which is now being adopted for the larger-sized air mains on the Rand consists of a weighted door D, Fig. 4, swung on horizontal hinges H, placed in the air main. The motion of the door, which is a measure of the flow passing, is transmited out through the top of the meter case by means of the two bevel wheels W, and the gland shown. The weighted door thus replaces the orifice and manometer, or the Venturi Tube, and the oil sealed bell. Although this instrument looks, and actually is, extremely simple mechanically, it is somewhat expensive to manufacture. Felt protected roller bearings are used to carry the weighted door, and dashpots are provided on each side of the meter to damp down the oscillations of the door. Then, in addition, although it is possible to design the meters so that the body casting is of the correct size, it is quite impossible to calculate the discharge for each position of the door beforehand. Each meter therefore has to be calibrated; but when all this has been done the measurement of the air is extraordinarily simple and easy.

The "weighted door" meters have a very much greater range than the orifice and the Venturi meters. By suitably shaping the cavity in which the door swings it is quite possible to measure down to 1-100th of the full flow. With a manometer it is difficult to measure less than ⅛ of the full flow. Even on the elaborate and carefully designed meters of the V. F. & T. P. Co. it is impossible to measure much below 1-30th of full flow. Another advantage of this type of meter is the case with which its capacity may be changed. All that has to be done is to alter the loading of the door and to put a new change wheel in the counter train. Although the weight-door meters are more troublesome to construct than are those of the Venturi type, they are in every way more desirable from the user's point of view.

PNEUMATIC TROLLEY CAR TRACK SCRAPERS

The Root pneumatic equipment for double truck cars, made by the Root Spring Scraper Company, Kalamazoo, Mich., consists of an air cylinder fastened to the truck of a car, operating a Root spring scraper, and controlled from the platform by means of a three-way air valve. The reason for installing in this way, where there is space enough for the scraper to swing on curves and not interfere with the steps and other equipment, is that the scraper follows the rail much better on curves than when fastened to the body of the car. The Root scraper equipment and the air cylinder may, however, be attached to the frame of the car, the air pipes being carried from the scraper air cylinder to the platform of the car, where it is controlled by a three-way valve. On city cars that are equipped with air this is a very important improvement as it does away with the wheel and the staff on the platform. It can be adjusted so that any pressure required can be applied to the scrapers, and when the scrapers are not in service they are safe from falling down at either end of the car. When it is desired to use the scraper the motorman has only to turn on the air which holds the scraper to the rail and when the air is released the spring on the inside of the cylinder holds the scraper up out of commission. This scraper is designed to meet the requirements of the pay-as-you-enter car, on which type of car the windlass rod is dispensed with.

POWER FROM COMPRESSED AIR

By H. Macintire.

In the transmission of compressed air local conditions are the all-important factor, and these conditions will affect the laying out of the pipe line to the same extent as in power-station design in different parts of the country.

The loss of head or pressure has been found to be proportional directly to the density and the length of pipe, as the square of the volume discharged and inversely as the diameter in inches. In other words, the economy of transmission depends, exactly as in the transmission of direct-current electricty, on how much capital is to be tied up in the first cost. For example, in driving the Jeddo mining tunnel a 6-inch main was used to convey the air power to two 3¼-inch machine drills over a distance of 10,900 feet and the loss of pressure was only 0.002 pound, a practically negligible loss. However, it would not be economy usually to design a pipe for such low velocity of the air, as the interest and depreciation on the additional investment over the cost of a smaller pipe line would more than counterbalance the saving in fuel, unless a future demand should make a decided change in the conditions.

In designing the transmission line, therefore, reasonably definite consideration must be given to the future. The pipes, as a rule, are run underground, and are difficult and costly of access. It costs to pass a certain volume of air through a length of 1-inch pipe over three times the head necessary to carry the same volume through the same length of 2-inch pipe, for the periphery increases as the first power and the area as the second power of the diameter. Therefore, as the demand comes on for extra power and an extra pipe is required, the loss of head in the two pipes would be greater than the loss occasioned by a single pipe of an internal area equal to the sum of the areas of the two pipes. The ratio of the periphery to the area of the transmission pipe is the important point affecting friction loss of head. Besides the diameter, the factors affecting loss of head are: The condition of the inner surface, the kind of joint employed, the number of valves and bends, and other factors of like nature. Although a number of tests on the mains in Paris and elsewhere have been made, the data obtained have not been full enough to enable any but approximate calculations. The allowable velocity, however, was clearly brought out. In each case with an initial pressure of 100 pounds, it was found that a loss of 2.4 pounds per mile in the pressure occurred with a velocity of 25 feet per second, 9.4 pounds per mile with 50 feet per second, and 46.2 pounds per mile with a velocity of 100 feet per second.

Many of the precautions taken in laying out a steam-pipe line are required for air transmission. The joints must be carefully made so as to prevent air leaks and to eliminate friction as far as is possible; allowance must be made for expansion and contraction, especially if the pipe is carried above ground; pockets in the line without means of emptying the segregated moisture must be avoided, and, finally, provision must be made for repairs on the pipe should these be necessary.

Some time ago, when the question of air versus electric power was being considered, one important argument in favor of air was that the steam engine could be used with but slight changes in the valve gear when operating with air instead of with steam as the woking medium, whereas, of course, electric power requires absolutely new machinery. The indicator diagram for air is almost indentical with the steam diagram. When used, however, as is done now almost entirely, to drive special tools, this argument in favor of air will not hold, as pneumatic tools have been designed for air power only.

In general, then, it can be said that the air motor, or machine, is one specially designed for the working fluid. The pneumatic tool cannot be easily described because of the great diversity in the varieties of makes. It uses, however, a pump diagram; that is, it takes air for the whole stroke, exhausts at the end of the stroke, and in consequence is not economical.

Moisture in the air has harmful effects during expansion unless some means can be had to prevent the temperature from going below 32 degrees Fahrenheit. During expansion the temperature drops, the expansion being almost exactly adiabatic, to a greater or lesser degree, according to the conditions. With an initial pressure of 75 pounds, and using a pump diagram, the discharge temperature will be—60 degrees Fahrenheit, but when expanding to the back pressure an economical diagram will be obtained and the temperature will be—144 degrees Fahrenheit. This reduction of temperature is very inconvenient because of the impossibility in practice of removing all the moisture in the air, and of the remainder freezing during exhaust. This fall in temperature can be prevented by injecting steam into the air at admission or by reheating. In the case of the addition of steam, its latent heat is given up during expansion and the temperature of exhaust can be kept above 32 degrees Fahrenheit. However, in many cases steam is not available; if it is available it can be used to drive the motor itself.

The second method—that of reheating—is very practical. A coil of pipe similar to those used for superheating steam is usually placed over a coke or charcoal fire and the air is increased some 300 to 400 degrees in temperature at constant pressure. As, however, dry air is slow in taking up heat from dry walls, water is sometimes sprayed in. The effect is twofold: First, the troublesome fall below the freezing point is avoided, and, second, a great increase in efficiency is obtained. The increase in work is about six times what could be obtained from a first-class steam engine at a minimum first cost. Prof. J. T. Nicholson in experimenting with a 27-horsepower Corliss engine, with air at 53 pounds, found that 850 cubic feet of free air was required per horsepower-hour, and dry reheating to 287 degrees Fahrenheit reduced this to 640 cubic feet, or a gain of 25 per cent. The same test showed that 1.42 pounds of coke per hour were required for each additional horsepower, a result which will compare very favorably with good steam-engine practise.

ECONOMICS OF AIR TRANSMISSION.

So far the discussion has been confined to the means of obtaining power from an air system and certain problems arising therefrom, but now the economics of its use and an idea of its possibilities will be considered. The best idea of its economy can be obtained from the plant in Paris, which has been very carefully tested.

These tests have made the Paris plant very economical. The compressor has an efficiency of from 75 to 80 per cent., the transmission line of 95 to 98 per cent., and the motor, of the best design, from 75 to 80 per cent. The poorer designs of motors, or those badly worn or adjusted, will show as low as 10 per cent. The Paris plant therefore shows that good economy can be obtained with air as the motive power.

Not only is the economy very high, but the uses to which air power can be put are almost without number. These include all kinds of mining tools, the pneumatic tools used in ship, bridge and boiler construction; pneumatic engines for mining and power-mill traction work, subway and tunnel work where compressed air is used to prevent the ingress of water; for refrigeration to a small extent, and as a means of pumping water (as in the Pholé air lift).

The advantages of using air are many: It is cheap; there is no danger of explosion from air alone; it is reliable; no insulation is required, nor will the transmission line heat its surroundings. In mining or other confined quarters the exhaust can be used for ventilation. Air replaced steam at the Cleveland Stone Company's works with a daily saving of about 49 per cent.

The great difficulty is lack of flexibility and large first cost. To design an economical plant, either the demand for power must be definite and unvarying or the gift of prophecy must be in evidence. Besides this, the size of the pipe line and the engine is very much larger than electric power would require for the same power, and the difficulty in maintaining the transmission line is greater.

Air power, however, has its own particular sphere, in mining and quarrying, and in all probability it will be found there for some time to come.—*Power.*

LIQUID AIR RESCUE APPARATUS AT THE MAKIEWKA (DONETZ) RESCUE STATION

By D. Lewitsky.

The problem of the application of liquid air in rescue work was solved by M. Süss, the inventor of the Aerolith apparatus; but in spite of the interest aroused by this apparatus in all who are interested in such work, the apparatus itself has not made any headway.* The reason for this is to be found in the difficulties in the way of transporting and storing the liquid air. Moreover, in spite of its advantages, the lightness of the apparatus and the agreeable temperature of the air inhaled, the Aerolith is attended with serious drawbacks resulting from the fundamental idea on which it is based. The Aerolith is a reservoir apparatus, since the air inhaled by the wearer is obtained by the vaporisation of the liquid air in consequence of the influx of external heat, the quantity of the gaseous air resulting from such vaporisation is not constant but gradually diminishes, so that one is faced with the problem of how the effect of the Aerolith calculated that the conditions of vaporisation of the liquid air would themselves prevent the uncomfortable results of this fact, for though the quantity of gaseous air obtained from the liquid air decreases progressively, the percentage of oxygen in same goes on increasing. On the other hand, the peculiarities of construction of the apparatus were intended to afford the possibility of regulating the quantity of air vaporized. The *diagonal* tube traversing the liquid air reservoir and forming a conduit for the exhaled air, was intended to transmit the heat received from that air to the liquid, and thus assist vaporisation. Practical experience, however, shows that the sides of this tube are very quickly covered by deposited flakes of solid carbon dioxide, whereby the transmission of the heat to the liquid air is retarded; and it is possible that, even apart from this circumstance, the heat would not be transmitted very completely to the liquid air. Hence the first transmission was only based on hope. Moreover, the physiological phenomenon of respiration was investigated from the chemical side only, the mechanical side being overlooked. Experiment has shown that the human lungs require a certain minimum volume of air, below which it is impossible to go; and this minimum may be taken as about 1,200 to 1,500 cubic inches per minute. Now, if the volume of air supplied by the Aerolith apparatus falls below this limit, it follows that the lungs are compelled to obtain the remainder from wherever they can; and in these circumstances they inhale the partially vitiated air contained in the breathing bag. As the experiment is continued, the amount of pure air, although enriched with oxygen, still goes on diminishing, and that of the vitiated air progressively increases, so that the air inhaled becomes very rich in carbon dioxide. Thus it was found that during the first hour of wearing the apparatus, work could be performed with ease, but less so during the second hour and particularly towards the end; whilst if any strenuous work has to be done in the second hour the situation becomes critical.

Another liquid air apparatus investigated at Makiewka is that of G. Claude, who bases on the idea that—contrary to older opinion—oxygen is not injurious for respiration, the oragnism consuming as much as it needs. On this account, Claude constructed his apparatus for 1½ litres of liquid air. It is evident that, here also, the above mentioned minimum limit has been left out of consideration. The result showed that the apparatus is unsuitable for rescue work. Hence the existing apparatus for liquid air (or oxygen) do not satisfy requirements so far as construction is concerned.

The author has made experiments with a view to solving the problem from a different starting point, and decided on the construction of a regenerative breathing apparatus for liquid air, the regeneration being effected by purely physical and not chemical processes. In this apparatus the exhaled air is allowed to pass through the liquid air, whereby two

*For example, the Makiewka rescue station is provided with five sets of Aerolith apparatus, but has never used them, although a Linde oxygen plant is available.

purposes are fulfilled—namely, that the exhaled air is freed from carbon dioxide—which falls, in the state of a hard white powder, on to the bottom of the reservoir, and at the same time the heat of the exhaled air assists in vaporizing a portion of the liquid air (this liquid air should be rich in oxygen), the exhaled air becoming mixed with the vaporized air, rich in oxygen, and again suitable for respiration. It is possible that the process is very complicated. For example, it may be that when such portion of stratum of the exhaled air as comes in contact with the sides of the metal tube traversing the liquid, attains the temperature of the liquid air, a portion of the nitrogen in the gaseous air, in its passage through the liquid air, may displace a portion of the oxygen of the latter. A result of this kind is, at first sight, unexpected, though it will become clear if one remembers that when gaseous and liquid mixtures of nitrogen and oxygen are left in immediate contact, there is always a certain equilibrium for gaseous and liquid mixtures. For instance, the liquid mixture containing 50 per cent. of oxygen is in equilibrium only with a gaseous mixture containing 21 per cent. of oxygen; whilst the liquid mixture containing 70 per cent. of oxygen is in equilibrium with a gaseous mixture containing 41 per cent. of oxygen, in accordance with the subjoined diagram compiled by M. Baly, showing that the liquid mixture may be in

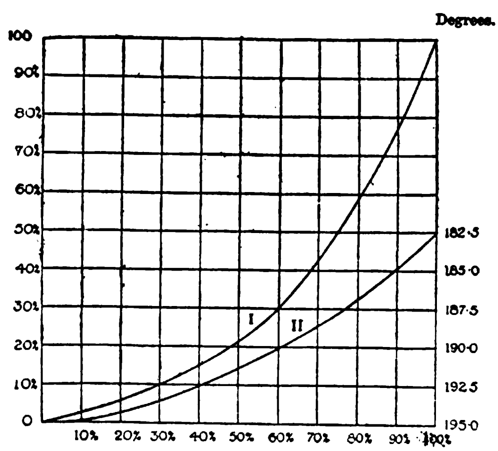


Fig. 1.—Baly's Diagram.

I. The maintenance of the oxygen in the gas as a function of the maintenance of the oxygen in the liquid air.

II. The temperature of the liquid.

equilibrium with such gaseous mixtures as it liberates during its own vaporisation (confirming the interesting experiments carried out by G. Claude in his work *L'Air Liquide*, p. 342-43).

If this process be allowed to take place even in part, the result is the same, viz., the air for breathing is obtained in a beneficial condition, rich in oxygen. In addition, it gives the advantage that a given amount of liquid air will last for a longer time than in apparatus of the reservoir type, because the exhaled air is re-inhaled at once. This, however, might *a priori*, appear incomprehensible, the question arising whether the vaporisation of the liquid air does not proceed too rapidly in the apparatus, in consequence of the heat transmitted from the exhaled air. The theoretical aspect of the case is difficult to establish, but may be illustrated by an experiment. The heat of evaporation of liquid air is about 50 calories (48 calories for nitrogen and 51 calories for oxygen). The specific heat of the gaseous air, increasing as the temperature falls, may be taken as ¼ calorie on the average. Hence, if we take 5 litres of liquid air, this quantity will be sufficient to cool down to—200 degs., a volume of gaseous air equal to 800 times that of the liquid air, and, therefore, 4,000 litres. If the temperature of the exhaled air were actually reduced to—200 degs., and the volume of air exhaled amounted to 50 litres per minute, then the above quantity of liquid air would be sufficient to last for 4,000 ÷ 50 = 80 minutes. As a matter of fact this calculation is disturbed by other factors, some tending to lengthen the period, and others to shorten it. In the first place, as a matter of fact, a portion of the air is vaporised by the influx of heat from outside; and secondly, a certain amount of heat is absorbed from the carbon dioxide in solidifying, both of which circumstances reducing the effective working time of the apparatus. On the other hand, however, the exhaled air is not cooled down to such a low temperature as given above; so that, as the experiments carried on at the Makiewka station have demonstrated, the 5 litres of liquid air enable work to be done for more than two and a half hours. This result is due to the following circumstances:—On commencing work with the apparatus, the circumambient temperature vaporizes such a

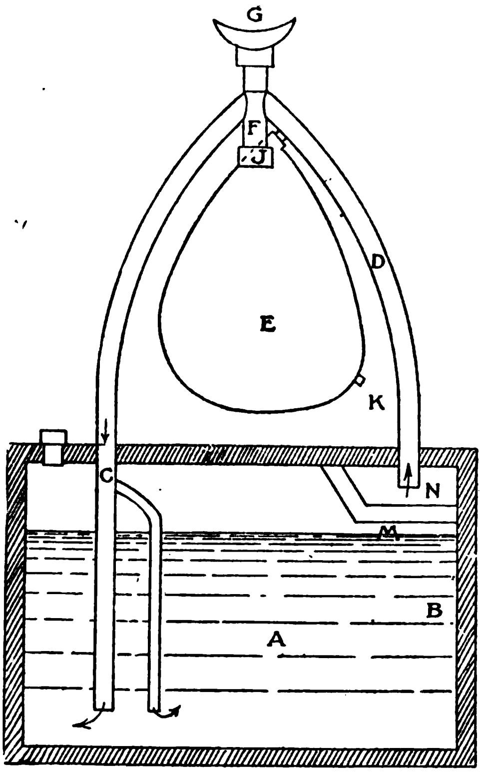


Fig. 2.

quantity of the liquid air that it is unnecessary to pass the whole of the exhaled air through the liquid, a portion being allowed to escape through a relief valve. This gives the following advantage:—Among the drawbacks of this apparatus must be included the necessity for passing the exhaled air through the liquid air, since this passage increases the difficulty of exhaling as compared with inhaling. Now, it is just when the difficulty of exhaling is greatest, owing to the height of the column of liquid, that the larger portion of the exhaled air can be discharged through the relief valve. Although in this way the volume of air discharged is regulated automatically, diminishing in proportion as the height of the column of liquid decreases, it has been found useful to provide the valve with means enabling its rate of delivery to be modified by hand.

To prevent spilling the liquid air, the apparatus is fitted with partitions, leaving free passage at alternate ends. In addition to the risk of spilling, there has also to be considered that of excessive vaporisation of the likquid air in consequence of sudden turns and bendings; but it is believed that these defects can be minimized by covering the liquid air reservoir with insulating material. A further drawback of the apparatus resides in the valves; to prevent them from freezing up, metallic heating devices have been provided.

In spite of these defects, the experiments carried out with the apparatus at the Makiewka rescue station gave satisfactory results. One good feature is that when heavy work is being done a good supply of air is always obtainable (good regulation); and the proportion of carbon dioxide in samples of exhaled air from the bag does not exceed ½ per cent. in any case.

In the apparatus (fig. 2) the reservoir A has double metallic walls B, between which the insulating material (such as glass wool) is placed. A flexible metal pipe for the exhaled air is screwed on to the tube C, which is branched in order to secure better distribution of heat in the liquid air. The vaporised air, together with the purified air (the carbon dioxide from which falls to the bottom as a white precipitate) passes through the flexible pipe D into the mouth. The superfluous air flows into the bag E. F is the divider, and G the mouthpiece (which may be replaced by a mask).

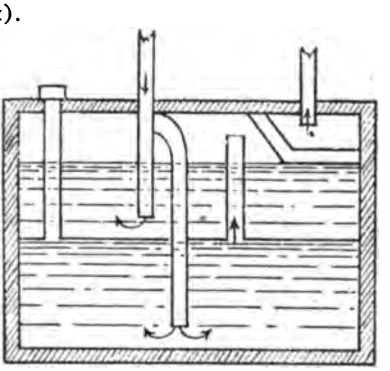


Fig. 3.

The surplus quantity of exhaled air escapes outwardly through the valve J. The bag is fitted also with a storage valve K. M N are partition walls which prevent the liquid air from spilling over when the wearer stoops.

The construction of the apparatus has been modified to some extent recently, as indicated in Fig. 3. The reservoir is divided horizontally so as to reduce the difficulty of exhaling by one-half since the height of the column of liquid has been lowered to an equal extent.

The attention of the author has recently been drawn to the existence of the apparatus described in English Patent 17589 (1910), working with liquid air and chemical purification. Being desirous of trying the apparatus, but unable to obtain a set in commerce, the author had one constructed in accordance with the details given in the patent specification. The trials, which are not yet completed, have given satisfactory results, the apparatus working better than the Aerolith. The inventor of the said apparatus is of the author's opinion that rescue apparatus operating with liquid air should be of the regeneration tpye, and not of the reservoir type exclusively. Whether, however, the regeneration is to be effected by chemical or physical means must be left for the future to decide.

MINE FARMING

The hanging gardens of Babylon may soon have to give way to the underground truck farms of Mexico if an experiment recently made by a Chihuahua miner becomes generally prevalent in the mining districts of that country. An Almoloya miner has found out that he can save a great deal of time over the putting together of a lettuce leaf sandwich for his lunch, or the occasional partaking of a luscious raw tomato, without having to go to the surface to satisfy his tastes. All he has to do, and he has done it, so he says, is to bring down some good top soil into the mine, plant the seeds and Nature will do the rest, due to the even temperature which prevails in the mine. As a result of this experiment, this progressive miner has a fine truck farm growing down in one of the old levels of his mine, and so far has produced a diminutive but at the same time a satisfactory crop of potatoes, onions, lettuce and tomatoes. All that is necessary is to take down some planks and on these spread about an inch of good earth, place large potatoes in this without covering and at a good distance apart, they will soon sprout and all the work necessary is to keep the suckers and leaves cut off. The potatoes grow to a good size and having been grown in the dark have practically no skin, are dry and mealy and of excellent flavor.—*Mexican Mining Journal.*

A TURBO COMPRESSOR HELPS A RECIPROCATING PISTON MACHINE

By C. Van Langendonck.

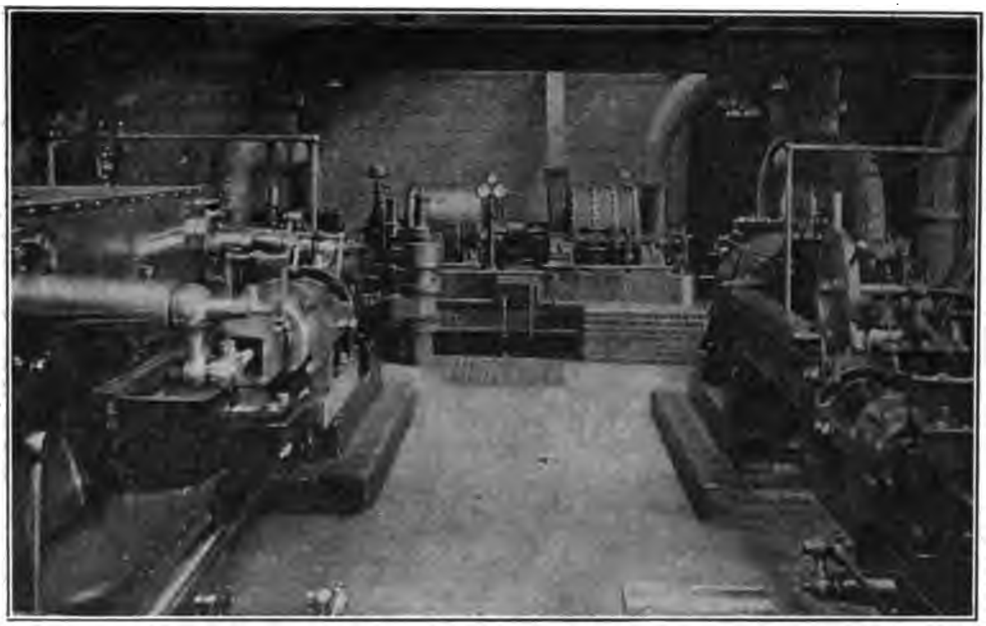
It is often a very difficult matter to know what to do when, owing to the growth in size of industrial establishments, their power plant, which, in the beginning was more than ample, is not more adequately fulfilling the demands that are made upon it.

A case of the kind recently arose at an English colliery, where in order to meet the increased demand for air, either the existing piston-compressed air plant—a cross-compound engine with cylinders 28 in. and 50 in. in diameter by 60-in. stroke, driving duplex air-cylinders of 33-in. diameter, running up to from 30 to 35 revolutions per minute as a maximum—could be augmented by a similar set, or, with a view of increased efficiency on the air cylinders, by the installation of a compound two-stage compressor, or finally by the adoption of a turbo-compressor set receiving its driving energy from the exhaust of the low-pressure steam-cylinder.

Here the plan contemplated was that the turbo-compressor should pass its discharge through an intercooler into the existing air cylinders. It was found that the cost of the second piston compressor would very much exceed the first cost of the turbo-compressor installation and would also occupy much more floor space. Moreover, a gain of efficiency could be obtained only with the new piston compressor plant, whereas the turbo-compressor would improve the working efficiency over the whole combined capacity. For these reasons, therefore, it was decided to install the turbo-compressor.

The complete arrangement is shown in the accompanying illustration, and it may be said that the results have fully justified this decision; a gain of about 17 per cent. over what would have been secured from a second piston compressor having been obtained.

The turbo-compressor is of the Rateau type, and easily delivers from 6,000 to 7,000 cubic feet of free air per minute at a pressure of 12.8 pounds per square inch by gauge. The steam consumption claimed for the turbine was also established. The flexibility of the plant was particularly noteworthy, as outputs up to 12,000 cubic feet per minute, and pressures up to 16 pounds per square inch



TURBO COMPRESSOR TO HELP PISTON MACHINE.

were easily realized. When running the existing piston compressor at the normal speed of 30 revolutions per minute, taking in air at atmospheric pressure and temperature, the maximum volume discharged at 60 pounds was 3,000 cubic feet per minute of free air, while, with the addition of the turbo-blower set, and with the same number of revolutions of the piston compressor, an increase in the free air capacity of over 100 per cent. was obtained, and the total efficiency both of the air and of the steam end was greatly improved.

The low pressure steam cylinder of the existing duplex piston compressor now discharges into a large steam receiver, an old boiler shell with automatic relief valve arranged so as to prevent undue accumulation of pressure. From this the steam passes through the exhaust steam turbine to the condenser arranged underneath the turbine exhaust branch. The turbine is absolutely under the control of the reciprocating compressor, as a demand for more work from the plant requires more steam from the duplex compressor, and provides the turbine with the necessary steam for the required air capacity or pressure. A butterfly emergency valve is arranged between the turbine stop valve and the turbine wheels; it is closed automatically when the turbine speed reaches a predetermined limit of about 4,200 revolutions per minute, but opens again when the steam supply and the speed have become normal. The butterfly emergency valve is also automatically closed should the oil pressure to the bearings become insufficient, thus preventing heating of journals.

The Rateau turbine is of the multicellular type, the cylinder of which is divided into a number of compartments, in each of which are fixed the distributing vanes. It is of the "Action" type, the fall of pressure taking place in the distributors only, the expansion being utilized to create kinetic energy. As the pressure is the same on both sides of the moving wheels, balancing pistons are not required as in "Reaction" turbines, where the fall of pressure takes place partly in the moving wheels. A Rateau type of centrifugal multi-stage blower is also used. Diaphragms are placed between the wheels and take the air at the outlet of each wheel and lead it through channels of special shape into the eye of the next wheel after having transformed the velocity head into pressure head.
—*National Engineer.*

VARIOUS PNEUMATIC DEVICES

Upon the opposite page are grouped a number of cuts of pneumatic devices which have recently appeared in our exchanges.

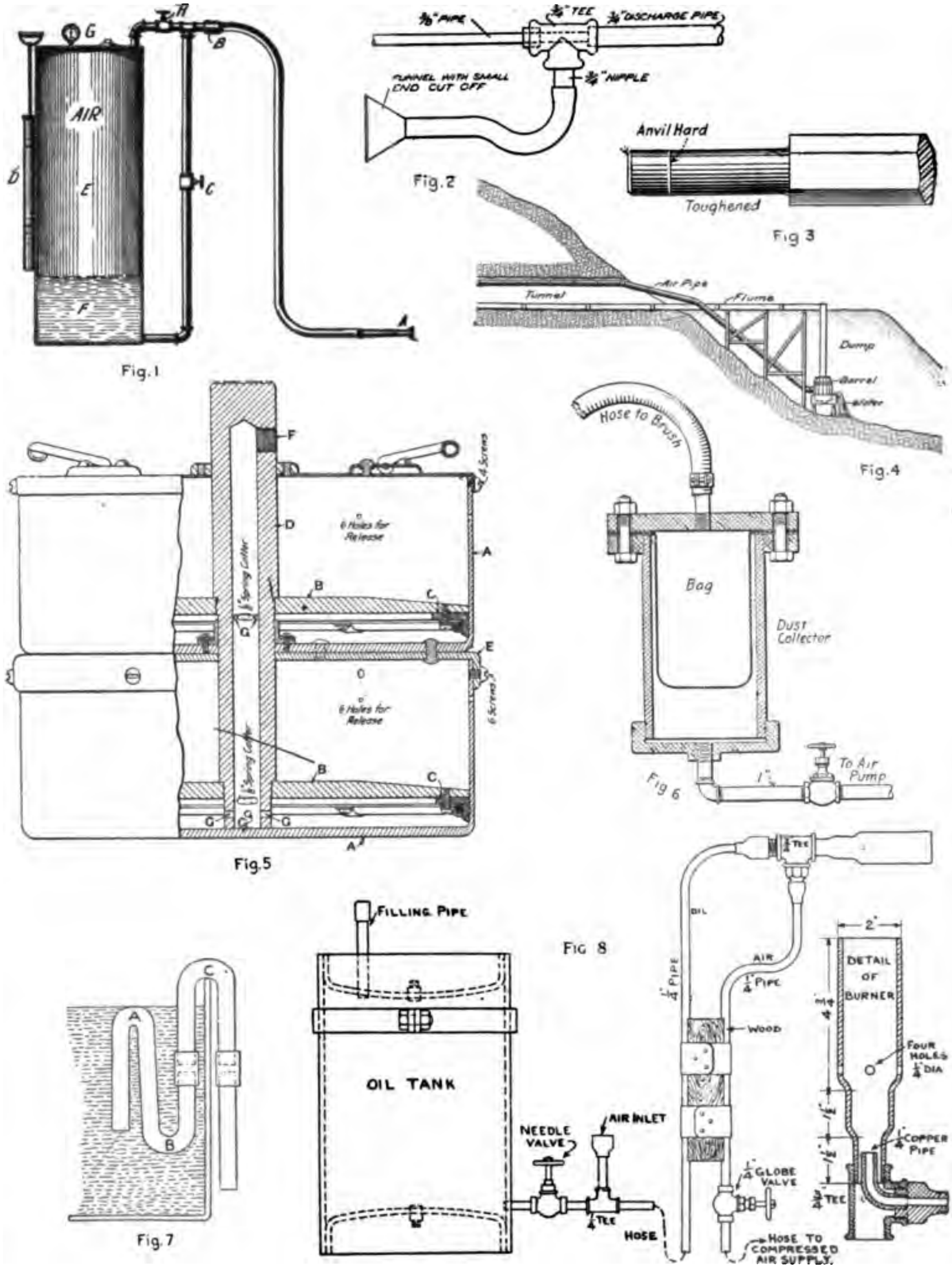
Fig. 1., from the *Scientific American,* shows a kind of home-made apparatus for spraying gasoline for cleaning automobiles. It consists of a galvanized tank *E* provided with a tube soldered into it at the top, and another one at the bottom. These tubes are fitted with valves *C* and *H*. The tubes are joined and are connected by means of a ⅜-inch hose *B* of any suitable length, say twenty feet, to a nozzle *A*. The nozzle should be provided with a quarter-inch aperture and a flared outlet. A bicycle pump *D* is connected with the tank at one side and a pressure gage *G* is secured to the top. In use, a gallon of gasoline is poured into the tank, as indicated at *F*, and then the pump is operated to produce a pressure of several pounds in the tank. The valves *C* and *H* may now be opened to such an extent as to permit a small quantity of gasoline and a comparatively large quantity of air to flow through the hose and the nozzle *A* may be directed to spray the parts which need cleaning. A single gallon of gasoline and a few strokes of the air pump have been found sufficient to clean thoroughly a single automobile.

Fig. 2, from the *Practical Engineer,* is another home-made device, a steam operated vaccum soot cleaner, made by an engineer correspondent and used for cleaning off the soot from the top of a battery of boilers, the work being done without raising a dust. The cleaner was made by connecting a ⅜-in. pipe from the steam line to a ¾-in. tee which connects as shown to a discharge pipe to the sewer, or other convenient place, and a steam hose upon which a funnel was attached. Use good stiff hose without kinks, and carry the funnel over the soot, which will be sucked into the hose and discharged into the sewer. It does not require much steam and will clean the boilers off thoroughly.

Fig. 3 is a sketch by A. Montgomery in the *American Machinest,* illustrating his method of hardening the shanks of tools used in the pneumatic hammer. It is necessary, he says, that the end of the shank of the tool, where it receives the blow of the hammer, should be hardened to a certain extent, so as to prevent upsetting and consequently enlarging; also to give it wearing qualities, and in order to obtain the best results the following is suggested: Take a pail and fill it about three-quarters full of salt water, covered with thin lard or fish oil to a depth not to exceed three-quarters of the entire length of the shank of the tool. Heat the shank a regular hardening heat and quench in this bath, being careful to keep the shoulder of the tool at the base of the shank, just on a level with the surface of the oil. Move the tool gently in this bath until entirely cold. Do not draw the temper, merely flash the oil from the tool. It will be readily seen that if the action is performed quickly by the operator, the tip of the shank will be hardened more than the body of the shank, as it reaches the water practically before any cooling takes place, and the actual hardening of the end will take place in the water beneath the oil. This gives a shank hardened absolutely right without any further heat treatment, such as drawing the temper, and rivet sets treated in this manner have been known to drive as high as 24,000 rivets before crystallization took place.

Fig. 4, from *Mines and Minerals,* illustrates a method of ventilating a mine by means of the water it makes, so that when once installed it costs nothing for operating. The method is said to be in common use in many camps, but to many it is unknown. A tunnel can be ventilated for 1,000 feet or more if ample water flows from it. As the water flows from the tunnel into the flume, it is carried out on to the dump until it reaches a point where it can have a fall of about 15 feet or more. Then it falls through a box made of four boards nailed together as nearly air-tight as possible. This box is connected to the inverted barrel as shown. The connection should be air-tight. The air pipe from the tunnel also connects with the barrel about in the middle of the side. This inverted barrel sets in a box which must be a few inches above the bottom of the barrel. The water as it flows from the bottom of the barrel rises over the box and flows away as indicated. The water flowing out in this manner and dropping some 15 to 20 feet causes a suction which will almost put out the flame of a candle in 1,000 feet through a 6-inch air pipe.

Fig. 5, from *Railway Age Gazette,* is a tandem pneumatic jack giving a double lifting power without increasing the cylinder diame-



VARIOUS PNEUMATIC DEVICES.

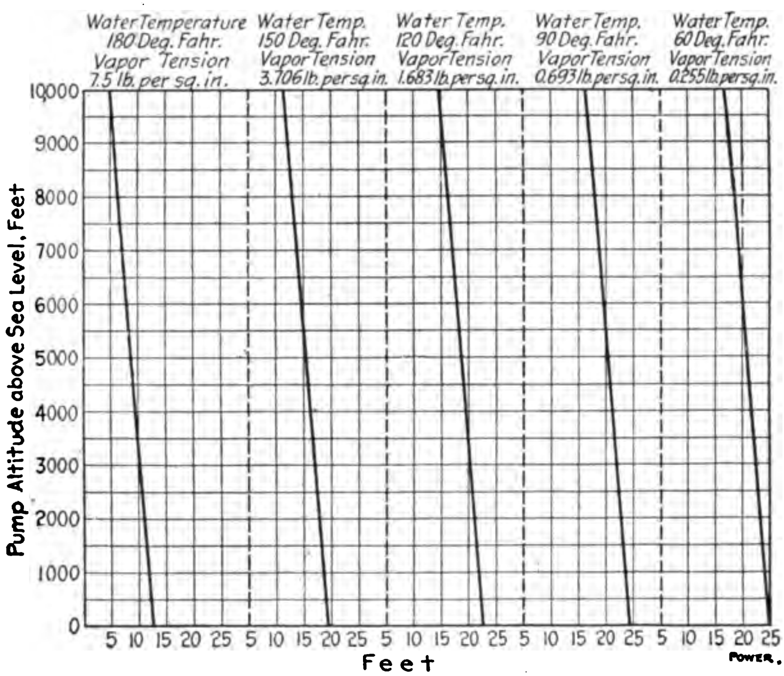
ter. The operation of the jack is self-evident and its design and construction are interesting. The parts *A* are pressed steel cylinders into which the boiler steel pistons *B* fit. The pistons are screwed to the same piston rod or plunger *D*, which is made of cold rolled steel shafting, and are locked to it by 1/8-in. spring cotter pins. The center of this rod has a ¾-in. hole running part way through it which conducts the air from the hose connection *F* to the underside of the pistons through the ports *G*. Leather washers *C*, of the Westinghouse standard, are fastened to each of the piston heads, and are forced against the sides of the cylinders by expansion rings, forming air tight joints. A cover *E* is placed over the lower cylinder and gives additional stiffness to both the walls of that cylinder and the base of the upper cylinder. The six holes shown near the top of each cylinder are for the purpose of releasing the air when the piston has traveled above them, thus preventing the rupturing of the cylinders. These jacks are made in 12-in. and 18-in. sizes by the Pneumatic Jack Company, Louisville, Ky.

Fig. 6 is a vacuum cleaner described by J. G. Dennington in *Power*. It will be found useful in an engine room or elsewhere for sweeping the floor or cleaning the walls and is also especially effective in the cleaning of street car or steam-road coach seats. It can be used wherever there is a pump or a condenser. First, take a piece of pipe, preferably 12 inches in diameter, and cut it to the desired length (not less than 2 feet). Cover one end with a cap having a 1-inch pipe connection in it. Cover the opposite end as shown in the drawing. Make a bag out of good strong material like duck or canvas that will fit nicely inside the 12-inch pipe, not coming closer to the bottom than 6 or 8 inches. The top should be made flaring and will last longer if bound with a couple of sheet-iron rings the size of the flange. This sack is to catch the dirt and dust and is to be inserted inside the 12-inch pipe, and flaring top to be clamped between the halves of the flange union. To clean the bag, simply take it out and turn and brush it; it should go in either side out. The 12-inch vacuum chamber can be placed in any convenient location and connected to the suction side of the air pump or condenser with a 1-inch pipe, the connection being made in the bottom below the bag. For the top there should be a 1-inch hose connection, taken preferably from the center of the flange union, or a pipe may be run from the flange union around the plant to any desired location and taps taken from it at different points, when a shorter length of suction hose will answer for the cleaner. The cleaner may be made from hardwood, or a heavy brush may be used to advantage by cutting the bristles out of the center lengthwise of the brush, so as to form a slot about ½ to ¾ inch wide. The brush loosens the dirt and the air will draw it up into the hose. A slot will, of course, have to be cut through the wood of the brush and a holder for the hose may be made from a piece of pipe secured to the tin back with which it will be necessary to cover the brush.

Fig. 7, from *Popular Mechanics*, is a self-starting siphon which has proved useful in laboratory work in siphoning certain solutions, such as sulphuric acid or nitric acid when it would be dangerous to start the siphon by the usual method of suckig until the tube is full. If made of one piece of glass tube, so much the better, although it may be found easier to use two or three pieces connected with rubber. The ratio between the lengths of A-B and B-C must be about as four is to five. To begin with, the solution must be high enough to cover the first bend, then according to the law that a liquid always seeks its own level, one would suppose that it would enter the tube and settle at a point between B and C. However, the kinetic energy produced by the falling of the liquid from A to B is sufficient to force it up over the bend C. From there it simply falls and the siphon is in running action, having started automatically.

Fig. 8 is an oil burner, described in *Canadian Machinery*, and used in the G. T. R. shops at Toronto for a variety of purposes, such as the removal of locomotive tires, heating bent frames preparatory to re-straightening, heating boiler patches, etc. The whole apparatus is easily portable and of extremely simple construction. The oil tank, with capacity of about 5 gallons of crude oil, is filled through a funnel fitted with a strainer, so as to preclude the possibility of choking the needle valve which controls the supply to the burner. In front of the needle valve is a tee, into which is screwed a short length of pipe. At its end is a reducing coupling, forming a short cone, which serves to introduce atmospheric air to the oil pipe and is effective in causing a steady flow. Before this feature was adopted, it was found impossible to obtain a uniform and regular stream. The compressed air pipe terminates in a piece of bent copper pipe, as shown in the separate detail of the burner. The issuing jet of air, creates a partial vacuum, and induces a flow of oil, which becomes vaporised as it enters the burner cone.

In taking off a tire, without removing the wheels from under the locomotive, the burner is packed-up on the rail, so that the flame strikes the tread of the tire at a small angle. The axle boxes are jacked-up, to bring the tire clear of the rail, and the wheel slowly revolved by bars to ensure the tire being uniformly heated all round. The time occupied averages about twenty minutes, depending to some extent, on the tire diameter.



SUCTION LIFT OF PUMPS AT DIFFERENT TEMPERATURES AND ALTITUDES

The diagram on this page, which seems to require no explanation, was sent to *Power* by Mr. W. Vincent Terry, Essex, England. For those who only cursorily glance at the diagram attention is called to the numbering of the feet on the bottom line, this not being continuous but repeated for each curve. The curves provide a ready and easy means of ascertaining the maximum suction lift that a pump is capable of dealing with at various altitudes and with different water temperatures. The curves, the writer says, are based on theory with suitable corrections from practice for mechanical efficiency"—what has that to do with it?—"leakage and air pressure, and have proved very useful to me in my work."

STORAGE PURIFIES WATER

The value of water storage as a means of improving its quality has been investigated for the Metropolitan (London) Water Board by its director of water examination, Dr. A. C. Houton. He carried on extensive experiments of the comparative vitality of uncultivated and cultivated typhoid facilli in artificially infected samples of water from the river, and reached the conclusion "that even a week's storage of raw river water is an enormous protection, and less than a month's storage an absolute protection against typhoid fever." He further asserts in his report that "the possibility of London water conveying epidemic disease may be finally dismissed from the minds of inhabitants of the metropolis as a fear which, on convincing experimental evidence to the contrary, has at last been definitely proved to be baseless."

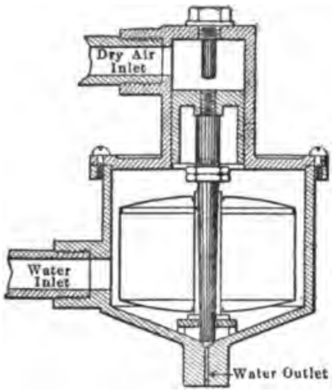


FIG. 1. EJECTOR VALVE FOR AIR LINE

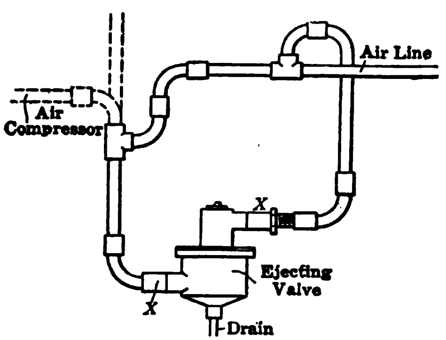


FIG. 2. PIPING FOR EJECTING VALVE

DRAINING THE AIR LINE

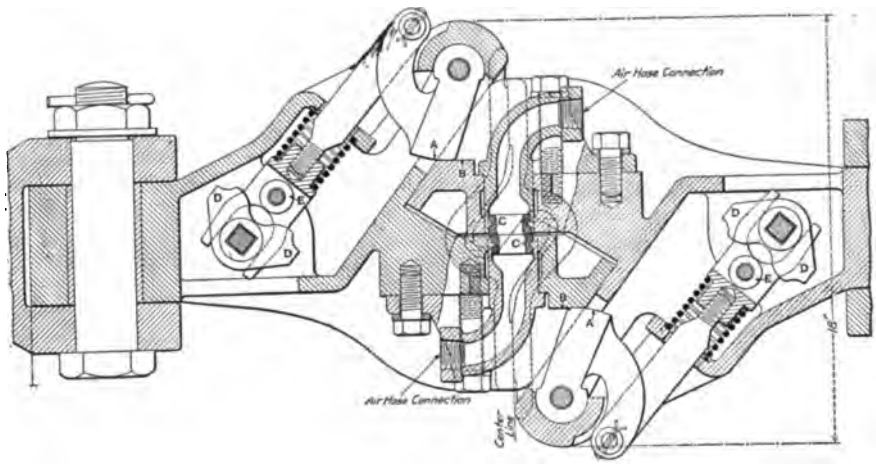
The cuts which we here reproduce from *Engineering and Mining Journal*, show an automatice device recently developed in England for removing the water which usually accumulates in compressed air pipe lines. Fig. 1 shows by vertical section the internal construction and Fig. 2 shows the mode of piping. It will be seen that the apparatus is not large. The case is a cylindrical casting of gun metal having, with its cover, three openings, two of which are threaded for pipe and the third is a small hole at the bottom normally closed by a small conical valve. This valve is the end of a gun metal spindle which carries a copper float, with a plunger above, the top of which is exposed to the pressure of the pipe line. This pressure is balanced by the air which may enter at the water inlet, the unsupported weight of the float being sufficient to keep the bottom drain-opening closed. When water enters the chamber from the water inlet the float is lifted, its travel being limited by an adjustable stop screw above, and the water outlet is opened. The pipe line pressure then blows all the water out and the float falls and closes the opening. When grit or other foreign substances are likely to get into the pipe line, strainers X are inserted at the points indicated in Fig. 2.

FIG. 1.

AUTOMATIC CAR AND PIPE COUPLER

The ingenious coupler shown in the half tone Fig. 1 and sectional drawing Fig. 2, has been designed by the Westinghouse Air Brake Company and is being largely adopted by the Interborough Rapid Transit Company, of New York. It automatically connects not only the drawbars but also the air connections of the two cars brought together. The coupler head consists of a solid body casting, which has a suitable hook and recess in its face to engage with the corresponding face of the other coupler. The heads are so designed that they will couple when 3 in. out of vertical alinement and 7 in. out of horizontal alinement. The couplers are held to the drawbar by a horizontal pin, which allows them to swing up or down, giving the necessary flexibility when passing over imperfections in the track. When uncoupled they are held in a horizontal plane by a spring located underneath the drawbar and pressing against the coupler.

The air connections run alongside of the drawbar and are connected to the coupler by a flexible hose, which is comparatively short in length and has no bends, thus eliminating any possibility of kinking. This hose is permanently connected and will wear for a



FG. 2.

longer time than the hose of the ordinary air connections. When coupled, the couplers are locked so that there is no lost motion between them. This is accomplished by the type of lock used, which, as will be seen in the sectional illustration, automatically takes up the play as the couplers become more closely interlocked. In coupling the two heads slide into each other for about 1½ in. in a direction about 40 degs. with the axis of the drawbar.

The face of the locking cam *A* engages with the machined surface *B* of the opposite coupler. In case one locking cam should be out of service, it will be seen that the other is sufficient to hold the connection. It will also be noticed that the air connection gaskets *C* come together in almost a perpendicular line, which prevents undue wear from abrasion. The locking cam is controlled by a lever on top of the drawbar, which operates the cam *D* through segmental gears. This cam, working on the pin *E* throws the locking cam in and out of service as desired. Both of these locking cams must be thrown out before the cars can be separated and after being uncoupled they can be thrown into the coupling position again, allowing the couplers to lock automatically. When the couplers are locked together they are as rigid as a single casting, thus providing a tight joint for the air connections.—*Railway Age Gazette.*

The speed at which rock can be drilled does not indicate how it will break. It often happens that rock easily drilled is hard to blast.

PATCHING A SEA WALL WITH THE CEMENT GUN

The Massachusetts coast line in the vicinity of Lynn, is protected by a heavy concrete sea wall. The structure is continually wetted by the spray, and as there is a considerable rise and fall in the tides, the low portions of the wall are alternately above and below the water surface. These conditions, it is believed, have tended to cause the disintegration of the concrete face of the wall. Large holes have been formed and there are patches where the mortar surfacing has scaled off, ex-
this fact can be neutralized. The inventor of
posing the large stones of the concrete aggregate. The reason advanced for the disintegration of the face is not that the salt water has any destructive effect upon the concrete, but that the water works into porous

sections in the wall and freezes, causing the face to peel off.

Attempts were made to patch up the holes by hand, using a Portland-cement mortar, but the results were not satisfactory, and when finished the patches stood out like large blotches on the surface, destroying the uniformity of the face of the wall.

A more efficient method of doing the work was sought, and Mr. John R. Rabin, chief engineer of the Metropolitan Park Commission, decided to try the "cement gun." This device consists essentially of superimposed steel tanks forming two compartments, from the bottom of which a dry mixture of sand and cement, which is entirely under the control of the operator, is ejected by compressed air through a hose line carrying a specially designed nozzle at its discharge end. To this nozzle a second and smaller hose delivers a supply of water under pressure. The mixture of sand, cement and water, the latter being supplied to the dry constituents just before they emerge from the nozzle, shoots out through the nozzle orifice with considerable force and impinges upon the surface at which the gun is pointed. The mortar issues in the form of a spray, which adheres to the surface, and may be built up to any thickness desired.

A cement gun machine was therefore shipped to Lynn and set up on top of the sea wall. The hose lines were carried down along the face of the wall and the nozzle was manipulated by an operator at the base, as shown in the accompanying illustration. Practically all of the patch work was near the foot of the wall, so that no scaffolding had to be erected. One of the advantages of the cement gun over the hand-patching method lay in the fact that all of the plant was located on top of the wall, so that nothing had to be moved when the tide came in. It was found also that the stream of mortar from the nozzle packed in tightly in all of the small crevices of a honeycombed section of wall, completely filling the gap. Before the patching work was actually started, however, all the loose pieces of concrete were picked away from the surface and an air blast from the cement gun nozzle turned upon the area to be repaired in order to blow away the dirt and dust, thereby securing a clean surface and making a good bond.

The mortar was mixed in the proportions of one part Portland cement to three parts sand. This resulted in an actual mixture, as applied to the wall, of about one to two, for when the blast is turned on a portion of the sand bounds away from the surface before the mortar starts to build up. Air pressure was furnished by a portable gasoline-driven compressor, and as an experiment 10 per cent. of hydrated lime was mixed in with some of the batches and about 2 per cent. of Toxement waterproofing compound in others.

After the patches had been made the entire wall was given a thin surfacing coat of mortar with the gun, and this resulted in making the entire face a uniform color and added greatly to its appearance. It was found that after the mortar had set from four to five hours it was sufficiently hard to resist the wave action—Condensed from *Engineering Record.*

THE RUPING PROCESS FOR CREOSOTING TIMBER

At a recent demonstration of this process, various shapes and kinds of wood were selected, such as redwood poles, timbers, sleepers, fencing, paving blocks, and whitewood battens and boards. These were all weighed and measured and then sealed up in a cylinder, where they were subjected to an air pressure of about 50 lb. per square inch, and then the cylinder was filled with creosote, the air-pressure being maintained. Next a pressure of 80 lb. per square inch was put on, after which the pressure was released and the cylinder opened. The timber was then taken out and re-weighed, showing the amount of oil remaining in it. Various pieces of the wood were cross-cut, and showed a remarkable penetration of oil, nearly to the centre. This, it was stated, was impossible in the old method except at a great cost, and this also applied to the whitewood, into which it used to be practically impossible to inject the oil. One of the features of the process is the extreme cleanliness of the treated wood. It is quite dry and clean to handle, and not dirty and clogged with oil as is generally the case with creosoted wood. By this method, it is stated, the cost is very greatly reduced, for waste of the preserving liquid is entirely avoided, whilst better results are obtained, it seems, than by the old method.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

SKILL PROMOTERS

Mechanics in general are not wanting in respect for personal skill and the achievements of skill, but individually they still are quite apt each to assume that his own trade requires and develops more skill than any other. The machinist, the blacksmith and the molder, for instance, can each think that he can do and actually does things which for each of the others would be impossible. If it should come to be recognized and appreciated that each is probably correct in his view the fact should tend to promote mutual respect instead of the reciprocal depreciation which is most familiar.

It may be true in some things that "the looker-on sees the most of the game," but in watching the routine manipulations of workmen in the trades the looker-on cannot really be said to see the true inwardness of the game at all. The one operation of the molder's trade which has always taken more of his time and strength than any other has been the ramming of the sand in the molds. The unthinking on-looker can regard this as simply hard muscular labor and nothing more, and in that view of it the invention of the sand rammer was inevitable for the relief on the tired workman.

But to the well informed the operation of sand ramming in the foundry is one of great responsibility, and the success of the molder in the trade is never contingent upon the use alone of his muscle in ramming, but upon the judgment—skill's most potent factor—with which it is employed. There is, as the phrase is, ramming—and ramming, and skill is the differentiator. If the requirement were simply to pack the sand in the mold as tightly as possible the task of ramming would be a simple one and the power rammer might well be made automatic; but in fact it is usually most desirable and often very necessary to have the sand packed as loosely as possible, if it will only hold the molten metal to its shape, it thereby retaining some porosity to permit the escape of the gases generated or liberated when the mold is poured. It often happens also that some portions of the mold require to be rammed heavier or lighter than other portions and here the skill of the molder has a chance to show itself. Foundry experience is full of instances where the successful production of certain castings has been defeated by injudicious ramming and where later perfect results have been secured by a change in this detail alone.

The heading of this article suggests that the pneumatic hammer is a promoter of skill in the molder, and it should not be difficult to justify the title. The pneumatic hammer in the first place relieves the molder of the most fatiguing detail of his work and saves more of his energies for the thinking portion of it. This is not an imaginary benefit, for, other things being equal, the man strong in the arm and worked to the limit in that function is not also strong in the head, active in planning for the best results and quick to see the best ways leading to their attainment.

But in the act of ramming, the pneumatic hammer does much more than merely to supply the power for the work. It also changes the character of the ramming, and gives the molder a variety of execution in the ramming which his muscles at the best could not command. The force, the direction and especially the rapidity of the blows are so completely under the control of the molder that we might compare the manipulation of the hammer to the playing of a musical instrument, with its legato, staccato, crescendo, diminuendo passages, and all the rest of it.

THE HOISTING PROBLEM

There are no industries where the operation of hoisting and lowering of material, of tools and appurtenances, of work in progress or of the finished product, do not frequently and constantly occur, and other means than human muscle have to be provided; but we have been slow enough in getting at it.

The steam engine is well along into its second century, but we had only the hand-cranked crane and the rope and tackle blocks for all our heavy lifting up to the middle of the last century. Then the differential chain hoist came in. This, though still hand-operated, was a great improvement, in that it would hold the load; but it was slow in operation, both for hoisting and for lowering, and it required about as much power for the latter as for the former operation. The ingenuity of the device did much to give it a start and to continue its vogue so long.

The lifting of weights is one of the simplest operations for which mechanical power can be employed, and where men are still doing it the question is always pertinent as to why such waste of labor is permitted. The actual means by which the power is applied to the specific job must be determined by the conditions. For the simplest lifts we have at once the simplest device which can probably be devised. The direct air hoist is quite common now, but its general employment began only about a score of years ago, and there are still many places where it is conspicuous by its absence. Many industrial concerns even up to the present day have failed to provide for themselves an air supply, and for these, of course, there is an explanation, but not an excuse or justification; but where the air is there should be the air hoist. Quite recently the writer noted the anomaly of a stone yard with pneumatic tools at work but with only hand-operated hoists.

Though the direct air hoist is so simple in its action, responding with ideal promptness to the manipulation of its valve for either motion, still its very simplicity and promptness sometimes seem to be in excess. It may hoist too quickly and may not stop the load at the precise point desired, while a careless hand may drop the load too sharply. It also, when the air is shut off, will not hold its load continuously, slight leakage allowing a slow descent—extremely slow, if everything is all right—but still it cannot hold absolutely. The motor hoist has more than all of the desirable properties and none of the objections here suggested. It is entirely responsive to the control of its manipulator. It will hoist at any speed desired; it will stop with precision; it will hold its load absolutely for any length of time; it will lower gently and will not run down to make unnecessary slack to be taken up before the next hoist. It is useful for running along overhead tracks and holding the load suspended from place to place. The desirable features seem to be all there, with nothing to offset them.

The electric air drill made it possible to run an entire mining, tunneling or quarrying plant entirely by electricity and to dispense with the air compressor. The air motor hoist does the reverse of this and makes it just as possible to dispense with the electric current when it is not otherwise imperatively needed and to use only the air. The desirability of using in either case the single style of power transmission is sufficiently apparent. The type of motor which actuates the air-motor hoist can be used, and is used, for driving rotating drills for metal, and for other tools in machine shops, boiler shops and elsewhere. Like all other air-operated devices, the motor hoist costs nothing for power or for power maintenance except when it is actually working. The moment the dynamo stops the electric motor is paralyzed, but there is always air enough for a hoist in the receiver.

QUESTIONS AND ANSWERS

I. S. G. How far would the piston travel in an air compressor cylinder to raise the pressure of the cylinder of air from atmosphere to 1 lb. gage? Also supposing the contents of the air cylinder to be 1 lb. above atmosphere at the beginning of the stroke, how much greater would be the quantity of air in the cylinder as compared with a cylinderful at just atmospheric pressure? A. For the first question, neglecting the change of temperature and assuming the cylinder to be just filled with air at atmospheric pressure at the beginning of the stroke, the difference in the air volume before and after the compression would be inversely as the absolute pressure, thus:

$$147+1:14.7::1:.936$$

and the piston travel would therefore be: $1-.936=.064$, or say just a trifle over 1-16 of the stroke. Again, as the cylinderful of free air when compressed to 1 lb. above atmosphere occupied only .936 of the cylinder the cylinderful at 1 lb. pressure would be $1\div.936=1.068$.

C. S. D. Will you kindly give us the solution to the following: The diameter of the piston is 1—9-16", the stroke of the piston is ⅜" and the number of revolutions per minute is 3500. How many cubic feet of free air would be required at a pressure of 135 pounds? What capacity of air compressor would be required to maintain this pressure of 135 pounds?

A.— We offer the following rough solution, as the case does not warrant the going into questions of temperature, etc. In fact we think the figures we give are the best to use for such small practice. We understand that you want to drive an engine or motor with compressed air and you wish to know the volume of free air required. Assuming that the engine is double acting and that there is no cut off, the computation for the air consumed would be:

1.5625 (cyl. dia) × .7854 × .75 in. (for double stroke) × 3500 (revs. per min.) ÷ 1728 = 2.91 cu. ft. per min.

This is very nearly 3 cubic feet, and adding one-third for clearance and other losses, we have 4 cubic feet of air at 135 lbs., gage pressure, or 135 + 15 = 150 lbs. absolute pressure, or ten atmospheres. Then the volume of free air will be: 15:150::4:40 cu. ft. of free air per minute. A common commercial size for a small compressor, usually power driven, would be 6 in. diameter by 6 in. stroke. This, either double acting or with two single acting cylinders, at 250 revs. per min., would have a theoretical capacity as follows:

$6^2 \times .7854 \times 1$ ft. (for double stroke) × 250 ÷ 144 = 49 cu. ft. per min.

Such a compressor could not be run continuously up to such a pressure on account of the heat developed, and it should not be so run on account of the greater power requirement as compared with two-stage compression, but it would do for short, intermittent runs.

NEW BOOK

Rock Drilling with particular reference to Open Cut Excavation and Submarine Rock Removal, By Richard T. Dana and W. L. Saunders. Data compiled by Construction Service Company, New York, John Wiley & Sons, 327 pages, 6 x 9 inches, 127 illustrations, mostly half tones, $4.00 (net).

The book is fairly described by its title-pages. It is a compilation of practical data from reliable sources. It tells of work actually done and of the means and methods employed. Blasting and Explosives are first discussed, then the Rock Drill in all its relations, while the bulk of the work is made up of records from actual operations, first in open work on land and then in subaqueous drilling and excavation.

The volume of the lithosphere, or stony crust of the earth, including the continents elevated above the sea, is estimated at 1,633,000,000 cubic miles.

OZONE IN THE INDUSTRIES

In an article which recently appeared in the *Times,* of London, it is stated that experimental trials have been carried out, both in England and elsewhere, relating to the use of ozonized air in the various operations carried on in breweries, and these indicate that ozone could be used with advantage either in the treatment and cleansing of brewing vessels and casks or in the ventilation of the vessels and tuns in which the wort is stored. The presence of large numbers of bacterial and other living organisms in the air of towns has a prejudicial influence upon the fermentation of the wort, and in some cases the troubles that arise in brewing are attributed to the action of these agents. By means of ozonizing apparatus sterilized air could be supplied to the refrigerating and storage vessels containing the wort, and the dangers of contamination be avoided. Another advantage of the applications would be that the mould fungi and other micro-organisms, which are usually found upon the walls of the vessels and rooms, would be killed and their further growth stopped. The use of ozone for bleaching flour has also been the subject of many experiments, and has also led to considerable patent litigation. This application of ozone, however, has not developed, and it is now generally considered that pure ozone will not bleach flour, and that it was probably the presence of nitrogen oxides or of hydrogen peroxide which yielded the results, which were claimed to be due to ozone in the earlier experiments.

IMPROVED AIR SERVICE FOR A CRUCIBLE FURNACE

An oil-fired, tilting crucible furnace, recently patented in Germany by W. Buess, makes provision for cooling the bottom of the furnace and heating the air at the same time. The furnace consists of the usual, cylindrical chamber lined with fire brick and is provided with hollow trunnions supported in bearings in a standard to permit of tilting the furnace. The furnace is equipped with a detachable base formed of a slab of refractory material supported by a cellular metal bottom provided with flanged edges to enable it to be bolted onto a corresponding flange on the bottom of the furnace casing. The air is conveyed by means of the trunnion to the hollow bottom where it circulates in such a manner as to cool the bottom and at the same time absorb the maximum amount of heat. From the chamber the heated air passes to the burner through a valve controlled pipe. By this arrangement the compressed air, which serves to inject the liquid fuel, not only serves to cool the hottest part of the furnace, but is simultaneously warmed prior to its mixture with the oil, resulting, it is claimed, in a considerable saving in repairs and fuel.—*The Foundry.*

THE LARGEST SHOCKLESS JARRING MOLDING MACHINE

The shockless jarring machine, for packing the sand in foundry molds to the required density without the tedious operation of ramming, was described and its principle of operation explained in COMPRESSED AIR MAGAZINE, July, 1910, page 5710.

In its usual form the machine consists of a jarring table—this the top of the machine upon which the mold to be jarred is placed—the table mounted upon an upstanding plunger forming the anvil, which in turn is mounted in a cylindrical base and supported upon long helical springs. Compressed air is admitted through an automatic valve, under hand control, attached to the plunger or anvil base, and passes first into the jarring cylinder to raise the loaded table, At some predetermined point in the table movement, the air is automatically cut off from the cylinder, and while the valve is reversing, the air will expand and lift the table further from its anvil, provided its initial pressure exceeds the balancing pressure due to the weight carried. Then, when the operating valve completes its reverse movement the air from the jaring cylinder may be exhausted into the atmosphere, but preferably it passes from the jarring cylinder to the anvil cylinder beneath, and the table drops by gravity against the reduced pressure in the cylinder. At the same time the plunger base or anvil is relieved of a considerable part of the load carried by its supporting springs, which immediately expand, giving the anvil an upward velocity to meet the falling table. When air is expanded from the jarring cylinder into the anvil cylinder this upward velocity of the anvil is augmented and the falling velocity of the table is

LARGEST SHOCKLESS JARRING MOLDING MACHINE.

somewhat retarded, but in any case the momentum of the rising anvil is substantially equal to that of the falling table at the instant of impact. As a result, both table and anvil come to rest with great jarring or ramming effect upon the sand, but without shock or jar upon the foundation or any surrounding material.

These machines have been built in various sizes and operated with complete success, perhaps the most satisfactory practical endorsement being in the possibility of such a machine as shown in the halftone, believed to be the largest jar-ramming molding machine ever built and being actually the largest of the shockless type yet manufactured. This machine was built by the Tabor Mfg. Co., Philadelphia, and is equipped with a steel table, 8 x 12 feet, with cylinder attached, 36 inches in diameter. It is mounted upon a plunger base of cast iron, weighing about 65,000 pounds. The plunger base is fitted in the cylinder base, five feet in diameter and rests upon 22 helical steel springs, aggregating over 3,000 pounds in weight. The total weight of the machine, as shown, is between 90,000 and 100,000 pounds. The machine has already been tested and will soon be shipped to a large iron foundry in the vicinity of Philadelphia. The tests have shown that the action and control is equal to that of any of the smaller machines of the same type, and the company for which it has been built expects to ram molds with this device from six to eight feet wide and 12 to 18 feet long, weighing anywhere within the rated capacity of 50,000 pounds.

NOTES

A subsidiary company of the Canadian Northern Railway has completed plans for effecting an entrance into the heart of the city of Montreal by building a three-mile tunnel under Mount Royal. A new terminal will also be constructed, in which the latest improvements in terminal facilities will be embodied. The total cost of the tunnel and terminal together will be $25,000.000.

Calculation shows that a thistle-down starting from an elevation of 20 feet, in still air, would require two-thirds of a minute to reach the ground. With a wind blowing 20 miles an hour it would be carried, on the average, about a fifth of a mile. The total surface exposed to the air in an average thistle-down is, on account of the great number of hairlets, a little more than one-third of a square foot.

Natural gas can be liquefied by pressure, either alone or with the aid of refrigeration in a manner similar to that employed in the manufacture of "blau gas," which is liquefied under a pressure of 15000 lb. per square inch and is shipped in steel drums to wherever it is needed. On releasing the pressure the liquid becomes a gas again and can be employed for any purpose for which gas is used.

The reason that explosions in bituminous mines are more apt to occur in late fall and winter than any other season, is because the mines are drier in winter. Cool air contains less moisture than warm air, the warmth of the mine raises the temperature of the entering, cold, winter air, and as the air becomes warm, it absorbes water, thus taking up the moisture and depositing it outside.

When it is desired to secure an approximate idea of the movement or velocity of an air current that appears almost stagnant, and if an anemometer is unavailable for immediate use, a heavy rag, or a piece of brattice cloth charged with dust will prove a ready means of making the test. A rap of the hand on the rag or cloth will raise a cloud of dust which the air current will carry away, allowing the observer to form an estimate of the velocity.

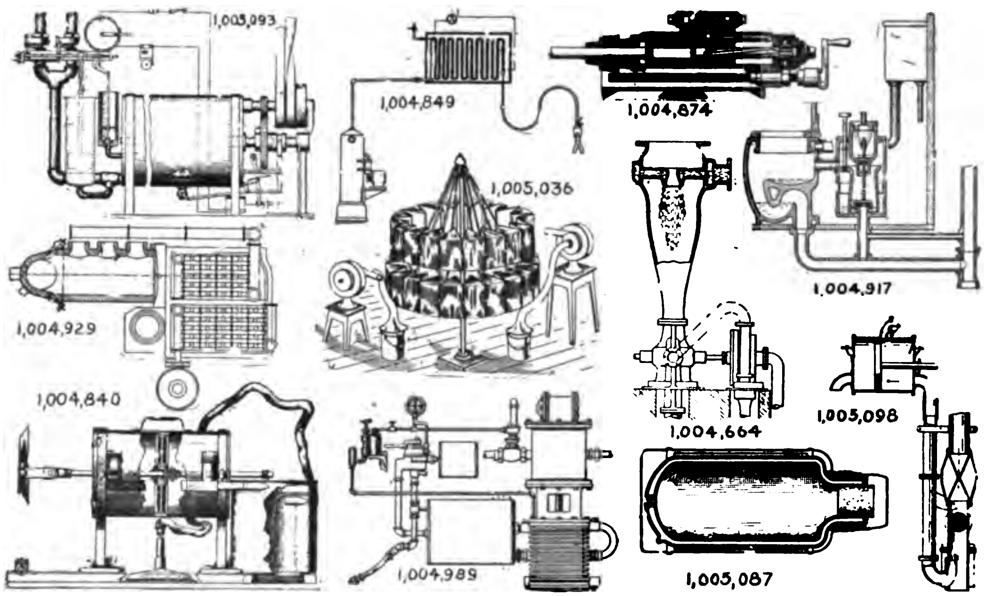
A great dam is being built in the Mississippi River, between Illinois and Iowa, at Dallas City, Ill., which will cost $27,000,000 and develop about 200,000 horsepower. It is expected that the cheap power thus made available will develop a great manufacturing city.

The number of men employed in the word's mines and quarries exceeded 6,000,000 for the year 1909, according to a recent report of the British chief inspector of mines. The total number was probably nearer 8,000,000; since the English figures include for the United States only our coal miners, and but part of our metal miners. A few countries comprising Bolivia with its tin mines, Brazil with its gem fields, China with its coal, iron and tin mines, Turkey and Persia are unrepresented in the statistics.

It is stated that Messrs. Krupp, of Essen, are now producing a type of steel for safes which resist the action of quick-cutting drills and breaks the best bits like glass, and it is equally proof against the blowpipe. To cut it in this way a length of time is required not at the disposal of a burglar. To cut a plate 1½ in. thick with a blowpipe, it takes 6 to 14 hours, 420 cu. ft. of hydrogen and 450 cu. ft. of acetylene. This would involve the conveying of six steel cylinders of compressed gas, each weighing 150 pounds, which is presumably beyond the resources of the average burglar.

At a recent meeting of the Lancashire section of the British Assocation of Managers of Textile Works, Mr. F. W. Parks, of Fitchburg, Mass., in a paper on the development of pneumatic service for textile mills, described the wide use that was being made in the United States cotton mills of compressed air cleaning plant. By the aid of a pneumatic service, he staid, there was an enormous saving of time and money, while the cleaning of the mill machinery was more efficiently done. He predicted that in a few years a pneumatic service would be installed in all our textile mills if pace was to be kept with the onward march of modern improvement. In the course of a brief discussion the view was expressed that in England, at all events, vacuum suction would be a more effective agent in the cleaning of mill machinery than compressed air, which drove dust and lint merely from one place to another. It was agreed that in some departments of work compressed air would be valuable.

An international machinery and engineering exhibition will be held at Olympia, London, from October 4 to 26, 1912, inclusive. This exhibition is organized by the Machine, Tool and Engineering Association, Ltd., and the exhibition offices are at 104 High Holborn, London, W. C. The projectors of the exhibition state that it is their purpose to secure, if possible, so comprehensive a display that it will be really representative of the engineering trades throughout the world. Copies of the prespectus, etc., will be furnished to those addressing the Bureau of Manufactures, Washington, D. C.



PNEUMATIC PATENTS, OCTOBER 3.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 3.

1,004,573. CRUDE-OIL BURNER. WILLIAM B. JOHNSTON, Clinton, Okla.

1,004,629. APPARATUS FOR CONTROLLING THE FLOW OF LIQUIDS OR GASES. SAMUEL COOK, Wilmerding, Pa.

1,004,664. CONDENSER. MAURICE LEBLANC, Paris, France.

4. The combination with a centrifugal device adapted to separate air from water and to discharge the water, of a condensing chamber connected to the inlet of said device and constructed so that air passing therethrough is compressed, and an air pump connected to said device so as to remove the air therefrom.

1,004,840. VACUUM-CLEANER. WILLIAM J. ACKLEY, Batavia, N. Y.

1,004,849. TONSORIAL APPARATUS. WILLIAM J. CITRON, San Francisco, Cal.

1. A tonsorial apparatus, comprising a tank adapted to contain fluid under pressure, a massaging implement, tubular connection between the tank and implement, said connections including a tube bent into coils to form a tortuous passage for the fluid, valves controlling the flow of fluid through the coils, and means for heating the coils during the passage of fluid therethrough.

1,004,874. POWER-OPERATED PERCUSSIVE TOOL. CHARLES H. HAESSLER, Philadelphia, Pa.

1,004,906. AIR-PUMP. JOHN ROBERTSON, Cincinnati, Ohio.

1,004,917. VENTILATING APPARATUS FOR CLOSET-FIXTURES. CHARLES E. SHADALL, Milwaukee, Wis.

1,004,929. APPARATUS FOR THE MANUFACTURE OF STEEL. GUY JAMES STOCK, Darlington, England.

1,004,989. LUBRICATOR FOR AIR-PUMPS. MARTIN CARLE and WILLIAM E. KRAFT, Clifton Forge, Va.

1,005,005. VACUUM-CLEANER. CHARLES A. DILLON, Canton, Ohio.

1,005,036. METHOD OF DISINFECTING BOOKS. THOMAS H. HOOD, Greenville, Miss.

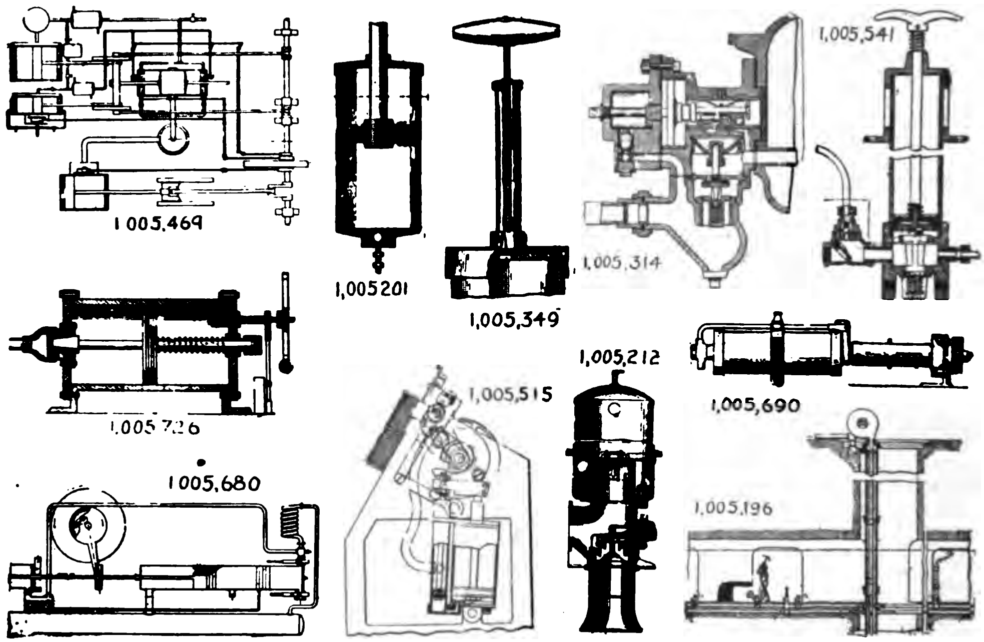
1,005,087. VACUUM-INSULATED BOTTLE. GARRY P. VAN WYE, New York, N. Y.

1,005,093. AUTOMATIC CONTROLLING

MEANS FOR WASHING-MACHINES. GEORGE WILSON, Boston, Mass.
1,005,098. PNEUMATIC CONVEYING APPARATUS. PHILIPPE VAN BERENDONCK, Brussels, Belgium.

OCTOBER 10.

1,005,196. MINE SAFETY APPARATUS. MATUREN GOLD, Hayward, Okla., and WILLIAM ARTHUR MONTGOMERY, Solano, N. Mex.
1. The combination of a mine, a system of pipes therein provided with a series of valved taps, means for forcing air through said pipes, and a helmet provided with an air vent and with a plurality of flexible air inlet pipes having couplings connectible with said taps.
1,005,201. PNEUMATIC CUSHION FOR VEHICLES. CALEB STEVENS GURNEY, Portsmouth, N. H.



PNEUMATIC PATENTS, OCTOBER 10.

1,005,212. AIR-COMPRESSOR. STIRLING B. HILL, CLIMIE E. HILL, and WILLIAM R. HILL, Seattle, Wash.
1,005,290. COMPRESSED - AIR CARPET-CLEANER. EDWIN E. OVERHOLT, Washington, D. C.
1,005,314. TRIPLE VALVE FOR FLUID-PRESSUE BRAKES. JOHN W. ROBINSON, Yoakum, and FRANK L. DOUGLAS, Rockport, Tex.
1,005,349. VACUUM-PACKAGE APPARATUS. GRAY STAUNTON, Evanston, Ill.
1. The combination with a receptacle having a single opening, and an imperforate closure therefor, of an exhaust pump, and a valveless cap terminal secured to said pump, inclosing the receptacle closure and adapted to make air tight contact with the receptacle beyond said closure.
1,005,469. STAGE-COMPRESSION INTERNAL-COMBUSTION ENGINE. SIDNEY A. REEVE, Worcester, Mass.
1. The combination of a two-stroke cycle explosion motor having serially-related high-pressure explosion and low-pressure expansion cylinders and their pistons, external means for charging said high-pressure cylinder with air and fuel under pressure, means for holding the high-pressure exhaust open to the low-pressure cylinder for a variable part of the cycle to scavenge and charge the high-pressure cylinder, and means for admitting fuel to the latter during a period inversely related to the duration of exhaust opening.
1,005,515. VACUUM-PUMP. HENRY B. COOLEY, New Britain, Conn.
1,005,541. ENGINE-STARTING APPARATUS. EDWARD A. HALBLEIB, Rochester, N. Y.
1,005,680. EXPLOSION CYCLE AND MOTOR OF ATMOSPHERIC TYPE. JULES ALFRED BABIN, Versailles, France.
1. An internal combustion engine, comprising in combination, an explosion cylinder having a piston, a pump cylinder also having a piston, said pistons being coupled together, an air-tank containing air under pressure, and having an open communication with said explosion cylinder in front of the piston therein, a charge coil, means openly connecting said coil and said air-tank, a conduit connecting said pump cylinder and said coil, a valve connection between said coil and said explosion cylinder behind said piston therein, and a valved outlet from said explosion cylinder.
1,005,690. AUTOMOBILE TIRE-PUMP. FRANK E. CARLSON, Chicago, Ill.
1,005,726. TRAIN EMERGENCY-STOP. WINFIELD L. MATCHETT, Harrisburg, Pa.

OCTOBER 17.

1,005,816. PORTABLE BREATHING APPARATUS. ALEXANDER BERNHARD DRAGER, Lubeck, Germany.
1,005,878. EXPANSION-ENGINE. GEORGE H. REYNOLDS, Mansfield Depot, Conn.
1,005,911. HYDRAULIC-POWER AIR-COMPRESSOR. FRANCIS P. WILBUR, Milwaukee, Wis.
1,005,923. VALVE-GEAR FOR FLUID-PRESSURE ENGINES. HENRY W. AYLWARD, New York, N. Y.
1,005,940. AIR-COMPRESSOR. CHARLES JEROME COSTELLO and STEPHEN GUION SKINNER, Chicago, Ill.

1,006,034. BLOW-TORCH. JACOB WEINTZ, Cleveland, Ohio.

1,006,063. DEVICE FOR CRANKING AUTOMOBILES. JOHN S. CLARKE, East Cleveland, Ohio.

1. In a road machine having an engine shaft, a rotary device adapted to be operatively connected with one end of said shaft, an air storage tank and a plurality of air passages open from said tank into said rotary device, valves controlling the passage of air in said passages respectively, a hand lever and mechanism therefrom adapted to open and close said valves and an air passage between said passages leading to the connection between the said rotary device and said shaft and a piston in said latter passage adapted to close said connection with the shaft.

1,006,100. DIFFERENTIAL-PRESSURE GAGE. WALTER GEORGE KENT and JOHN LAWRENCE HODGSON, London, England.

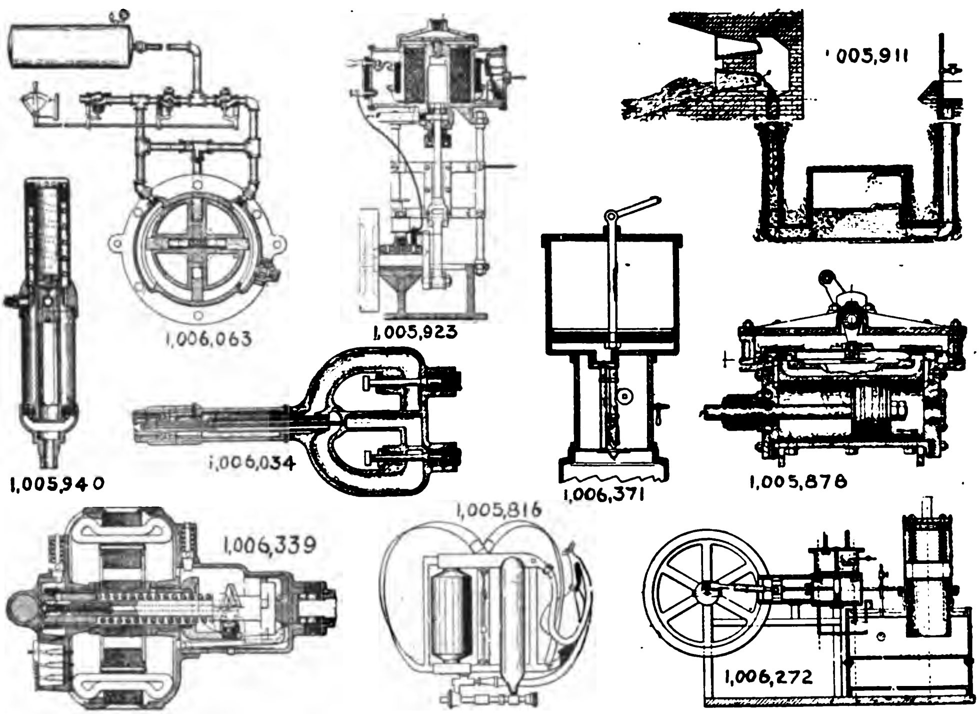
and vertically movable therein; a socket adapted to hold a plug for the can and loosely supported on the end of the rod and axially movable thereon; a spring connecting said rod and said socket to keep the socket near the end of the rod; and a toothed rack and wheel adapted to be operated from outside of said chamber and engaging said rod to move it vertically whereby the socket is moved to carry the plug to the can and whereby the rod continues its motion and frees the plug from the socket.

OCTOBER 24.

1,006,497-8-9. AUTOMATIC AIR-BRAKE. WILLIAM A. PENDRY, Detroit, Mich.

1,006,540. INTERNAL-COMBUSTION PUMPING-ENGINE. CHARLES EMMONS, Everett, Wash.

1,006,577. AIR PURIFIER, MOISTENER, AND HEATER. WILLIAM F. MCGUIRE, Rockford, Ill.



PNEUMATIC PATENTS, OCTOBER 17.

1,006,249. PNEUMATIC SEPARATOR. ERNEST D. MAXWELL, Clifton Forge, Va.

1,006,272. POWER APPARATUS. JOSEPH PREATKA, San Francisco, Cal.

1. In a power plant, the combination of a fluid pressure reciprocating engine, a drive shaft rotatable thereby, a piston reciprocated through said drive shaft, means by which the exhaust fluids from said engine will be compressed in a tank, means by which hot products of combustion mingled with air will be delivered by said piston under pressures into said tank, and heating means for expanding the fluids in said tank, the compressed fluids in said tank forming a reserve pressure.

1,006,339. ROCK-DRILL. THOMAS EDGAR ADAMS, Cleveland, Ohio.

1,006,371. CANNING APPARATUS. JAMES DUNN, Tacoma, Wash.

A canning apparatus comprising an air pump adapted to exhaust air from a can; a chamber connected thereto; a rod within said chamber

1,006,640. INSULATED AIR-PIPE. ARTHUR FAGET, San Francisco, Cal.

1,006,809. CARBURETER FOR INTERNAL-COMBUSTION ENGINES. JULIUS M. ULRICH and WILLIAM RAHR, Jr., Manitowoc, Wis.

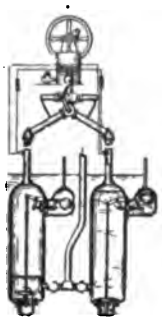
1,006,822. APPARATUS FOR EJECTING FLUID MATTER. HUBERT BEDDOES, Philadelphia, Pa.

1,006,883. ENGINE FOR PORTABLE PNEUMATIC REVERSIBLE DRILLING - MACHINES. CHARLES SCHOFIELD, Newcastle-upon-Tyne, England.

1,006,912. COMPRESSED-AIR SYSTEM. WILLIAM S. COOK, Atlantic City, Wyo.

1,006,921. PNEUMATIC OR VACUUM CLEANER. THOMAS B. DOWNEY, Springtown, Ark.

1,006,980. FLUID-PRESSURE ENGINE, PUMP, EXHAUSTER, OR COMPRESSOR. WILLIAM REAVELL and EDWIN WALTER JONES, Ipswich, England.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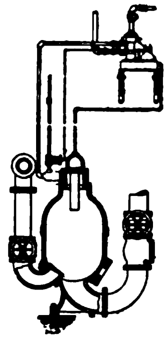
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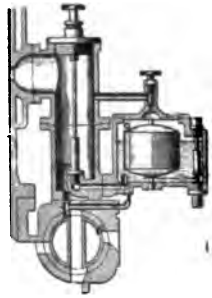
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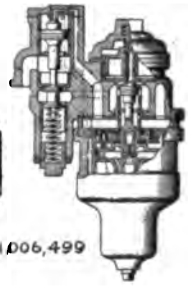
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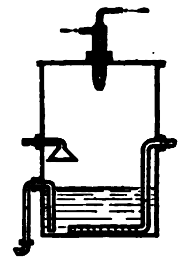
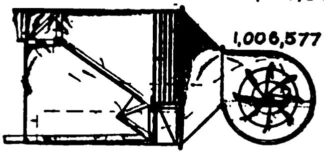

1,006,992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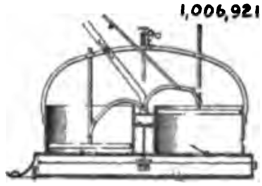
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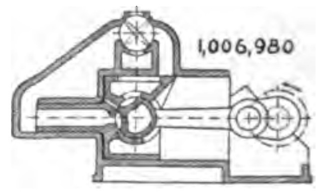

1,006,980

PNEUMATIC PATENTS, OCTOBER 14.

1,006,992. PROCESS FOR STERILIZING MILK AND MILK PRODUCTS. EMIL WIENER, Vienna, Austria-Hungary.

1. The process for sterilizing milk and cream by ozone, which consists in exposing the liquid to the ozonized air in an atomized form and then subjecting the same to an aerating process and removing the ozonizing taste and simultaneously preventing any particles of the ozonized air from remaining in the liquid.

OCTOBER 31.

1,007,046. PROCESS OF PRESERVING MILK. JOSE M. AGUAYO, Artamisa, Cuba.

The process of preserving milk consisting in excluding the same from the atmosphere, subjecting the milk, while so excluded, to the action of oxygen gas at a pressure of from five to six atmospheres, maintaining the milk under the action of the oxygen gas at such pressure for a suitable period of time, then reducing the gas pressure, and thereafter continuously subjecting the milk to the action of the oxygen gas under the reduced pressure.

1,007,095. HYDRAULIC AIR-COMPRESSOR. ALFRED O. GIRARD, Milwaukee, Wis.

1,007,105. AIR-BRAKE. NORMAN A. HILL, Baltimore, Md.

1,007,145. ESCAPE DEVICE FOR SUBMARINE BOATS. JOHN SCHNITTER, Baltimore, Md.

1,007,249. ELASTIC-FLUID TURBINE. WILLIAM E. SNOW, Hyde Park, Mass.

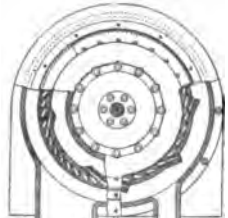
1,007,252. MANUFACTURE OF GLASS ARTICLES. CHARLES C. STUTZ, Norwood, Ohio.

1,007,295. PNEUMATIC HAMMER. VICTOR EDWARD LANE, Berwick, Pa.

1,007,381-2. APPARATUS FOR DESICCATING AND COLLECTING SOLIDS FROM FLUID SUBSTANCES. WILLIAM S. OSBORNE, New York, N. Y.

1,007,451. FLUID-PRESSURE REGULATOR. WILLARD A. KITTS, Jr., Oswego, N. Y.

1,007,599. METHOD OF DESICCATING LIQUID SUBSTANCES. WILLIAM SILAS OSBORNE, New York, N. Y.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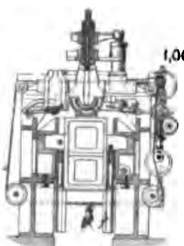
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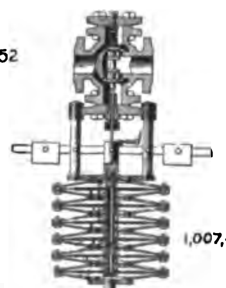
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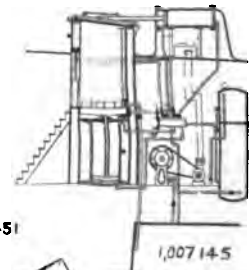
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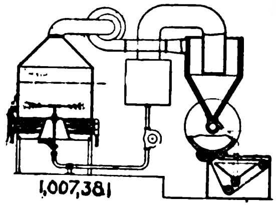
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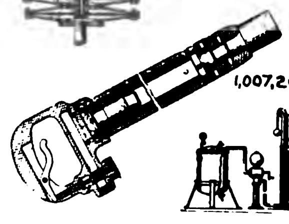
1,007,095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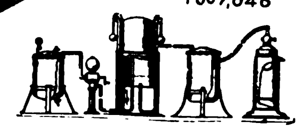
1007,046

PNEUMATIC PATENTS, OCTOBER 31.

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- Vacuum Oil Co.

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- Janney, Steinmetz & Co.
- Latta-Martin Pump Co.
- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Westinghouse Air Brake Co.

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- Bury Compressor Co.
- Chicago Pneum. Tool Co.
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- Ingersoll-Rand Co.
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- Porter Co., H. K.
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- Republic Rubber Co.

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- Jos. Dixon Crucible Co.

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- Chicago Pneumatic Tool Co.
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The water from this well is discharged under our umbrella well top and flows into the weir box where it is accurately measured.

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Galigher Machinery Co.
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Ingersoll-Rand Co.
[illegible] Pump Co.
McKiernan-Terry Drill Co.
National Brake and Electric Co.
Pangborn Co., Thomas W.
Powell Co., Wm.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

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Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.
Powell Co., Wm.
Republic Rubber Co.

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Gardner Compressor Mfg. Co.
Mason Regulator Co.

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Sullivan Machinery Co.

Core Drills, Diamondless.
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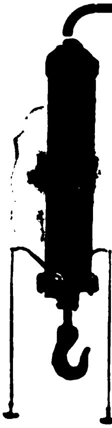

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Sullivan Machinery Co.

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