THE HYDRAULIC SYSTEM OF AIR COMPRESSION.

There are some inventions which appeal to one's mechanical instincts at the very first sight, the principles upon which they are based being so perfectly sound, and the mechanical means adopted to achieve the desired results so admirably chosen, that the device carries its own credentials. Of this character is the new system of air compression illustrated upon the front page of this issue, which has been in successful operation for the past two years at Magog, Quebec, where it has shown very economical results. In speaking of the system as new, we are aware that its principles are old, being found in the water-blast of the ancient Catalin furnace; but we believe this is the first time that hydraulic air compression has been successfully applied in competition with the other well-known systems of air compression.

We are all familiar with the methods commonly adopted in which the work is done by compressors operated by steam or some other suitable power. One of the latest air compressing plants of the standard type is that erected to furnish compressed air for the crosstown cars of the Metropolitan Street Railway Company. This plant, which was illustrated in the SCIENTIFIC AMERICAN, of September 16, 1899, may be taken as representative of the most advanced state of the art where steam compressors are used. The air is compressed in four stages, with cooling between each compression. The intermediate cooling is necessary to keep down the temperature of the air and deliver it to the storage tanks at the desired temperature and pressure for use on the line. A plant of this kind is necessarily complicated and costly.

The hydraulic air compressor, as herewith illustrated, is very simple in its construction, all that is required being the provision near a suitable waterfall of a vertical shaft, a large vertical iron pipe, and two receiving tanks, one at the top and the other at the bottom. Beyond the slight repairs which may be necessary after a considerable lapse of time, there is practically no expense for operation, and the system once started will run uninterruptedly, the plant which forms the subject of our illustration having been in continuous operation, day and night, since it was first started, more than two years ago. The expenses for repairs and attendance have been absolutely nothing during this period.

This plant, which is situated at Magog, Quebec, was installed to furnish power for the printing works of the Dominion Cotton Mills Company. The head of water is 22 feet, and a series of tests made by Prof. McLeod, of McGill College, Montreal, showed that 100 horse power is being delivered with a hydraulic efficiency of 70·7 per cent. The water is conveyed through the penstock, *A*, to the upper tank, *B*, which is known as a receiving tank, where it rises to the same level as the original source of supply. Projecting upwardly through the bottom of the receiving tank is the compressing or downflow pipe, *C*, which is 44 inches in diameter. The pipe extends down through a vertical shaft or well, *E*, which measures 10 feet by 6 feet in section, and is 128 feet deep. At the bottom of the shaft the compressing pipe enters a large tank, 17 feet in diameter by 10 feet in height, which is known as the "air chamber and separator." The water flows through the penstock, *A*, and the pipe, *C*, to the air chamber, *D*; out under the lower edge of the air chamber and then up through the vertical excavated shaft to a final discharge through the tailrace, *F*. Suspended above the flaring mouth at the top of the down-flow pipe is a head piece, *J*, which consists of a bell mouth casting, *b*, opening upward, a cylindrical and conoidal casting, *c*, and a circle of small vertical air supply pipes, *d*, each of which has, at its lower end, a number of small air inlet pipes, extending from it toward the center of the compressing pipe. The head piece is raised and lowered by means of a hand wheel and a screw, *f*.

The supply of water to the compressor is governed by the depth to which the head piece is lowered into the water, the water entering the compressing pipe by way of the annular and variable opening, between the two castings, *A* and *B*. As it enters the compressing pipe it flows among and in the same direction as the small air inlet pipes, *D*, and produces a partial vacuum, with the result that the atmospheric pressure drives the air through the air space into the inrushing water in innumerable small bubbles, which are carried by the water down the compressing pipe. As the bubbles descend they are subjected to a pressure due to the hydraulic head, the final pressure when they reach the bottom of the pipe being, of course, proportional to the column of return water in the shaft, *E*, and the tailrace, *F*.

The reduction of volume and increase of pressure of the air bubbles is shown in the diagram on the front page, the volume decreasing from 1 to ·227, with an increase of pressure from 0 to 50 pounds to the square inch. At the bottom of the compressing pipe is arranged a circular table or diaphragm, *K*. Equivalent to the "altar" of the old "trompe," or water blast, called the disperser, and in its center, immediately below the pipe, is another conoidal casting which serves to change the direction of the flow of water and air from the vertical to the horizontal, directing it toward the circumference of the separating chamber, *D*. After flowing over the edge of the disperser, the water is conducted back to the center by the action of an apron, *L*, and then returns again toward the circumference, finally passing beneath the bottom of the air chamber and rising through the shaft to the tailrace, *F*. During the passage of the water through the separating tank, where its movement is slow compared with the vertical motion in the compressing pipe, the air, on account of its buoyancy, rises through the water and collects in the upper part of the air chamber, as shown, such of the air bubbles as are carried beneath the table, *K*, escaping to the upper part of the air chamber through a series of pipes, *M*. The air in the chamber is kept at nearly uniform pressure by the weight of the water in the shaft and tailrace. The compressed air is led from the air chamber through the vertical pipe, *I*, to an automatic regulating valve, *P*, and from this it is carried to the engines, or, if the power is to be used at a distance, a connection is made at *P* with the pipe line.

The pressure of air in the separating chamber is 0·43 pounds on the gage for each foot of difference in level between the surface of the water in the tailrace and the level of the surface of water in the separating chamber. As the air space in the separating chamber of the largest plant is not likely to exceed 10 feet in depth, the variation of air pressure, as this fills or empties of air, will not exceed four pounds to the square inch.

The hydraulic system of air compression has a distinct advantage in the fact that the compression is isothermal. One of the chief difficulties in the compression of air by the usual methods is connected with the increase of temperature due to compression and to the condensation of water vapor. This condensation may be due either to a fall of temperature or an increase of pressure, or both. The heat of compression is one of the permanent, non-recoverable, losses which must be written down against the ordinary method of compressing; for the heat which is lost by radiation represents a large part of the work done in compression, and no serious effort has been made, and probably no successful effort ever will be made, to recover the heat which is now carried away in the cooling water of the cylindrical jackets and intermediate coolers of the ordinary systems. In the hydraulic air compressor the bubbles of air during their passage down the compressing pipe are kept cool by the body of water which surrounds them.

As the bubbles take from 10 to 25 seconds to descend, according to the depth of the pipe, the process of compression is rather slow, and the temperature of the water is scarcely affected by the heat that it absorbs from the air during its compression. The air bubbles, therefore, are compressed at a constant temperature, and the excess of moisture due to the increasing pressure is deposited on the walls of the bubble as it descends. Hence, by the time the air is collected in the separating chamber, it carries the low temperature of the water and is practically free from moisture.

A series of tests made shortly after the first plant was put in operation showed that 100 horse power in air was being delivered with an efficiency of 62·4 per cent. The number of air inlet pipes was then increased, with the result that an efficiency of 70·7 per cent was obtained. It is believed that the diameter of the separating chamber is at present too small, with the result that 20 per cent of the air that is compressed fails to separate and is retained and carried away by the water up the shaft. It is expected that with an enlarged chamber the plant will show a hydraulic efficiency of over 82 per cent. It is claimed by the designer that the best turbine and mechanical compressor will not give an efficiency from water to air of over 55 per cent.

The second hydraulic air compressor to be installed, is located at Ainsworth, in the Kootenay mining district of British Columbia. The compressed air in this case is to be transmitted about four miles, and distributed among the silver lead mines of that locality. The compressing pipe in this case is 29 inches in diameter, and the air pressure obtained is 85 pounds to the square inch. In another plant which is now being constructed at Peterborough, Ontario, a gage pressure of 25 pounds to the square inch will be realized. The plant which is being constructed at Norwich, Conn., will give 1,365 horse power, at a pressure of 85 pounds per square inch, the depth of the shaft in this case being 203 feet and the diameter of the compression pipe, 13 feet. The air will be transmitted to a distance of four miles. The first tests of the efficiency of the Magog plant were made by C. H. McLeod, Professor of Civil Engineering, of McGill College. We are informed by Mr. Charles H. Taylor, who is the inventor and patentee of the system, that it is proposed in the future to increase the efficiency of the compressor by a system of heating the air prior to expanding it in the motors.

We are indebted to Mr. John A. Inslee, of the Continental Compressed Air Power Company, Philadelphia, for courtesies extended in the preparation of this article.

Automobile News.

There are 5,207 motor cycles in France on which the annual tax has been paid, says The Automotor Journal.

An automobile recently covered the distance from Coventry to London, 92 miles, in four hours, this being an average of 23 miles an hour.

The Assembly Committee on Judiciary of the State of New York, has reported the bill of Assemblyman Apgar, of Westchester County, which is intended to prevent the reckless operation of automobiles. To reach this end the measure provides that no one shall run an automobile without a license procured from a specified examining board. One dollar is to be charged for an examination and $2 is added for the issuing of a license, which may be revoked upon satisfactory proof of drunkenness, incompetency or reckless driving of the licensee.

An automobile show will be held in Madison Square Garden the first week in November. It will be held under the auspices of the Automobile Club of America, and will be the first exhibition of automobiles on a large scale ever held in this country, and it is expected that vehicles of European manufacture will be included in the exhibit. A circular track will be provided in the Garden, so that various types of automobiles can be shown.

The Automobile Club of London will have a motor car trial from April 23 to May 12, the course being 1,000 miles. The course is from London to Edinburgh and return, and includes one-day exhibits at Bristol, Birmingham, Manchester, Edinburgh, Newcastle-on-Tyne, Sheffield, and Leeds, and shorter exhibitions at other places. A number of prizes will be offered, and it is expected that a large number of motor carriages of various classes will participate.

The Baltimore and Ohio Railway Company, has established an automobile service at Washington, D. C., in connection with their trains. This is believed to be the first railroad to introduce this means of transportation regularly to and from a railroad station. An electrical system is used. Two small trunks can be carried on supports on each vehicle and additional baggage can be placed upon the top. As the streets in Washington are in very fine condition there is every prospect of the service being successful.

A party of Frenchmen are to attempt to reach the Klondike in an automobile. They are to take with them a Bollée carriage in which the rear driving wheel is spiked and the front wheels are taken off and replaced by runners. We have already illustrated a Bollée carriage which has been metamorphosed in this way. The car will draw a sledge carrying 250 liters of petroleum spirits, and a motor tricycle which will be used for assisting the carriage when necessary. The usual means of transport to Vancouver, Skagway and Lake Bennett will be used, from which point the horseless carriage journey will begin. It is very easy to prophesy the ultimate fate of the carriage.

Two of the largest traction engines in the world and eight steel carriages for use in the mining district of Siberia were shipped, March 15, from San Leandro, Cal. There has also been planned a carrying service across the desert in China in competition with the trade now done by means of camels. It is "said" that the camels can carry only about 600 pounds each and make only 20 miles a day, while traction wagons will carry ten tons each and can make 60 miles. It is expected to have 50 engines and 3,000 wagons actively engaged within a year. An agent is now at Bucyrus, Ohio, says The Railway Review, purchasing the first installment of 10-ton traction wagons and engines with which to haul them.

A decision of considerable importance was rendered on appeal at Rochester, New York, by Judge Sutherland. The circumstances were as follows: The inventor of a gasoline carriage was sued by a tradesman for damages, due to a runaway caused by the horseless vehicle. Judgment was given to the plaintiff, and the defendant appealed the case, with the result that the judgment was reversed. The Court said: "If one should find it desirable to go back to primitive methods and trek along a city street with a four-ox team and wagon of the prairie schooner variety, it would possibly cause some uneasiness in horses unused to such sights. Yet it could not be actionable, in my opinion, if a runaway should result, provided due care were shown not unnecessarily to interfere with the use of the highway. Horses may take fright at conveyances that have become obsolete, as well as those which are novel; but this is one of the dangers incidental to the driving of horses, and the fact cannot be interposed as a barrier to retrogression or progress in the method of locomotion. Bicycles used to frighten horses, but no right of action accrued. . . . The temporary inconvenience and dangers incident to the introduction of these modern and practical modes of travel upon the highway must be subordinate to the larger and permanent benefits to the general public resulting from the adoption of the improvements which science and inventive skill have perfected."

SCIENTIFIC AMERICAN

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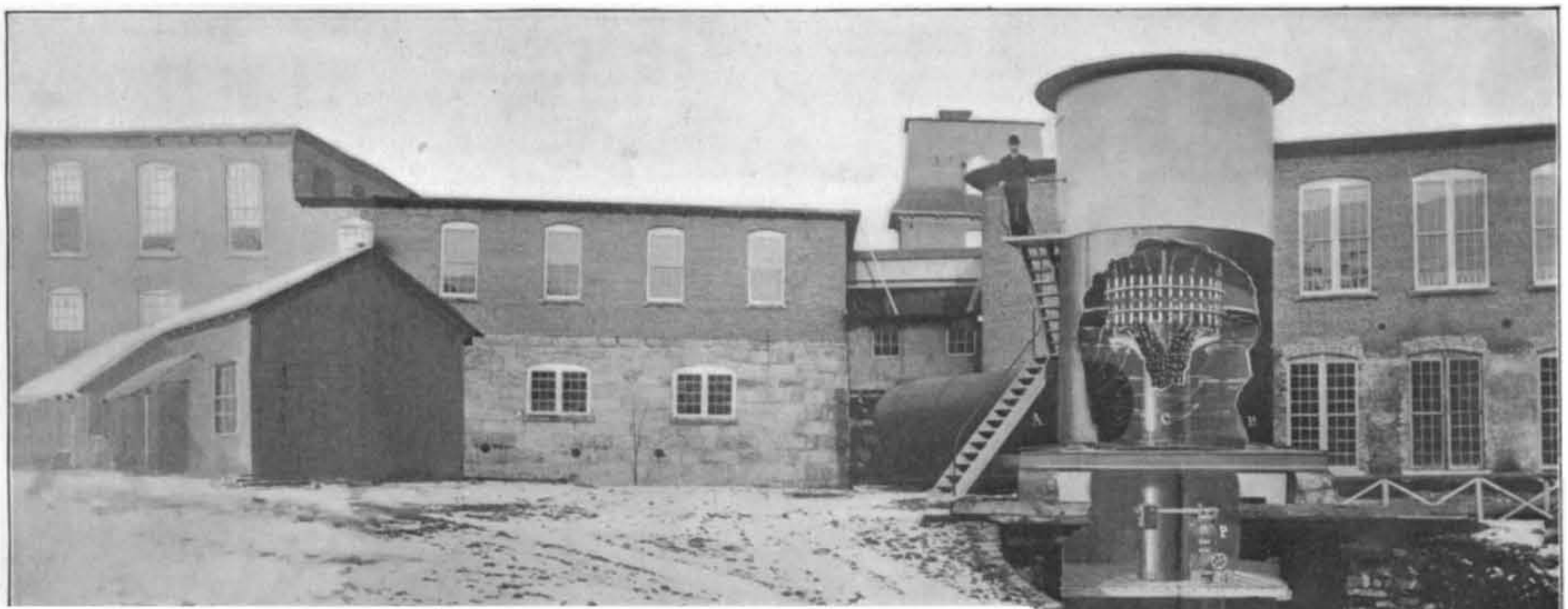
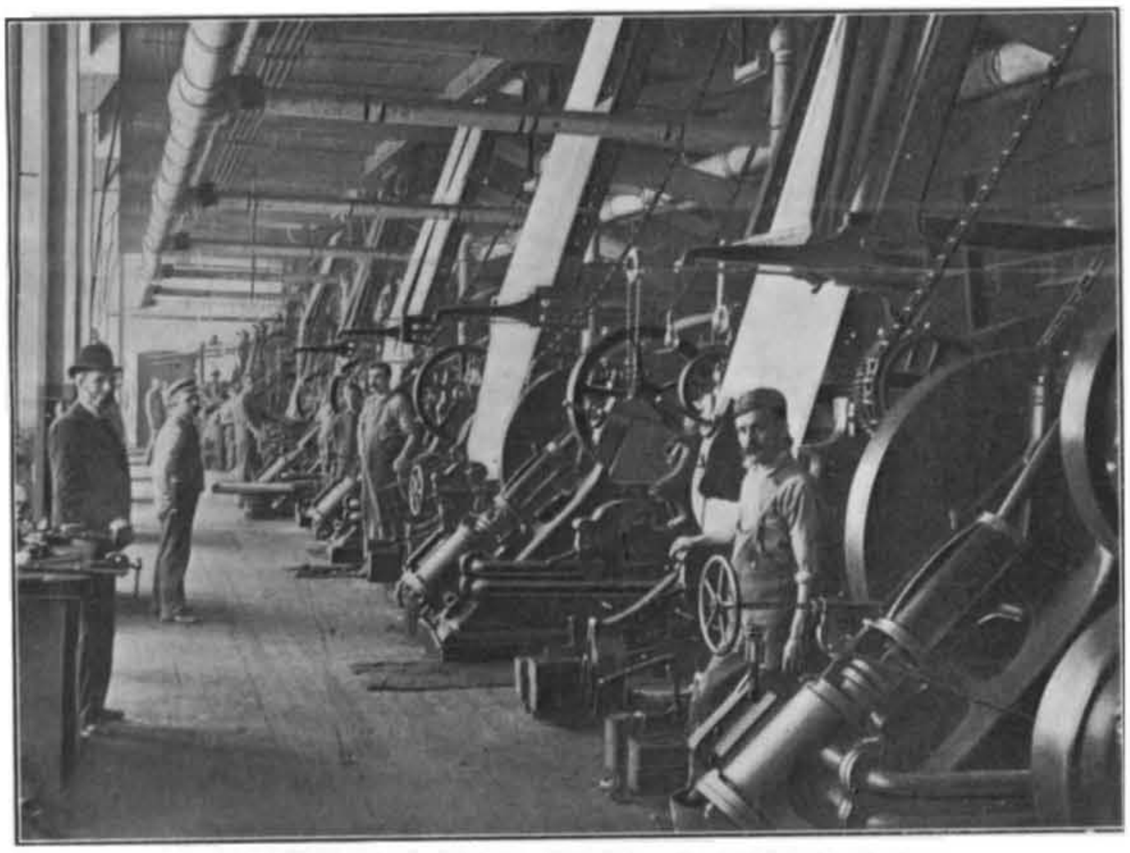
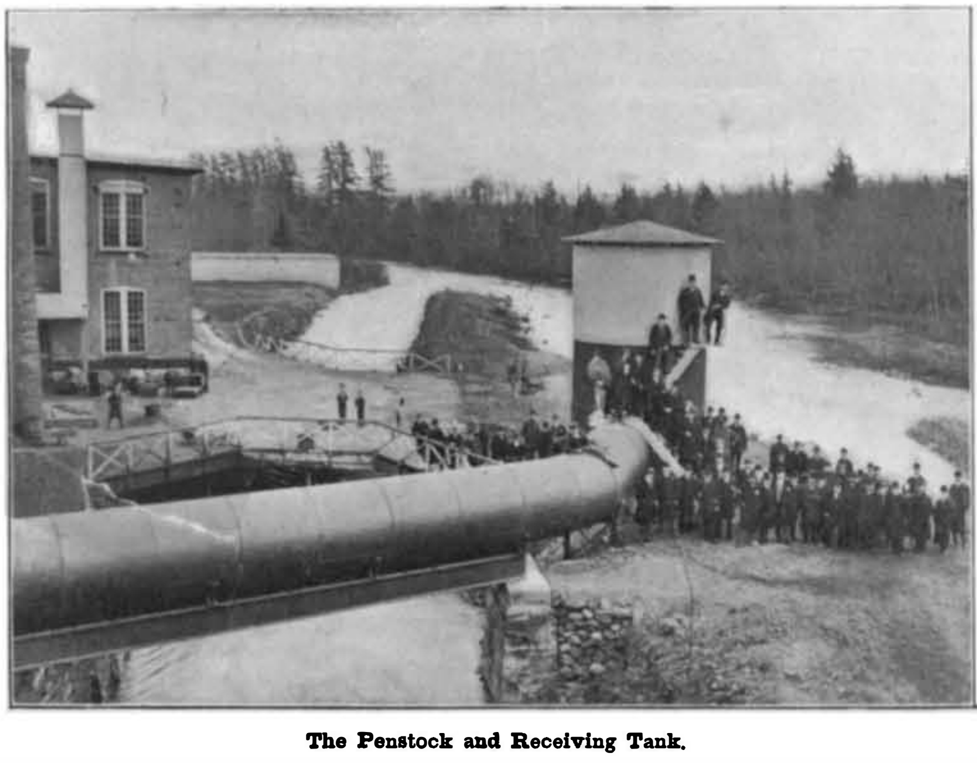
A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS CHEMISTRY AND MANUFACTURES.

Vol. LXXXII.—No. 17.] ESTABLISHED 1845. NEW YORK, APRIL 28, 1900. [$3.00 A YEAR. WEEKLY.

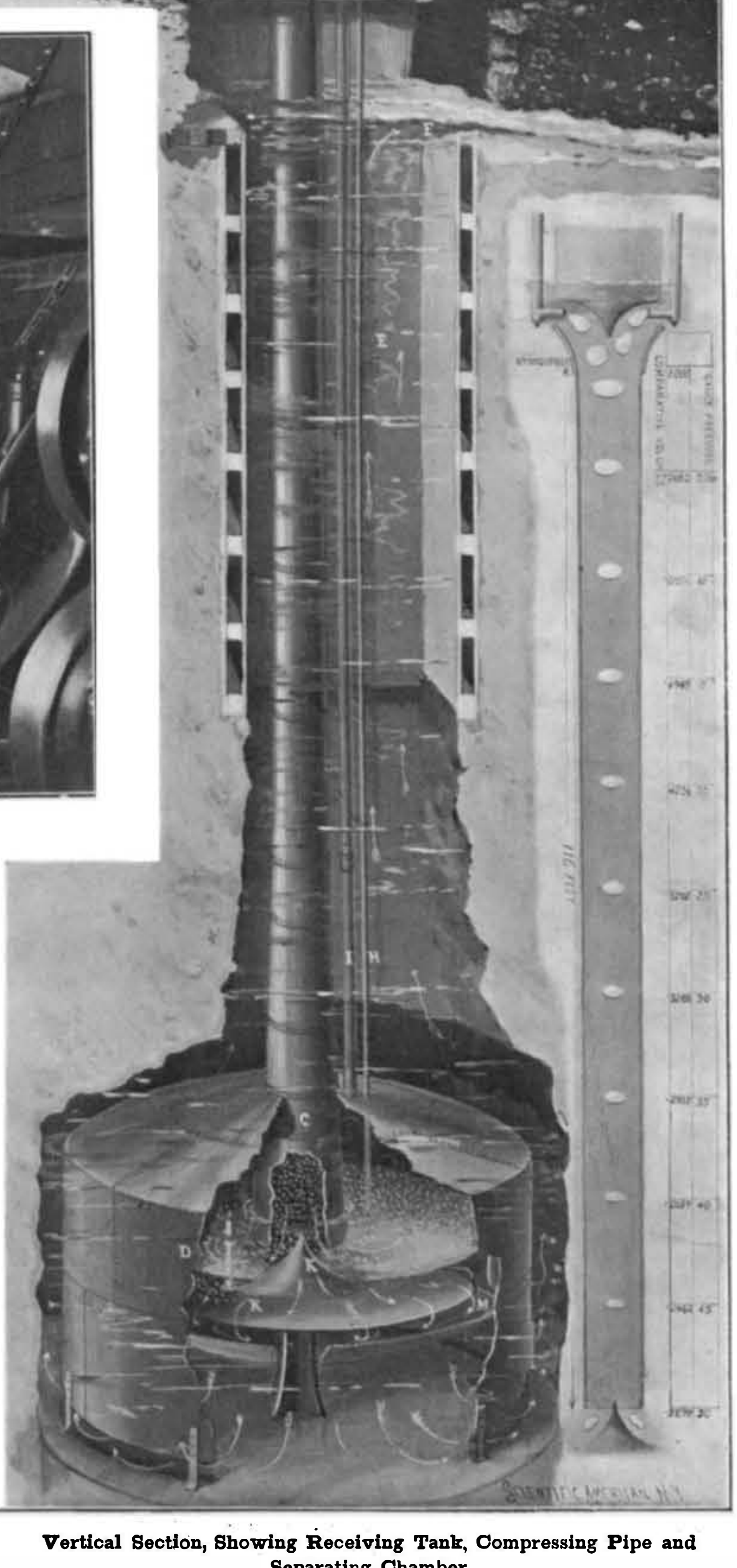




Cotton-Mill Printing-Machines Driven by Compressed Air Engines.



The Penstock and Receiving Tank.



Vertical Section, Showing Receiving Tank, Compressing Pipe and Separating Chamber.

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