TRANSMISSION OF MOTIVE POWER BY RAREFIED AIR.

Manufacturing on a small scale, which numbers in Paris so many representatives in what are called workers at home, is still in search of a small and economical motor, which shall be easy of installation and simple of operation, without any special *personnel*, and unaccompanied by any annoyance, for either him who employs it or for his neighbors.

A small and economical motor, presenting all the advantages just enumerated, would work a transformation in the small industries, which, up to the present time, have been obliged to perform by hand a large number of operations that an ever ready motive power would permit of doing by machinery. The solution of the problem lies in the distribution of such power to houses, and solutions up to the present have not been wanting; for water under pressure, illuminating gas, compressed air, and electricity have already received a certain number of applications, or have been submitted, with this end in view, to some experimentation. We have no desire to pass in review the advantages and disadvantages special to each of these modes of distribution; for our design is to make known now a new champion which has entered the contest open between these different systems, and whose first passes are not without interest. This new system is *rarefied air*, or the *pneumatic transmission* of power.

In qualifying this system as new, we should be understood as speaking of the application to a *distribution* of motive power, and not of the pneumatic system itself. It is now nearly two hundred years ago that Denis Papin spoke of it in the Acts of Leipzig (*Acta Eruditorum*, Lipsiæ, 1688). In another work, which appeared at Cassel in 1694, this same individual showed the advantages that would accrue from being able to *transmit* a power, from the point where it is disposable to that at which it can be utilized, by means of a relatively small tube; and he indicated the use of thin lead for the manufacture of such a tube, remarking that it would never contain any water. The authors of the system that we are about to describe, however, make no pretensions to priority, but, on the contrary, pay homage to the genius of one of our most illustrious compatriots. Their sole aim has been to develop Papin's idea by applying it to the *distribution* of motive power for small manufacturers. The need of such a power, which was far from being felt in 1688 or 1694, is at present becoming more and more imperative.

The pneumatic system consists, in principle, in establishing a line of pipes, in which a certain amount of vacuum is kept up by means of powerful pumps located at a central establishment. This piping terminates, as with water and gas pipes, at the house of each subscriber, where it receives the atmospheric air whose pressure is more elevated, and which effects the work by traversing an appropriate motor.

Central Works.—The power of the engines located at the central works must be proportioned to the extent of the pipe line, and to the total power of the motors to be supplied; friction, loss of charge, leakage, etc., being taken into the account. The *quantity* of air to be extracted from the pipes in order to keep up a pressure proper for the good performance of the receivers is equal to the quantity that enters therein through the different motors at each moment in action; but, as a consequence of expansion, the *volume* to be extracted is about four times greater than that occupied by the air at atmospheric pressure. The vacuum kept up in the system of pipes is about 75 per cent, or about 57 centimeters of mercury, or 7·75 meters of water.

The extraction of one cubic meter of air, at the mean pressure of the atmosphere, requires a theoretic power of 14,310 kilogrammeters. In the installation for study, made on Boulevard Voltaire, the pump is run by a belt; but there will be an evident advantage in fixing the rod of the pump on the prolongation of the piston of the steam engine, in an installation which is established specially for an application of the system.

The System of Piping.—The piping is calculated for an anticipated extension of one kilometer distance from the central works, and for losses by friction in the mains not exceeding 3 per cent. The pipes may, according to circumstances, be laid in the sewers or in trenches. The installation for study is made in Boulevard Voltaire and Avenue Parmentier. The distance is about 600 meters, and the piping is 6 centimeters in diameter.

In practice, it is proposed to employ cast-iron pipes for the mains and principal branches iron ones for the secondary branches, and lead pipes for service.

The joints of the iron pipes laid in Boulevard Voltaire are of rubber, and have given good results, as the pressure is not excessive, and elongation and contractions of the pipes is almost null, owing to the slight variations in temperature in the trenches in which they lie.

The Motors.—The receiving apparatus furnished customers must present very peculiar features. By the very fact of the nature of the power distributed, the motors must be scattered in great numbers among consumers without being subject to continual surveillance and keeping in repair by the company. The type of motor, then, should be as simple as possible, without any delicate parts, and should be capable of being taken apart and put together again in a few instants, and, finally, the price should be moderate, and the space occupied by the apparatus should be small. All the motors applied up to the present time have been oscillating ones. They have answered requirements perfectly, and have not necessitated the least repair during several months of service.

Fig. 1 represents one of these machines of the 5 kilogrammeter model. An analogous machine of smaller size actuates a sewing machine (Fig. 2), without any change being requisite in the parts of the latter, as constructed for being operated by a pedal. The operation of these machines is analogous to that of oscillating steam engines, the air at the pressure of the atmosphere acting in the place of steam, and a vacuum being effected on the side of the escapement. The machine is of a double-acting and expansion type. Admission ceases at about three-eighths of the piston's travel, and the volume of air before and after expansion is in the ratio of 1 to 2·66. Expansion being incomplete as a consequence of the practical ratio adopted, the work effected per cubic meter of air is only 13,500 kilogrammeters, the theoretic loss thus not exceeding 6 per cent. The *practical* performance, that is to say, the ratio of theoretic or utilizable work, measured by the brake, increases rapidly with the power of the motor. With the 3 to 5 kilogrammeter sizes, the practical performance varies between 0·40 and 0·50, while it easily attains 0·60 in machines of 25 kilogrammeters.

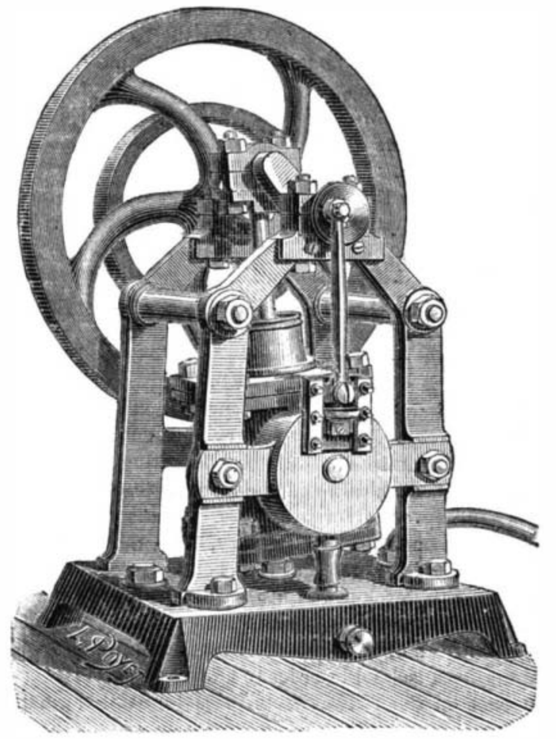

Fig. 1.—RAREFIED AIR MOTOR FOR DOMESTIC USE.

The velocity of the oscillating machines also has an influence on the performance, as well as on the absolute work effected in a unit of time. Thus, for example, in one experiment, the performance did not reach 0·40 at a speed of 145 revolutions per minute, while it exceeded 0·54 on reducing the speed to 120 revolutions. In this second case the motor, on revolving at a less speed, furnished more work.

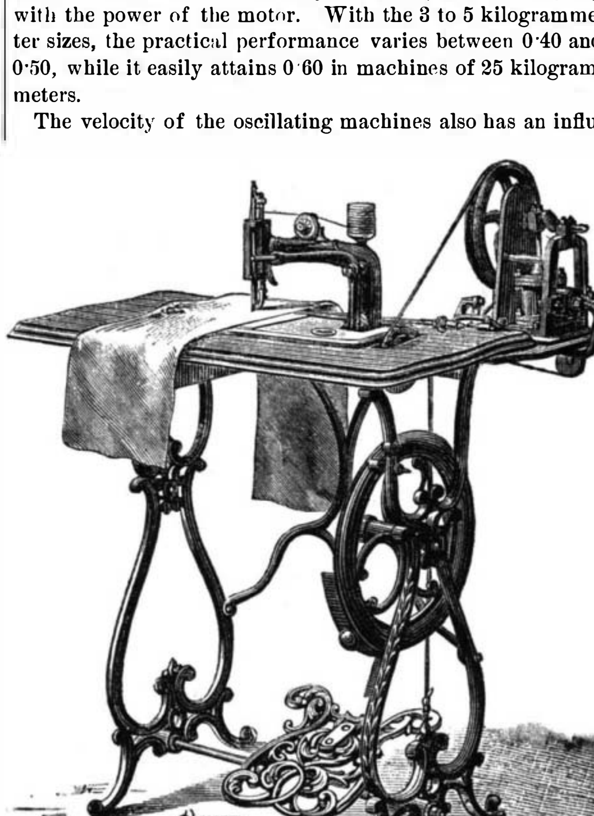

Fig. 2.—RAREFIED AIR MOTOR APPLIED TO A SEWING MACHINE.

In a new system of rotating motor now under study, phenomena are discovered that are slightly different. The performance diminishes with the speed, but the quantity of work effected increases with the latter.

To avoid the introduction of lubricating oil into the service pipe, which might, in the long run, retain atmospheric dust and produce an inevitable obstruction, the motors are mounted upon hollow bases (Fig. 1). The air that has just operated rushes into this base through a wide and short aperture. This empty space, being always in communication with the conduit, performs the role of an intermediate reservoir that is always kept at a medium degree of rarefaction. This receptacle retains the oils that are deposited at the bottom, and allows of their extraction from time to time through the removal of a simple screw-plug located at the lowermost part.

Each motor is so arranged as to run at a medium speed, according to the application for which it is designed, and deviates but little from it in practice. Under these circumstances, the work by all is perceptibly constant, and there results from this one of the simplest of methods of making the consumer pay in proportion to the use he makes of the machine.

It is only necessary to count the number of revolutions made by the motor during a given length of time (a day, a week, or a month) by means of a very simple counter in order to fix the price that the customer must pay, according to the type of motor furnished him. Changes of speed are very easily brought about by opening the cock that lets in the air, more or less, and a stoppage by closing the same cock completely. The maximum work is obtained by opening the cock to its full extent.

In sewing machines, wood and metal lathes, etc., it is convenient to utilize for this purpose the pedal which formerly served to put the machine in operation. The hands of the operator are thus rendered free, and the operations of setting in motion, slackening the speed of, and stopping the motor are easily disposed of.

In the experimental installation of Boulevard Voltaire, we have seen a series of machine tools actuated by a distribution established on the principles that we have just explained, and consisting of sewing machines, drilling machines, wood and metal lathes, sausage choppers, etc. All these tools were running with the greatest regularity, and those who were employing them were entirely satisfied with their operation. It is well to remark that the system of distribution by rarefied air is in reality a *negative* one, seeing that nothing is sent to the customer, and that the air is withdrawn from the room in which the motor is located. This latter feature proves very advantageous, moreover, in that it effects a ventilation and aeration of the apartment.

Although the merit of these labors and experiments reverts to the technical commission which has presided over their installation, we think that in all justice a large part of it ought to belong to Mr. V. Tatin; for it is due to his intelligent initiative and profound mechanical knowledge that the Société Civile d'Etudes has been enabled to make the application of the system whose success we now record.—*La Nature.*

Indelible Stamping Ink.

The ordinary stamping ink made by diluting printing ink (which is made of lampblack and linseed varnish) with boiled linseed oil stands pretty well if enough is used, but when poorly stamped will wash off. Dr. W. Reissig, of Munich, has recently made an ink for canceling stamps which is totally indelible, and the least trace of it can be detected chemically. It consists of 16 parts of boiled linseed oil varnish, 6 parts of the finest lampblack, and from 2 to 5 parts of perchloride of iron. Diluted with one-eighth the quantity of boiled oil varnish it can be used for a stamp. Of course it can only be used with rubber stamps, for metallic type would be destroyed by the chlorine in the ink. To avoid this the perchloride of iron may be dissolved in absolute alcohol, and enough pulverized metallic iron added to reduce it to the protochloride, which is rapidly dried and added to the ink. Instead of the chloride other salts of protoxide or peroxide of iron can be used. The iron unites with the cellulose and the sizing of the paper, so that it can easily be detected even after the ink has all been washed off. Sulphide of ammonia is well adapted to its detection.

Values of some Southern Fibers.

The *Southern Cultivator* says that Mr. Richard Goode, of Melbourne, Florida, recently sent to London a number of sample bales of fibers grown in that State. They found ready sale, the dealer's report of quality and value running as follows:

Agava, long samples. Is like a superior sisal hemp, color and quality both being good. Value, $145.80 per ton.

Agava, short sample. Very soft, fine fiber, and worth $170.60 per ton.

Sisal, good length and color. Valued at $136.08 per ton.

Aloe, useful, clean fiber, but rather short. Worth $136.08 per ton.

Yucca, or *Bear's Grass*, a useful fiber, but not so well prepared for market as the other samples. Value, $136.08 per ton.

A Submarine Metal Detecter.

A new application of the electric balance is seen in an instrument devised by Captain McEvoy, of London, for use in finding torpedoes, electric cables, lost anchors, chains, sunken vessels, or other metallic objects under water. The principle on which this invention is constructed is that of the induction balance of Professor Hughes.