IMPROVED AIR-COMPRESSORS.

CONSTRUCTED BY THE DELAMATER IRON-WORKS, FROM THE DESIGNS OF MESSRS. REYNOLD AND FISH.

The use of compressed air as a motive power is destined to receive an enormous development as its capabilities and advantages become better understood. What countless wealth is thrown away in the unheeded falls of our rivers and the flow and ebb of the ocean tides, simply because few consider that the power thus wasted could be conveyed to almost any distance, at very trifling cost, by means of compressed air or rope transmission! As long ago as 1837, a series of experiments was made in Coscia, by order of the Italian Government, to determine the resistance of tubes to the flow of air through them; it was found that:

1. The resistance is directly as the length of the tube.
2. It is directly as the square of the velocity of the flow.
3. It is inversely as the diameter of the tube.

And as the volume is directly as the square of the diameter when the velocity is given, it follows that, under a given pressure and velocity, the relative resistance — that is to say, the resistance divided by the power — will vary inversely as the cube of the diameter.

There is, consequently, a great advantage in making the tubes and openings through which the air has to pass as large as possible. Experience has shown that tubes can be made so as to allow of very little leakage. At the Mont Cenis tunnel no leak was ever found in tubes nearly a mile and a half in length, nor did the expansions and contractions of the tubes, due to changes of temperature, appear to affect sensibly the firmness of the joints. On one occasion it became necessary to leave the receivers full of compressed air for twenty-four days; the loss in all that time did not exceed $\frac{5}{1000}$ part of the daily supply.

It is therefore possible to transmit power by compressed air to very great distances with scarcely appreciable loss in its transmission. There is, however, a much more important source of loss than that just mentioned. When air or any other elastic fluid is compressed, there is generated an amount of heat which is the exact equivalent of the force employed in the compression. This heat, in practice, is radiated from the compressor, the reservoir, and tubes, and is lost; when the compressed air has attained the same temperature it possessed before compressing, it has lost in cooling exactly as much power as was expended in compressing it; but since the air still remains under a considerable pressure, if allowed to expand, its temperature falls below that of the atmosphere, and in so doing it develops work, but, inasmuch as the temperature in expansion will not be depressed nearly as much as it was increased in compression, the loss of work will always be considerable, increasing with the pressure to which the air has has been subjected; this loss is moreover susceptible of exact calculation. Taking the case of the Mont Cenis tunnel, where a pressure of six atmospheres was attained, the air, instead of being compressed to one-sixth of its volume, as would have been the case were no heat generated, actually entered the reservoir when its volume had been reduced but 3.6 times, and theoretically, the power available would have been but 60 per cent of that expended; practically, it was somewhat less than this. If the air were compressed to eight atmospheres, there would remain available but 55 per cent., and for about eleven atmospheres of compression but 50 per cent. of the compressing power could be obtained. If the compression is less, say four atmospheres, 67 per cent. would be secured, to three atmospheres 72 per cent. would, according to theory, be available, and so forth; hence we see that where the lower pressures will perform the work to be done, and will not necessitate the use of extra large and costly engines to utilize the power, there is an evident advantage in not using a very high degree of compression.

To this loss of power, practically inherent in compressed air, we must add the loss due to its transmission through tubes, this, where the pressure is not excessive and where the velocity is reduced by the use of large tubes, is a much smaller item of loss than the other; it would not be over one-third or one-fourth of it, and in carrying the air through say 10 to 15 miles of pipe would not exceed say 5 to 8 per cent.

As we have stated it is impossible, under ordinary circumstances, to utilize more than say 50 to 60 per cent. of the power expended in compressing the air, yet, from the fact that compressed air enables us to carry at a small cost the power wasted in waterfalls to points where it can be used with advantage, the loss of 50 per cent. in the motive power is a small matter, and the actual power obtained would cost, in general, much less than if generated with our most economical steam-engines.

The use of compressed air for driving underground machinery, whether it be hoisting-engines, rock-drills, coal-cutters, or other machines, is peculiarly advantageous, for it provides a valuable addition to the ventilation of the mine and reduces the temperature, which in deep mines is so excessive. It can be carried to much greater distances than steam, which, moreover, is very destructive to mine-timber

One of the chief reasons for the limited application of compressed air to the transmission of power has been the complexity and mechanical defects in the compressing-machines. These defects, however, are being overcome as the attention of our engineers is directed to the subject, and the application of compressed air for the transmission of power will undoubtedly receive an immense extension from the simplification of these machines. We present to our readers on page 261 a cut of one of the most compact, simple, and practical of our air-compressors.

It can be driven by means of a water-wheel, wind-mill, steam engine, or other motor. It occupies a space of but 10 feet [illegible] inches by 6 feet, 4 inches on the ground plan, and 11 feet, 3 inches in height. The air-compressing cylinders are 20 inches in diameter, 24-inch stroke, and, in this particular machine are driven by a 14-inch belt on a 42-inch pulley, making about 60 revolutions per minute. The air-pistons are trunks connected to the crank-pins by connecting-rods three times the length of the stroke. The cylinder casings, tank, bed plate and housing-brackets are all cast in a single piece, making a very simple and substantial structure. The crank-wheels are turned and balanced; the crank-shaft, which also carries the large spur-wheel, is of wrought iron 7 inches diameter. The teeth of the spur are of small pitch, but are strengthened by a shrouding on each side and by one in the middle, making really two wheels in one casting.

One of the most important features in this compressor is an ingenious contrivance of Messrs. Reynolds & Fish, by which the air-discharge valve drops from its seat as soon as the pressure in the receiver exceeds that for which the weighted lever is set. This puts the compressing cylinders in direct communication one with the other, so that instead of the engine being strained by the full pressure of the steam, and making a useless expenditure of work, the work done is simply moving the pistons back and forth freely in an atmosphere compressed to the same degree on each side of the piston.—*American Artisan.*

HOW TO SEE STEREOSCOPIC PICTURES WITHOUT A STEREOSCOPE.

The ability to see binocular pictures in stereoscopic relief is twofold in its bearings. First: a photographer can examine properly mounted pictures with the unassisted eye with as much pleasure as though he were using a stereoscope, the effects of nearness and distance will be quite as thoroughly appreciated, and, as a whole, the advantage will equal that obtained by proper stereoscopic inspection, keeping out of sight the enlargement obtained by the examination through the eye-piece, the function of which, in this case, is to enlarge pictures as well as to diverge the rays coming from them. Incidentally arising from this is the possession of a power of being able instantly to detect a pair of pictures which have been wrongly mounted. Some time since a well-known wholesale dealer in stereoscopic slides in London was very much surprised when, upon bestowing what he supposed to be a mere cursory glance at a number of stereoscopic pictures sent in for selection by a photographer, we threw a number aside as being unsuited for sale on account of improper mounting, and this gentleman also marvelled when, upon testing each of these condemned pictures in the stereoscope, he found that in every one of them the effect was pseudo-scopic, the near objects being shown as the more distant ones.

Before giving directions with respect to the method by which the eye may be so tutored as to readily discern between the one and the other, we may observe that, if a print from a binocular camera negative be placed uncut in the stereo-