The application of the principle is simple, and where an abundant water-supply exists excellent results are obtained. The second form of wet compressor has attained a wide application on the Continent of Europe, where, particularly among the highly educated Belgian and French engineers, the principles of air-compression are more thoroughly understood than in Britain. It is, however, a question if their adherence to this method is not an instance of the length to which a desire to reach an ideal perfection may lead one from the best practical solution of a problem. As will be shown later on, the dead space at the end of the air-piston stroke is undesirable, and it was largely to eliminate this defect and to keep the air cool that liquid pistons had such a vogue on the Continent. The water forced back and forward in the cylinder and up the pipe at each end, carrying the necessary valves, filled the dead space. But, unfortunately for this ideal, there are a number of inconveniences attendant on the system. The cooling of the air is insufficient because it is only on the surface of the water. The speed of the piston is extremely limited, and cannot exceed 40 ft. to 50 ft. per minute, on account of the mass of water to be moved; consequently the number of compressors required for a given work is large. The water agitated by the motion is frothed and causes an excessive moisture in the air. Various devices more or less successful have been used to lessen these defects; but, in spite of all, the fact remains that in other countries these compressors have not found favour.

Dry Compressors.—This type of compressor has a cylinder and piston similar to those of a steam-engine, with suitable outlet- and inlet-valves at the cylinder ends. The temperature of the air is kept within reasonable limits by the constant flow of cold water through the water-jacket of the cylinder from the bottom upwards. It is, however, doubtful if the process of cooling, even under the most favourable conditions, does more than keep the cylinder from becoming excessively heated, and so imparting heat to the incoming air. A more thorough method of cooling is obtained by injecting a fine spray of cold water into the cylinder near the outlet-valves. To this the objection has been strongly urged that the presence of water, with its non-lubricating properties, causes an undue wear-and-tear in the cylinder and loss in power.

(3.) Causes of Low Efficiency in Air Compressors.

These causes, briefly stated, are the heating of the air during compression, mechanical defects in the inlet- and outlet-valves, and leakage past the piston. It has been already shown that air when subjected to compression is heated, and that as the volume is thereby increased much power is uselessly expended in dealing with the heated air. The most efficient compressor, therefore, in this regard, must be the one presenting the best cooling arrangement for the air as it is being compressed. That form of compressor in which the piston is represented by the falling water supplying the power, such as Sommeiller's, permits of a very thorough cooling, as the water-piston is renewed each stroke, and the cylinder is kept perfectly cool. But in the second form of wet compressor, such as Dubois's or Mariehaye Colliery, Belgium, in which the water, only slightly renewed per stroke, becomes considerably heated, the cooling is not more perfectly effected than in the dry compressor. As the pressures to which the air is raised become greater the losses from this source become serious, and as the efficiency of the motors increases with the pressure, and the size of the conduits can be correspondingly small, it is desirable, particularly in large installations, to use high-pressure air. The most satisfactory results in this direction have been obtained by stage compression—that is, by pressing the air to a certain pressure in one cylinder, and further compressing it in a second, and, if desired, in a third, or even a fourth. By this system the air is cooled between each stage, and the losses from this source are minimised. For low pressure it is doubtful if any practical economy would result from stage compression, but it is now fully demonstrated that for pressures above 60 lb. the advantages of stage compression are very marked. To diminish the losses caused by resistance to the passage of the air through the inlet, and outlet-valves many devices have been resorted to. In the ordinary valves held to their work by springs the valves rattle or chatter if the springs are weak. On the other hand, if the springs are made very strong a resistance to the passage of the air is set up, resulting in a loss of power which, in some cases, becomes serious. To obviate this defect the valves are occasionally devised to open mechanically. In a short paper such as this it is impossible to enter into the details of the various valves used. It is not uncommon to hear much stress laid on the losses caused by the unavoidable dead space occupied by compressed air at the end of each stroke, and it may be pointed out at once that the loss is not in power, but solely in the volumetric capacity of the compressor. To diminish this inconvenience the air-piston is usually run as close to the cylinder ends as practical, and care is requisite to avoid sailing too close to the wind in this direction and damaging the mechanism. The best plan is to arrange trick passages, or grooves, on the inside of the cylinder, for a short distance back from each end, to allow the air in the dead space to pass the piston to the end in which compression is about to begin. The inside pressure against the suction valves is thereby relieved, and compression on the other side of the piston begins at once. To prevent knocking, through the sudden relief caused thereby at the end of the stroke, a certain amount of cushioning in the steam-cylinder is required. The low efficiency due to leakage in the pistons can only be effectually reduced by carefully attending to their condition. Naturally, the higher the compression the greater the leakage; but stage compression greatly lessens this evil.

(4.) Air-conduits.

Two considerations are of importance in determining the pipes to be employed; these are the size of the pipes and the character of the joints. The frictional loss in the passage of the air through the pipes increases very rapidly as the diameter decreases, as shown by the following example: If a volume of air at 60 lb. pressure, equivalent to 18,000 cubic feet per hour at atmospheric pressure,