passing through the hole to a plate above. These valves, like the covers already mentioned, were held in their places when closed by the pressure of the air against them.

On the side of the cap furthest from the chamber, \( M_1 \) was bolted the nozzle, \( R_1 \), to which was attached the pipe leading from the air-pump. This pipe was 8 in. in diameter, and was made of sheet iron in lengths of 1 metre (3 ft. 3½ in.) connected by india-rubber tubes, \( T_1 \). The india-rubber junction pieces were protected by wrappings of woollen list, and were secured by the steel clips, \( U_1 \). The pipes formed in this way were found to be very suitable for the work, as they were sufficiently flexible to accommodate themselves to the sinking of the shaft, and they could be readily lengthened or shortened as required. About 5 ft. 6 in. below the cap was placed a shelf or platform for the accommodation of the men employed in raising or lowering the materials, and access to the bottom of the shaft was given by the rope ladder, \( X_1 \).

The pumps employed for supplying the compressed air are shown by Figs. 4 to 9. These pumps are of a kind which has been frequently employed with success for pumping water, and they have the advantage of being little liable to get out of order and of being cheaply constructed, the total cost of each pair of pumps, with their pipes, was only 1500 francs (30£). Similar pumps were employed at the bridge at Bordeaux, and in draining the Lake of Fucine. The lower part of the pair of pumps is formed of the cellular cast-iron base plate, \( A_1 \), which is divided longitudinally by the partition, \( B_1 \), as shown in Fig. 9. Two compartments are thus formed, the one, \( C_1 \), being the inlet, and the other, \( D_1 \), the discharge side. On the top of the base plate are bolted the pair of cast-iron cylinders, \( E_1 \), each cylinder being formed of two parts placed one above the other, and bolted together through flanges holding between them the edge of a strong cupped leather, \( F_1 \). The centre of this leather is held between the piston, \( I_1 \), and the cast-iron plate, \( H_1 \), as shown, and as the pump is worked the leather is alternately deflected upwards and downwards, as shown in Fig. 7. At the bottom of each cylinder is placed the iron plate, \( K_1 \), which is ¼ in. thick, and is perforated with holes slightly countersunk to prevent the india-rubber valves, of which the plate forms the seat, from being cut. Each plate forms the seat for two valves, each uncovering, when open, rather less than half its surface. These valves are simply semicircular pieces of sheet india-rubber secured round their peripheries, the suction valve, shown open at \( M_1 \), Fig. 7, being placed above, and the delivery valve, \( N_1 \), Fig. 8, below the plate \( K_1 \).

Between the cylinders there are cast in one piece with the bedplate the two conical nozzles, \( P_1 \), which communicate with the short pipes, \( Q_1 \), to which the pipes leading to the shafts were attached. Above the nozzles just mentioned, there is bolted to the faces, \( R_1 \), formed on the cylinders, the bracket, \( S_1 \), which carries the bearing on which the beam, \( T_1 \), oscillates. This beam is connected to the pistons by the forked rods, \( U_1 \), as shown in Figs. 5, 7, and 8. The pistons are each guided so as to move vertically by a spindle, \( V_1 \), which is fixed in the socket, \( X_1 \), by the collar, \( Y_1 \), and nut, \( Z_1 \), and which works in a tube, \( a_1 \), attached to the piston, this tube being closed at the top to prevent the escape of air. The action of the pumps will be readily understood without any special explanation. The contents of the two barrels are of course discharged alternately, and in the case of the pumps used at Perpignan, the quantity so discharged at each stroke was 35 litres, or about 7.7 gallons, and the quantity discharged per hour when the pumps were driven at 60 strokes per minute was 126 cubic metres, or about 4450 cubic feet. This quantity was found sufficient to keep down the level of the water in the shafts, but to empty the shafts in a quarter of an hour the speed was increased to 100 strokes per minute. When care is taken in choosing the materials, the cupped leathers of these pumps last a considerable time without being renewed. At Perpignan the white leather used by harness makers was employed, and it was lubricated from time to time with neat's-foot oil, care being taken to prevent, as far as possible, the access of the oil to the india-rubber valves.

We must now describe the general arrangement of the plant employed, and the manner in which the work of sinking the shafts was carried on. Referring to Fig. 1, which shows a pair of shafts in course of being sunk, it will be seen that the air-pumps were placed upon a platform, \( E_2 \), supported on piles, \( F_2 \). This platform was placed on the site of the centre shaft of each pier, the outer shafts being sunk before the centre shaft was proceeded with. The pumps were driven by a six-horse portable engine, \( H_2 \), placed on the ground level, this engine being connected by a belt, \( I_2 \), to a pulley, \( J_2 \), on the shaft, \( L_2 \). At the ends of this shaft were placed the cranks, \( M_2 \), to which the air-pump beams were coupled by the rods, \( N_2 \). The air was conveyed from the pumps to the two shafts simultaneously by the pipes, \( O_2 \), and the materials required were brought on trucks, \( P_2 \), running on a tramway on the service bridge, \( A_2 \), and were discharged down the incline, \( Q_2 \).

The system of working was as follows: The cover, \( F_2 \), Fig. 2, being closed, and the air-pumps set to work, the water was forced out of the shafts, fifteen minutes sufficient for this operation. After the expulsion of the water had been effected a sufficient quantity of air had to be continually forced in to supply respiration, and make up losses by leakage, any surplus air thus intro-