being generally named the feedpipe and tube. The two little tubes proceeding from the water in the

boiler, are slender pipes open at both ends, and have external stopcocks, which are always shut except when the attendant wishes to ascertain the height of the water in the boiler, when he opens these gaugecocks and observ­ing whether water or steam issues from them, forms his judgment accordingly. F is the steam-pipe, which carries the steam away from the boiler to be applied to its useful effect in the second great member of the engine.

The second great member of the machine is placed in the enginehouse. A is the working cylinder, in which is contained the moving piston B, which communicates the force impressed on it by the steam, through the piston-rod c, and the chain *f* to the end of the great lever or workingbeam, *fa e,* which is forced up and down nround the fixed centre or iron gudgeon 6, and so raises or depresses the other end of the lever on the righthand side of the figure, and thus gives the required motion to *h, j,* the piston and rods in the barrel of the great pump, in which the work of raising water to a height or from a mine is the useful labour or duty to be performed by the engine. Returning to the cylinder at A, we have now to examine the mechanism by means of which the steam is admitted alternately above and below the piston, through the openings or ports which may be observed on the right hand side of the cylinder at top and bottom. F is the steam pipe which brings steam from the boiler to the top of the valve passages, and the pipe I conducts it down to the bottom valves and port at K, and the pipe J forming the eduction pipe, conducts the steam into the refrigerating apparatus, where it is finally condensed. In commencing to work the machine, the duty of the attendant is to allow the steam to pass freely into all the pipes, passages, and ports, F G I J, &c. filling the cylinder A, the condenser M, and passing out at an aperture O,closed by a valve called the blowoff valve; by means of which operation, the whole of the parts being filled with steam, are rendered vacuous from air, and this preparatory process is called blowing through. At G it is to be observed that there is a steam-nozzle and valve or regulator, which allows the steam to enter the cylinder at the upper part whenever it is opened, by raising the metallic cover or valve from the open­

ing of the nozzle immediately below, which it exactly fits. At K is a similar nozzle and valve called the equilibrium-valve and nozzle, which admits steam through the pipe I into the bottom part of the cylinder ; and the third or exhaustion-valve and nozzle or aperture, allows the final egress of the steam into the condenser. After the engine has been wholly filled with steam, the piston B, being at the top of the cylinder, the injection-cock N is suddenly opened, and the cold *jet* *d'eau* playing amongst the steam condenses it instantaneously, forming a vacuum into which the steam from the cylinder instantly rushes, and is in like manner annihilated, leaving the cylinder below the piston equally vacuous; and of course the steam from the boiler, on being admitted by the valve G to the upper side of the piston, instantly presses it down into the vacuum below with a force proportional to the perfection of that vacuum and to the pressure of the steam. Thus the engine makes its first stroke and raises the water of the great pump on the right of the figure, and the weight of the chain, rod, and bucket, and also a counterpoise *h,* added for the purpose of restoring the beam to its former position, which it does in the following manner. The equilibrium-valve K is opened, and the steam getting admission below the piston, as well as above it, ceases to urge it in either direction, and being thus in equilibrio, the piston woιdd remain passively in its place at the bottom of the cylinder, but the action of the counterpoise A, and the weight of the water and pump-rods in the large pump on the outside, draw down the outer end of the great lever or working-beam *f a e,* and so raise the interior end f, and the piston B to the top of the cylinder. The equilibrium valve is then closed at K, and the eduction-valve L is opened, so as to allow the steam below the piston to rush down into the condenser and leave a vacuum under the piston, into which it is immediately forced down by the pressure of the steam above A as at first, and raising water at the other end of the beam through a second stroke ; and, thus by the continual opening and shutting of the valves by the attendant, the engine performs its work. But we have still to consider the mechanism by which the valves are shut and opened, and the machine is made to shut and open its own valves.

For this purpose we have given a separate and enlarged drawing of one of the valves and its working gear :—*l i l* is a part of the air pump rod, formed of wood, called the plug-frame or plug-tree, on which are two projecting plugs of wood to work the upper and lower valves ; one of these plugs is seen at *i*. As the plug-tree moves up and down, the plugs strike the handles or working gear of the valves, and open or shut them at

the proper instant. The valves D E are called conical valves, because the small cover I) which closes the opening of each nozzle under the valve is slightly tapered down wards so as the more readily to fit its seat, and each is lifted from its seat by a small toothed rack and pinion *c* moved by a spindle from without, communicating by rods with the valve gear at r, or at Z and Y in figure 41. When the plug-frame *l i I* descends, the valve ***d*** is closed by the plug », and the valve K is shut, and the valve L in figure 41 opened by the plug Y.

Returning to figure 41, it will he seen that the condensing apparatus and its appendages are placed almost immediately under the cylinder, and to the right of it. The eduction-pipe J conducts the steam into the condensing chamber M. This chamber is placed in the middle of the cold well, so us to be wholly surrounded