The following is Dr Robison's description and explanation of Newcomen’s engine :—

Let A (fig. 23) represent a great boiler properly built in a furnace. At a small height above it is a cylinder CBBC of metal, bored very truly and smoothly. The boiler communicates with this cylinder by means of the throat or steam-pipe N. The lower aperture of this pipe is shut by the plate N, which is ground very flat, so as to apply very accurately to the whole circumference of the orifice. The plate is called the regulator or steam cock, and it turns horizontally round an axis *b a* which passes through the top of the boiler, and is nicely fitted to the socket, like the key of a cock, by grinding. The upper end of this axis is furnished with a handle *b*T

A piston P is suspended in this cylinder, and made airtight by a packing of leather or soft rope, well filled with tallow ; and, for greater security, a small quantity of water is kept above the piston. The piston-rod PD is suspended by a chain, which is fixed to the upper ex­tremity F of the arched head FD of the great lever or working beam FK, which turns on the gudgeon O. There is a similar arched head EG at the other end of the beam. To its upper extremity E is fixed a chain carrying the pump-rod KL, which raises the water from the mine. The load on this end of the beam is made to exceed considerably the weight of the piston P at the other extremity.

At some small height above the top of the cylinder is a cistern W called the injection cistern. From this descends the injection-pipe ZSR, which enters the cylinder through its bottom, and terminates in a small hole R, or sometimes in a nozzle pierced with many smaller holes diverging from a centre in all directions. This pipe has at S a cock called the injection-cock, fitted with a handle V.

At the opposite side of the cylinder, a little above its bottom, there is a lateral pipe, turning upwards at the extremity, and there covered by a clack-valve *f* called the snifting valve, which has a little dish round it to hold water for keeping it airtight.

There proceeds also from the bottom of the cylinder a pipe *p eg h,* (passing behind the boiler,) of which the lower end is turned upwards, and is covered with a valve *h*. This part is immersed in a cistern of water Y, called the hot **well,** and the pipe itself is called the eduction-pipe. Lastly, the boiler is furnished with a safety-valve called the puppet-clack, (which, for want of room, is not represented in this sketch,) in the same manner as Savory's engine. This valve is generally loaded with one or two pounds on a square inch ; so that it allows the steam to escape when its elasticity is one-tenth greater than that of common air. Thus all risk of bursting the boiler is avoided, and the pressure outwards is very moderate ; so also is the heat. For, by inspecting the table of vaporous elas ticity, we see that the heat corresponding to 32 inches of elasticity is only about 216° of Fahrenheit’s thermometer.

These are all the essential parts of the engine, and are here drawn in the most simple form, till our knowledge of their particular offices shall show the propriety of the peculiar forms which are given to them. Let us now see how the machine is put in motion, and what is the nature of its work.

The water in the boiler being supposed to be in a state of strong ebullition, and the steam issuing by the safety valve, let us consider the machine in a state of rest, having both the steam-cock and injection-cock shot. The resting position or attitude of the machine must be such as appears in the sketch, the pump-rods preponderat­ing, and the great piston being drawn up to the top of the cylinder. Now open the steam-cock by turning the handle T of the regulator. The steam from the boiler will immediately rush in, and flying all over the cylinder, will mix with the air. Much of it will be condensed by

the cold surface of the cylinder and piston, and the water produced from it will trickle down the sides, and run off by the eduction-pipe. This condensation and waste of steam will continue till the whole cylinder and piston are made as hot as boiling water. When this happens, the steam will begin to open the snifting-valve *f,* and issue through the pipe; slowly at first, and very cloudy, being mixed with much air. The blast at *f* will grow stronger by degrees, and more transparent, having already carried off the greatest part of the common air which filled the cylinder. We supposed that the water was boiling briskly, so that the steam was issuing by the safety-valve which is in the top of the boiler, and through every crevice. The opening of the steam-cock puts an end to this at once, and it has sometimes happened that the cold cylinder abstracts the steam from the boiler with such astonishing rapidity, that the pressure of the atmo sphere has burst up the bottom of the boiler. We may here mention an accident of which we were witnesses, which also shows the immense rapidity of the condensation. The boiler was in a frail shed at the side of the enginehouse ; a shoot of snow from the top of the house fell down and broke through the roof of the shed, and was scattered over the head of the boiler, which was of an oblong or oval shape. In an instant the sides of it were squeezed together by the pressure of the atmosphere.

When the manager of the engine perceives that not only the blast at the snifting-valve is strong and steady, but that the boiler is now fully supplied with steam of a proper strength, appearing by the renewal of the dis charge at the safety-valve, he shuts the steam cock, and opens the injection-cock S by turning its handle V. The pressure of the column of water in the injection-pipe ZS, immediately forces some water through the spout R. This coming in contact with the pure vapour which now fills the cylinder, condenses it, and thus makes a partial void, into which the more distant steam immediately expands, and by expanding collapses, (as has been already observed.) What remains in the cylinder no longer balances the atmospherical pressure on the surface of the water in the injection-cistern, and therefore the water spouts rapidly through the hole R, by the joint action of the column ZS, and the unbalanced pressure of the atmosphere ; at the same time the snifting-valve *f* and the eduction-valve *h,* are shut by the unbalanced pressure of the atmosphere. The velocity of the injection water must therefore rapidly increase, and the jet will dash (if single,) against the bottom of the piston, and be scattered through the whole capacity of the cylinder. In a very short space of time, therefore, the condensation of the steam becomes universal, and the elasticity of what remains is almost nothing. The whole pressure of the atmosphere is exerted on the upper surface of the piston, while there is hardly any on its under side. Therefore, if the load on the outer end E of the working-beam be inferior to this pressure, it must yield to it. The piston P must descend, and the pump-piston L, must ascend, bringing along with it the water of the mine, and the motion must continue till the great piston reaches the bottom of the cylinder ; for it is not like the motion which would take place in a cylinder of air rarefied to the same degree. In this last case, the impelling force would be continually diminished, because the capacity of the cylinder is diminished by the descent of the piston, and the air in it is continually becoming more dense and elastic. The piston would stop at a certain height, where the elasticity of the included air, together with the load at E, would balance the atmospherical pressure on the piston. But when the contents of the cylinder are pure vapour, and the continued stream of injected cold water keeps down its temperature to the same pitch as at the beginning, the elasticity of the remaining steam can never increase by