The reader muſt now be ſo well acquainted with what paſſes in the ſteam-veſſel, and with the exterior reſults from it, as readily to comprehend the propriety of the changes which we ſhall now deſcribe as having been made in the conſtruction and principle of the ſteam en­gine.

Of all places in England the tin-mines of Cornwall stood moſt in need of hydraulic aſſistſance; and Mr Savary was much engaged in projects for draining them by his ſteam-engine. This made its conſtruction and principles well known among the machiniſts and engi­neers of that neighbourhood. Among theſe were a Mr Newcomen, an iron-monger or blackſmith, and Mr Cawley a glazier at Dartmouth in Devonſhire, who had dabbled much with this machine. Newcomen was a perſon of ſome reading, and was in particular acquaint­ed with the perſon, writings, and projects of his coun­tryman Dr Hooke. There are to be found among Hooke’s papers, in the poſſeſſion of the Royal Society, ſome notes of obſervations, for the uſe of Newcomen his countryman, on Papin’s boaſted method of tranſmitting to a great diſtance the action of a mill by means of pipes. Papin’s project was to employ the mill to work two air- pumps of great diameter. The cylinders of theſe pumps were to communicate by means of pipes with equal cy­linders furniſhed with piſtons, in the neighbourhood of a diſtant mine. Theſe piſtons were to be connected, by means of levers, with the piſton-rods of the mine. Therefore, when the piſton of the air-pump at the mill was drawn up by the mill, the correſponding piſton at the side of the mine would be preſſed down by the at­moſphere, and thus would raiſe the piſton-rod in the mine, and draw the water. It would appear from theſe notes, that Dr Hooke had diſſuaded Mr Newcomen from erecting a machine on this principle, of which he had expoſed the fallacy in ſeveral diſcourſes before the Royal Society. One passage is remarkable. “ Could he (meaning Papin) make a ſpeedy vacuum under your second piſton, your work is done.”

It is highly probable that, in the courſe of this ſpeculation, it occurred to Mr Newcomen that the va­cuum he ſo much wanted might be produced by ſteam, and that this gave rise to his new principle and conſtruc­tion of the ſteam-engine. The ſpecific desideratum was in Newcomen’s mind; and therefore, when Savary’s en­gine appeared, and became known in his neighbourhood many years after, he would readily catch at the help which it promiſed.

Savary however claims the invention as his own ; but Switzer, who was perſonally acquainted with both, is positive that Newcomen was the inventor. By his principles (as a quaker) being averſe from contention, he was contented to ſhare the honour and the profits with Savary, whoſe acquaintance at court enabled him to procure the patent in 1705, in which all the three were aſſociated. Poſterity has done juſtice to the modeſt in­ventor, and the machine is univerſally called Newco­men’s Engine. Its principle and mode of operation may be clearly conceived as follows.

Let A (fig. 7.) 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 NQ. 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. This plate ts called the regulator or ſteam-cock, and it turns hori­zontally round an axis *ba* 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 air-tight 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 HK, which turns on the gudgeon O. There is a similar arched head EG at the other end oſ the beam. To its upper extremity E is fixed a chain carrying the pump-rod XL, 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 air-tight.

There proceeds alſo from the bottom of the cylinder a pipe *deg h* (paſſing behind the boiler), of which the lower end is turned upwards, and is covered with a valve *b.* This part is immerſed in a ciſtern of water Y, call­ed the Hot Well, and the pipe itſelf is callcd the Eduction Pipe. Laſtly, the boiler is furniſhed with a ſafety-valve called the Puppet Clack (which is not represented in this ſketch for want of room), in the ſame manner as Savary’s engine. This valve is generally load­ed with one or two pounds on the ſquare inch, ſo that it allows the ſteam to eſcape when its elaſticity is 1/10th 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 elaſticity, we ſee that the heat correſponding to 32 inches of elaſticity is only about 216⁰ 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 ſhut. The reſting poſition or attitude of the machine muſt be ſuch as appears in this 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