a small one) over the common engines, in which a great part of the counter weight is expended in overcoming unbalanced atmoſpheric preſſure.

Whenever the piſton P arrives at the top of the cy­linder, the valve L is shut by the plug frame, and the valves I and *v* are opened. All the ſpace below the piſton is at this time occupied by the ſteam which came from the upper part of the cylinder. This being a lit­tle waſted by condenſation, is not quite a balance for the preſſure of the atmosphere. Therefore, during the aſcent of the piſton, the valve R was ſhut, and it remains ſo. When, therefore, the valve *v* is opened, the cold water of the cistern muſt spout up through the hole o, and condenſe the ſteam. To this muſt be added the coldneſs of the whole pipe O Q\_S. As faſt as it is condenſed, its place is ſupplied by ſteam from the lower part of the cylinder. We have already remarked, that this ſucceſſive condenſation is accompliſhed with aſtoniſhing rapidity. In the mean time, ſteam from the boiler preſſes on the upper ſurface of the piſton. It muſt therefore deſcend as before, and the engine muſt perform a second working ſtroke.

But in the mean time the injection water lies in the bottom of the pipe O Q R, heated to a considerable de­gree by the condenſation of the ſteam ; alſo a quanti­ty of air has been diſengaged from it and from the water in the boiler. How is this to be diſcharged ?— This is the office of the pumps ST and XY.The capacity of ST is very great in proportion to the ſpace in which the air and water are lodged. When, therefore, the piſton S has got to the top of its courſe, there muſt be a vacuum in the barrel of this pump, and the water and air muſt open the valve R and come into it. When the piſton S comes down again in the next returning ſtroke, this water and air gets through the valve of the piston ; and in the next working ſtroke they are diſ­charged by the piſton into the pump XY, and raiſed by its piſton. The air eſcapes at Y, and as much of the water as is neceſſary is delivered into the boiler by a ſmall pipe Y y to ſupply its waſte. It is a matter of indif­ference whether the pillons S and Z. rise with the outer or inner end of the beam, but it is rather better that they riſe with the inner end. They are otherwiſe drawn here, in order to detach them from the rest and ,ſhow them more diſtinctly.

Such is Mr Watt’s ſecond engine. Let us examine its principles, that we may ſee the cauſes of its avowed and great ſuperiority over the common engines.

We have already ſeen one ground of superiority, the full operation of the counter weight. We are autho­rized by careful examination to ſay, that in the com­mon engines at leaſt one-half of the counter weight is expended in counteracting an unbalanced preſſure of the air on the piſton during its aſcent. In many engines, which are not the worst, this extends to 1/5th of the whole preſſure. This is evident from the examination of the engine at Montrelais by Bossut. This makes a very great counter weight neceſſary, which exhauſts a pro­portional part of the moving force.

But the great advantage of Mr Watt’s form is the almoſt total annihilation of the waſte of ſteam by condenſation in the cylinder. The cylinder is always boil­ing hot, and therefore perfectly dry. This muſt be evi­dent to any perſon who underſtands the ſubject. By the time that Mr Watt had completed his improvements, his experiments on the production of ſteam had given him a pretty accurate knowledge of its denſity ; and he found himſelf authorized to ſay, that the quantity of ſteam employed did not exceed twice as much as would fill the cylinder, ſo that not above one-half was unavoidably waſted. But before he could bring the engine to this degree of perfection, he had many difficulties to over­come : He incloſed the cylinder in an outer wooden caſe at a ſmall diſtance from it. This diminiſhed the expence of heat by communication to ſurrounding bo­dies. Sometimes he allowed the ſteam from the boiler to occupy this interval. This undoubtedly prevented all diſſipation from the inner cylinder : but in its turn it diſſipated much heat by the outer caſe, and a very ſenſible condensation was obſerved between them. This has occaſioned him to omit this circumſtance in ſome of his beſt engines. We believe it was omitted in the Albion Mills.

The greateſt difficulty was to make the great piſton tight. The old and effectual method, by water lying on it, was inadmiſſible. He was therefore obliged to have his cylinders moſt nicely bored, perfectly cylindri­cal, and finely poliſhed; and he made numberleſs trials of different soft ſubſtances for packing his piſton, which ſhould be tight without enormous friction, and which ſhould long remain so, in a ſituation perfectly dry, and hot almoſt to burning.

After all that Mr Watt has done in this reſpect, he thinks that the greateſt part of the waſte of ſteam which he ſtill perceives in his engines ariſes from the unavoid­able eſcape by the ſides of the piſton during its deſcent.

But the fact is, that an engine of this conſtruction, of the ſame dimenſions with a common engine, making the ſame number of ſtrokes of the ſame extent, does not conſume above one fourth part of the fuel that is con fumed by the beſt engines of the common form. It is alſo a very fortunate circumflante, that the perform­ance of the engine is not immediately deſtroyed, nor in­desed ſenſibly diminiſhed, by a ſmall want of tightneſs in the piſton. In the common engine, if air get, in, in this way, it immediately puts a stop to the work ; but although even a conſiderable quantity of ſteam get paſt the piſton during its deſcent, the rapidity of condenſa­tion is ſuch, that hardly any diminution of preſſure can be obſerved, and the waſte of ſteam is the only incon­venience.

Mr Watt’s penetration ſoon diſcovered another moſt valuable property of this engine. When an engine of the common form is erected, the engineer muſt make an accurate eſtimate of the work to be performed, and muſt proportion his engine accordingly. He muſt be careful that it be f*ully* able to execute its taſk ; but its power muſt not exceed its load in any extravagant de­gree. This would produce a motion which is too ra­pid, and which, being alternately in oppoſite directions, would occaſion jolts which no building or machinery could withſtand. Many engines have been ſhattered by the pumps drawing air, or a pump-rod breaking ; by which accidents the ſteam-piſton deſcends with ſuch ra­pidity that every thing gives way. But in moſt ope­rations of mining, the taſk of the engine increaſes, and it muſt be ſo constructed at firſt as to be able to bear this addition. It is very difficult to manage an engine that is much ſuperior to its taſk; and die easieſt way is,