formed by it. We ſhall ſee this confirmed in the cleareſt manner in ſome particular employments of the new engines invented by Watt and Boulton.

In the mean time, we ſee that the equation which we gave from the celebrated Abbé Boſſut is in every respect erroneous even for the purpoſe which he had in view. We alſo ſee that the equation which we ſubſtituted in its place, and which was intended for determi­ning that proportion between the counterweight and the moving force, and the load which would render the working ſtroke and returning ſtroke of equal duration, is alſo erroneous, becauſe theſe two motions are ex­tremely different in kind, the one being nearly uniform, and the other nearly uniformly accelerated. This being ſuppoſed true, it ſhould follow that the counter weight ſhould be reduced to one half ; and we have found this to be very nearly true in ſome good engines which we have examined.

We ſhall add but one obſervation more on this head. The practical engineers have almoſt made it a maxim, that the two motions are of equal duration. But the only reaſon which we have heard for the maxim, is, that it is aukward to ſee an engine go otherwiſe. But w*e* doubt exceedingly the truth of this maxim, and, without being able to give any accurate determination, we think that the engine will do more work if the working ſtroke be made flower than the returning ſtroke. Suppoſe the engine ſo conſtructed that they are made in equal times ; an addition to the counter weight will ac­celerate the returning ſtroke and retard the working ſtroke. But as the counter-weight is but ſmall in pro­portion to the unbalanced portion of the atmoſpheric preſſure, which is the moving force of the machine, it is evident that this addition to the counter weight muſt bear a much greater proportion to the counter weight than it does to the moving force, and muſt therefore ac­celerate the returning ſtroke much more than it retards the working ſtroke, and the time of both ſtrokes taken together muſt be diminiſhed by this addition and the performance of the machine improved ; and this muſt be the cafe as long as the machine is not extravagantly loaded. The best machine which we have ſeen, in respect of performance, raiſes a column of water whoſe weight is very nearly 2/3ds of the preſſure of the atmoſphere on the piſton, making 11 ſtrokes of six feet each *per* mi­nute, and the working ſtroke was almoſt twice as flow as the other. This engine had worked pumps of 12 inches, which were changed for pumps of 14 inches, all other things remaining the ſame. In its former ſtate it made from 121/2 to 131/2 ſtrokes *per* minute, the working ſtroke being conſiderably flower than the returning ſtroke. The load was encreaſed, by the change of the pumps, nearly in the proportion of 3 to 4. This had retarded the working ſtroke ; but the performance was evidently increaſed in the proportion of 3×13to4×11, or of 39 to 44. About 300 pounds were added to the counterweight, which increaſed the number of ſtrokes to more than 12 *per* minute. No ſenſible change could be obſerved in the time of the working ſtroke. The performance was therefore increaſed in the proportion of 39 to 48. We have therefore no heſitation in ſaying, that the ſeemly equality of the two ſtrokes is a ſacrifice to fancy. The engineer who obſerves the working ſtroke to be flow, rears that his engine may be thought feeble and unequal to its work; a ſimilar notion has long miſſed him in the conſtruction of water-mills, eſpecially of overſhot mills ; and, even now, he is ſubmitting with heſitation and fear to the daily correction of ex­perience.

It is needleſs to engage more deeply in ſcientiſic cal­culations in a ſubject where ſo many of the data are ſo very imperfectly underſtood.

We venture to recommend as a maxim of conſtruction (ſuppoſing always a large boiler and plentiful ſupply of pure ſteam unmixed with air), that the load of work be not leſs than 10 pounds for every ſquare inch of the piſton, and the counterweight ſo proportioned that the time of the returning ſtroke may not exceed 2/3ds of that of the working ſtroke. A ſerious objection may be made to this maxim, and it deserves mature conſideration. Such a load requires the utmoſt care of the ma­chine, that no admiſſion be given to the common air ; and it precludes the poſſibility of its working in cafe the growth of water, or deepening the pit, ſhould make a greater load abſolutely neceſſary. Theſe conſiderations muſt be left to the prudence of the enginneer. The maxim now recommended relates only to the best actual performance of the engine.

Before quitting this machine, it will not be amiss to give ſome eaſy rules, sanctioned by ſucceſsful practice, for computing its performance. Theſe will enable any artiſt, who can go through ſimple calculations, to fuit the ſize of his engine to the talk which it is to per­form.

The circumſtance on which the whole computation muſt be founded is the quantity of water which muſt be drawn in a minute and the depth of the mine ; and the performance which may be expected from a good engine is at leaſt 12 ſtrokes per minute of fix feet each, working againſt a column of water whoſe weight is equal to half of the atmoſpheric preſſure on the ſteam- piſton, or rather to 7,6'4 pounds on every ſquare inch of its ſurface.

It is moſt convenient to eſtimate the quantity of wa­ter in cubic feet, or its weight in pounds, recollecting that a cubic foot of water weighs *62 1/2* pounds. The depth of the pit- is uſually reckoned in fathoms of fix feet, and the diameter of the cylinder and pump is uſu­ally reckoned in inches·.

Let Q be the quantity of water to be drawn per minute in cubical feet, and f the depth of the mine in fathoms; let *c* be the diameter of the cylinder, and p that of the pump ; and let us ſuppoſe the arms of the beam to be of equal length.

1st, To find the diameter of the pump, the area of 0,7854

the piſton in ſquare feet is p2x(0,7854/144) The length of the column drawn in one minute is 12 times 6 or 72 feet, and therefore its ſolid contents is p2(72x0,7854/144) cubical feet, or p2x0,3927 cubical feet. This muſt be equal to Q; therefore p2 muſt be Q/0,3927 or nearly Qx21/2. Hence this practical rule: Multiply the cu­bic feet of water which muſt be drawn in a minute by 21/2, and extract the ſquare root of the product : this will be the diameter of the pump in inches.

Thus ſuppoſe that 58 cubic feet muſt be drawn every minute ; 58 multiplied by 21/2 gives 145, of which the