riable quantity, and make the fluxion oſ this formula

= o. This will give us y = L/2.

Now P=L+y, =L+1/2 , = 3/2L. Therefore the *whole* load on the outer end of the beam, conſiſting of the water and the counter weight, muſt be 2/3ds of the preſſure of the atmoſphere on the ſteam piſton.

We have here ſuppoſed that the expenditure is the atmoſpheric preſſure ; and ſo it is if we conſider it me­chanically. But the expenditure of which we are ſensible, and which we are anxious to employ to the beſt advantage, is fuel. Suppoſing this to be employed with the ſame judgment in all caſes, we are almoſt intitled, by what we now know of the production oſ ſteam, to ſay that the ſteam produced is proportional to the fuel expended. But the ſteam requiſite for merely filling the cylinder is proportional to the area of the piſton, and therefore to the atmoſpheric preſſure. The reſult of our inveſtigation therefore is ſtill juſt ; but the ſteam wasted by condenſation on the ſides of the cylinder does not follow this ratio, and this is more than what is ne­ceſſary for merely filling it. This deranges our calcu­lations, and is in favour of large cylinders; but this ad­vantage muſt be in a great meaſure compenſated by a ſimilar variation in the production of the ſteam ; for in ſimilar boilers of greater dimenſions the fuel is leſs advantageouſly employed, becauſe the ſurface to which the fuel is applied does not increaſe in the ratio of the capacity, juſt as the ſurface of the cylinder which waſtes the ſteam. The rule may therefore be confided in as pretty exact.

It is a ſatissactory thing to obſerve theſe reſults agree very well with the moſt ſucceſsful practice. By many changes and trials engineers have eſtabliſhed ma­xims of conſtruction, which are probably not very far from the beſt. It is a pretty general maxim, that the load of water ſhould be 1/2 of the atmoſpheric preſſure. They call this loading the engine with 71/2 pounds on the inch, and they ſay that ſo ſmall a load is neceſſary on account of the imperfect vacuum. But we have now ſeen that it is neceſſary for giving a reaſonable ve­locity of motion. Since, in this practice, w is made 1/2 or 6/12ths of P, and L ſhould be 8/11ths of P, and L is *≡ w* + p ; it follows, that the counter weight ſhould be 1/6th of P; and we have found this to be nearly the caſe in ſeveral very good engines.

It muſt be remarked, that in the preceding inveſtiga­tion we introduced a quantity M to expreſs the reſiſtances to the motion of the engine. This was done in order to avoid a very troubleſome inveſtigation. The resiſtances are of ſuch a nature as to vary with the ve­locity, and moſt of them as the ſquare of the velocity. This is the caſe with the resiſtance arising from the mo­tion of the water through the piſtons of the pumps, and that arising ſrom the friction in the long lift during the working ſtroke. Had we taken the direct method, which is ſimilar to the determination of the motion thro’ a medium which resiſts in the duplicate ratio of the ve­locity, we muſt have uſed a very intricate exponential calculus, which few of our readers would have the pa­tience to look at.

But the greateſt part of the quantity *m* ſuppoſes a motion already known, and its determination depends on this motion. We muſt now ſhow how its different component parts may be computed.

I. What ariſes from the inertia of the moving parts is by far the moſt conſiderable portion of it. To ob­tain it, we muſt find a quantity of matter which, when placed at the end of the beam, will have the ſame mo­mentum of inertia with that of the whole moving parts in their natural places. Therefore (in the returning ſtroke) add together the weight of the great piſton with its rod and chains ; the pit pump-rods, chains, and any weight that is attached to them ; the arch-heads and iron-work at the ends of the beam, and 4/9ths of the weight of the beam itſelf ; alſo the plug-beam with its arch-head and chain, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of half the length of the beam ; alſo the jack-head pump-rod, chain, and arch-head, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of the half-length of the beam. Theſe articles added into one ſum may be called M, and may be ſuppoſed to move with the velocity of the end of the beam. Suppoſe this beam to have made a six-foot ſtroke in two ſeconds, with an uniformly accelerated motion. In one ſecond it would have moved 11/2 feet, and would have acquired the velocity of three feet per ſecond. But in one ſe­cond gravity would have produced a velocity of 32 feet in the ſame maſs. Therefore the accelerating force which has produced the velocity of three feet is nearly M

1/11th of the weight. Therefore — is the first constituent of *m* in the above inveſtigation. If the obſerved velocity is greater or leſs than three feet per ſecond, this value muſt be increaſed or diminiſhed in the ſame pro­portion.

The ſecond cauſe of refiſtance, viz. the immerſion of the pump rods in water, is eaſily computed, being the weight of the water which they diſplace.

The third cauſe, the friction of the piſtons, &c. is almoſt insignificant, and muſt be diſcovered by experi­ment.

The fourth cauſe depends on the structure of the pumps. Theſe pumps, when made of a proper ſtrength, can hardly have the perforation of the piſton more than a fourth part of the area of the working barrel ; and the velocity with which the water paſſes through it is increaſed at leaſt 1/4th by the contraction (ſee Pump). The velocity of the water is therefore five times great­er than that of the piſton. A piſton 12 inches diame­ter, and moving one foot per ſecond, meets with a re­fiſtance equal to 20 pounds; and this increaſes as the ſquare of the diameter and as the ſquare of the velocity. If the whole depth of the pit be divided into ſeveral lifts, this refiſtance muſt be multiplied by the number of lifts, becauſe it obtains in each pump.

Thus we make up the value of *m ;* and we must ac­knowledge that the method is still indirect, becauſe it ſuppoſes the velocity to be known.

We may obtain it more eaſily in another way, but ſtill with this circumstance of being indirect. We found that *p* was equal to √L*m,* and conſequently *m = p2/L.* Now in any engine L and *p* can always be had ; and unleſs *p* deviates greatly from the proportion which we determined to be the beſt, the value of *m* thus obtained will not be very erroneous.