and B, and let α and ß be the lengths of the arms by which they are ſupported. It is evident, that when both piſtons have arrived at the bottoms of their cylin­ders, the capacities of the cylinders are as *a α* and *b β.* Let this be the ratio of *m* to I. Let *g h i k* (fig. 16. ) and *l m n o* be two cylinders of equal length, communi­cating with each other, and fitted with a piſton-rod *p q,* on which are fixed two piſtons *a a* and *b b,* whoſe areas are as *m* and 1. Let the diſtance between the piſtons be preciſely equal to the height of each cylinder, which height we ſhall call h. Let *x* be the ſpace *g b* or *b a,* through which the piſtons have deſcended. Let the upper cylinder communicate with the boiler, and the lower cylinder with the condenſer or vacuum V.

Any perſon in the leaſt conversant in mechanics and pneumatics will clearly ſee that the ſtrain or preſſure on the piſton rod pq is preciſely the ſame with the uni­ted energies of the two piſton rods of Mr Hornblower’s engine, by which they tend to turn the working beam round its axis.

The baſe of the upper cylinder being 1, and its height h, its capacity or bulk is 1 *h* or *h ;* and this expreſſes the natural bulk of the ſteam which formerly filled it, and is now expanded into the ſpace *b h l a a m ib.* The part *b h i b* is plainly= *h — x,* and the part l a a m is = mx*.* The whole ſpace therefore is *m x* + h *— x, = h + m x - x, or h + m - 1x.* Therefore the denſity of the ſteam between the piſtons is h/ (h + m - 1x)

Let *p* be the downward preſſure of the ſteam from the boiler on the upper piſton *b b.* This piſton is alſo preſſed up with a force = p (h/h + m - 1x) by the ſteam between the piſtons. It is therefore, on the whole, preſſed downward with a force = *p* [(1- h/(h + m - 1x)]. The lower piſton *a a,* having a vacuum below it, is preſsed downwards with a force= p[mh/(h + m - 1x)]. Therefore the whole preſſure on the piſton rod downwards is *( mb* h (

= f\1 +

*in —* I *b ∖ pb m —* I *pb*

Γf≈ι^J, =/ + Th≡Γ=T.→ +Ξ⅛ ■

*m —* I "t^ ‘

This then is the momentary preſſure on the piſton rod correſponding to its deſcent *x* from its higheſt poſition. When the piſtons are in their higheſt poſition, this preſſure is equal to *m p.* When they are in their 2 m — 1

loweſt poſition, it is *= p* ———. Here therefore is an acceſſion of power. In the beginning the preſſure is greater than on a single piſton in the proportion of *m* to 1 ; and at the end of the ſtroke, where the preſſure is weakeſt, *it* is ſtill much greater than the preſſure on a ſingle piſton. Thus, if *m* be 4, the preſſure at the be­ginning of the ſtroke is 4p, and at the end it is 7/4, almoſt double, and in all intermediate poſitions it is great­er. It is worth while to obtain the ſum total of all the

accumulated preſſures, that we may compare it with the constant preſſure on a single piſton.

We may do this by considering the momentary preſſure *p* + —-, , as equal to the ordinate GF,

+ x *m—*I

Hi, or M *c,* of a curve F *b c* (fig. 10.), which has for its axis the line GM equal to *h* the height of our cy­linder. Call this ordinate y. We have *y = p* + *p b ph*

*—p* , and y—*p=z ~~p* . Now it is plain that

*χ* ∙⅛-w *m—*I *m—*I

∕> Z> a 1 . *e*

— is the ordinate of an equilateral hyperbola,

—i- +\* *m—*i

of which *p b* is the power or rectangle of the ordinate and abſciss, and of which the abſciſs reckoned from the centre is ——- + *χ.* Therefore make GE *— p,* and draw DEA parallel to MG, and make EA =

*m—1*

= — The curve F *b c* is an equilateral hyperbola, having A for its centre and AD for its aſſymptote. Draw the other aſſymptote AB, and its ordinate FB. Since the power of the hyperbola is = p *b,* — GEDM (for GE *— p,* and GM = h) ; and ſince all the inſcribed rectangles, ſuch as AEFB, are equal to *ph,* it fol­lows that AEFB is equal to GEDM, and that the area ABFcDA is equal to the area GFcMG, which expreſſes the accumulated preſſure in Hornblower’s en­gine.

We can now compute the accumulated preſſure very

, ∕ τ AI)\

eaſily. It is evidently *— p h* X ( 1 + L AD/AE )∙

The intelligent reader cannot but obſerve that this is preciſely the ſame with the accumulated preſſure of a quantity of ſteam admitted in the beginning, and ſtopped in Mr Watt’s method, when the piſton has descended through the mth part of the cylinder. In considering Mr Hornblower’s engine, the thing was preſented in ſo different a form that we did not perceive the analogy at firſt, and we were ſurpriſed at the reſult. We could not help even regretting it, becauſe it had the appearance of a new principle and an improvement : and we doubt not but that it appealed ſo to the in­genious author ; for we have had ſuch proofs of his liberality of mind as permit us not to ſuppoſe that he ſaw it from the beginning, and availed himſelf of the difficulty of tracing the analogy. And as the thing may mislead others in the ſame way, we have done a service to the public by ſhowing that this engine, ſo coſtly and ſo difficult in its conſtruction, is no way ſuperior in power to Mr Watt’s simple method of stop­ping the ſteam. It is even inferior, becauſe there muſt be a condenſation in the communicating paſſages. We may add, that if the condenſation is performed in the cylinder A, which it muſt be unleſs with the permiſſion of Watt and Boulton, the engine cannot be much ſuperior to a common engine ; for much of the ſteam from below B will be condenſed between the piſtons by the coldneſs of the cylinder A; and this diminiſhes the