cylinder on the moment when the steam is about to enter on the opposite side, that the full power of the steam can alone be obtained in useful effect. A perfect condenser must, therefore, have much greater capability than that of merely condensing the steam as fast as the boiler is capable of evacuating it, or the engine of passing it through.

We have insisted the more strongly on this point, inasmuch as it is here principally that power is to be gained at smallest expense. Many other modes of con­densation have been tried besides condensation by jet, and without effect. Newcomen tried to condense by cold water outside his condenser ; so did Savary, so did Watt, so did Cartwright, so did Napier on the Clyde, so did Stevens of Hoboken in America, so did Trevi- thic, Symington, Mills, and many others; but without success: for though they all succeeded so far as, by hav­ing cold water on the outside of the vessels, to condense the steam in the inside, yet this condensation by con­tact, however perfect in quantity, has always been slower in time than condensation by jet, and has conse­quently failed in developing the full power of the engine. In this list we have not mentioned the name of the ingenious and enterprising Mr Hall of Basford, as he still continues to persevere against the difficulty of in­troducing successfully into use the system which has baf­fled the efforts of his predecessors ; and perhaps his attempt may be attended with a higher degree of suc­cess than theirs.

It appears difficult to assign a volume to the con­denser which shall give it most efficiency. We have seen efficient condensers from one-fourth of the volume of the cylinder up to its full size. One-half the volume of the cylinder appears to be a size sufficiently con­venient and effective.

The proper distribution of the water forming the jet, throughout the whole volume of the condenser, seems the most important point of efficacy in the condenser. Some engineers accomplish this by allowing the water to rise from the bottom of the condenser in a *jet d'cau,* which striking the top, falls down in a shower, filling the whole condenser; others make this shower radiate in all directions from a perforated horizontal pipe ; and a third most effective method is, to spread out the jet in a thin film or sheet, like a waterfall, through which the steam is compelled to pass. In marine engines, the water is permitted to flow into the condenser through a pipe in the ship's side, regulated by a cock.

Much has been said regarding the perfection of the vacuum found in the condenser of a steam-engine, espe­cially a marine engine. It does not appear to bo known that a vacuum may be too good. We hear it boasted every day by rival engineers that their engines have the best vacuum. Some boast their vacuum at 27 inches, others at 28, others at 29, some at 30, and at last an engineer appears who boasts a vacuum of 301/2 inches. It is to be regretted that time and talent should be thus wasted. It is a fact of great importance, confirmed by experiment and by practice, that a vacuum may be too good, and become a loss instead of a gain. The truth is simply this, and should be known to every engineer : *If the barometer stand at* 29⅜ *inches, the standard of this country, the vacuum* in the condenser, *is* Too good *if it raise in the barometer more than* 28 *inches of mer­cury.* This important truth is incontrovertible, and is practically exhibited every day.

The following is a simple proof of this doctrine, di­vested as far as possible of a technical form, and put in the shape of an enquiry into the best state of a con­denser.

Let *t* = the caloric of water of 1°.

c = the constituent caloric of water in the state of steam.

*e* ≡ the total force of steam in the boiler in inches of mercury ;

and *x =* the elastic force of steam at the temperature of best condensation which we seek to dis­cover.

Then from the law which connects the elastic force of steam with temperature, as already determined in the article Steam, it follows, that in the case of maximum effect, or the temperature of best condensation,

*t/c = x/e* that is *x = et/c*

now *c=z* 1000, and if the steam in the boiler be at 5 lbs. above the atmosphere, or if *e =* 40 inches of mercury, and *t —*1,

*x =* 40/1000 = 0.04

Again, if the steam be at 71/2 lbs. = 45 inches,

Again, if the steam be at 10 lbs. = 50 inches,

Hence, we find that the best elasticity or temperature in the condenser depends on the elastic force of the steam in the boiler.

With steam of 5 lbs. in the boiler, the elasticity of maximum effect in the condenser is at 93° of Fahrenheit, and the best vacuum in the barometer is 28. With steam of 71/2 lbs. in the boiler, the elasticity of maximum effect in the condenser is 95° of Fahrenheit, and the best vacuum in the barometer is 27.8. With steam of 10 lbs. in the boiler, the elasticity of maximum effect in the condenser is 97", and the best vacuum in the baro­meter is 27.5. In like manner it would be found that with steam of 50 lbs. in the boiler, worked expansively, as in Cornwall, the best vacuum in the condenser would be about 26° on the barometer.

It is hoped, therefore, that engineers will not in fu­ture distress themselves, at finding the vacuum of their condenser much less perfect than the vacuum of others who have obtained 30, and 301/2 inches, at so great a loss of fuel and power. To obtain a vacuum of 291/2 with the weather-glass at 29.75, and steam at 71/2 lbs., would be to sacrifice four horse power out of every hundred. In a day when the barometer is as low as 281/2 inches, the vacuum in the condenser should indicate 2G.8.

In speaking of the vacuum in the condenser, it would save much ambiguity to indicate the elasticity merely of the gas in the condenser. Thus, if the barometer stands without at 291/2, and the barometer of the condenser at 28, it might be stated that the steam in the condenser stands at 11/2, being the point of maximum effect; and the indication would at all times convey more precise information.

An air-pump is an appendage rendered necessary by the condenser, and especially by condensation by *jet d'eau.* Ordinary water contains about 5 per cent, of air and other gases, which become disengaged in the condenser, and must be withdrawn, to maintain the vacuum. Hence the air-pump, which is also used to withdraw the water which accumulates in the conden­ser. A valve between it and the condenser is called the foot valve ; and a valve at the exit from the top of the air-pump is called the discharge valve. They are thus arranged : S the cylinder, C the condenser, A the air-pump, F the foot valve, and D the discharge valve.