the descent of the piston, nor exceed what corresponds to this temperature. The impelling or accelerating force therefore remains the same, and the descent of the piston will be uniformly accelerated, if there be not an increase of resistance arising from the nature of the work performed by the other end of the beam. This circumstance will come under consideration afterwards, and we need not attend to it at present. It is enough for our present purpose to see, that if the cylinder have been completely purged of common air before the steam-cock was shut, and if none have entered since, the piston will descend to the very bottom of the cylinder. And this may be frequently observed in a good steam-engine, where every part is airtight. It sometimes happens, by the pit-pump drawing air, or some part of the communication between the two strains giving way, that the piston comes down with such violence as to knock out the bottom of the cylinder with the blow.

The only observation which remains to be made on the motion of the piston in descending is, that it does not begin at the instant the injection is made. The piston was kept at the top by the preponderancy of the outer end of the working-beam, and it must remain there till the difference between the elasticity of the steam below it and the pressure of the atmosphere exceed this preponderancy. There must, therefore, be a small space of time between the beginning of the condensation and the beginning of the motion. This is very small, not exceeding the third or the fourth part of a second ; but it may be very distinctly observed by an attentive spectator. He will see, that the instant the injection-cock is opened, the cylinder will sensibly rise upwards a little by the pressure of the air on its bottom. Its whole weight is net nearly equal to this pressure ; and instead of its being necessary to *support* it by a strong floor, we must *keep it down* by strong joists loaded by heavy walls. It is usual to frame these joints into the posts which carry the axis of the working-beam, and are therefore loaded with the whole strain of the machine. This rising of the cylinder shows the instantaneous commencement of the condensation ; and it is not till *after* this has been distinctly observed, that the piston is seen to start, and begin to descend.

When the manager sees the piston as low as he thinks proper, he shuts the injection-cock, and opens the steam cock. The steam has been accumulating above the water in the boiler during the whole time of the piston’s descent, and is now rushing violently through the puppet clack. The moment, therefore, that the steam-cock is opened, it rushes violently into the cylinder, haring an elasticity greater than that of the air. It therefore immediately blows open the snifting valve, and allows (at least) the water which had come in by the former injection, and what arose from the condensed steam, to descend by its own weight through the eduction-pipe *d c g h,* to open the valve *h,* and to run out into the hot well. And we must easily see that this water is boiling hot ; for while lying in the bottom of the cylinder, it will condense steam till it acquire this temperature, and therefore cannot run **down** till it condenses no more. There is still a waste of steam at its first admission, in order to heat the inside of the cylinder and the injected water to the boiling tem­perature ; but the space being small, and the whole being already very warm, this is very soon done ; and when things are properly constructed, little more steam is wasted than what will warm the cylinder; for the eduution-pipe receives the injection water even during the descent of the piston, and it is therefore removed pretty much out of the way of the steam.

This first puff of the entering steam is of great service : it drives out of the cylinder the vapour which it finds there. This is seldom pure watery vapour : all water

contains a quantity of air in a state of chemical union. The union is but feeble, and a boiling heat is sufficient for disengaging the greatest part of it by increasing its elasticity. It may also be disengaged by simply removing the external pressure of the atmosphere. This is clearly seen when we expose a glass of water in an ex­hausted receiver. Therefore the small space below the piston contains watery vapour mixed with all the air which had been disengaged from the water in the boiler by ebullition, and all that was separated from the injection water by the diminution of external pressure. All this is blown out of the cylinder by the first puff of steam. We may observe in this place, that waters differ exceedingly in the quantity of air which they hold in a state of solution. All springwater contains much of it : and water newly brought up from deep mines contains a great deal more, because the solution was aided in these situa­tions by great pressures. Such waters sparkle when poured into a glass. It is therefore of great consequence to the good performance of a steam-engine to use water containing little air, both in the boiler and in the injec­tion cistern. The water of running brooks is preferable to all others, and the freer it is from any saline impregna­tion it generally contains the less air. Such engines as are so unfortunately situated that they are obliged to employ the very water which they have brought up from great depths, are found greatly inferior in their performance to others. The air collected below the piston greatly diminishes the accelerating force, and the expulsion of such a quantity requires a longcontinued blast of the best steam at the beginning of every stroke, lt is advisable to keep such water in a large shallow pond for a long while before using it.

Let us now consider the state of the piston. It is evident that it will start, or begin to rise, the moment the steam-cock is opened ; for at that instant the excess of atmospherical pressure, by which it was kept down in opposition to the preponderancy of the outer end of the beam, is diminished. The piston is therefore *dragged* upwards, and it will rise even although the steam which is admitted be not so elastic as common air. Suppose the mercury in the barometer to stand at 30 inches, and that the preponderancy at the outer end of the beam is 1/9th of the pressure of the air on the piston, the piston will not rise if the elasticity of the steam be not equal to 30—50/9, that is, 26.7 inches nearly ; but if it be just this quantity, the piston will rise as fast as this steam can be supplied through the steam-pipe, and the velocity of its ascent depends entirely on the velocity of this supply. This observation is of great importance ; and it does not seem to have occurred to the mathematicians, who have paid most attention to the mechanism of the motion of this engine. In the mean time, we may clearly see that the entry of the steam depends chiefly on the counter weight at E: for suppose there was none, steam no stronger than air would not enter the cylinder at all ; and if the steam be stronger, it will enter only by the excess of its strength. Writers on the steam-engine (and even some of great reputation) familiarly speak of the steam giving the piston a push ; but this is scarcely possible. During the rise of the piston the snifting valve is never observed to blow; and we have not heard any well-attested accounts of the piston-chains ever being slackened by the upward pressure of the steam, even at the very beginning of the stroke. During the rising of the piston the steam is, (according to the common conception and manner of speaking,) *sucked in,* in the same way that air is sucked into a common syringe or pump when we draw up the piston ; for in the steam-engine the piston is really drawn up by the counterweight. But it is still more sucked in, and requires a more copious supply, for another reason. As the piston descended only in consequence of the inside