sider, in the first instance, its mechanism and management, and afterwards, how far it may require to he modified in order to acquire the advantage of condensation.

*The high-pressure non-condensing steam-engine.*

The elastic force of steam is a phenomenon with which we become acquainted very early in life. We see that when water boils furiously in a kettle or caldron which is closely fitted by a lid or cover, it has a tendency to raise it up or drive it off with considerable force ; and that the steam, collecting in the upper part of the vessel, rushes with considerable velocity out of any crevice or pipe which communicates with the open air.

The force of the steam which is thus issuing from the spout of a kettle or crevice in the cover of a caldron is comparatively slight; and the steam which thus rises from boiling water is called low-pressure steam. But if we stop up the spout and close the cover with accuracy, so as to confine the steam within the kettle or boiler, the water will become hotter and hotter, and the steam stronger and stronger, until it will either force up the cover with violence, or altogether burst asunder the sides of the boiler. In this confined and heated state the steam acquires, from its properties, the descriptive appellation of high-pressure steam.

Engineers are in the habit of reckoning the force of high-pressure steam by a very simple expedient. They place a weight such as W (Fig.

47,) upon a hole on the top of the boiler. This hole being square, and an inch in length and breadth, and the weight being equal to one pound, when the steam is strong enough just to blow the weight off the hole, they call that *steam of an elastic force equal to one pound on the square inch.* They then place a weight of two pounds upon this hole of a square inch, and continue the heat until the steam just blows it off, and that is called *steam of the pressure Of two pounds On the square inch.* And, in like manner, when steam is confined and heated until it acquire force enough to blow weights of three, four, five, fifteen, or fifty pounds off an aperture of not more than a square inch in extent, that is technically called *steam of the elastic pressure Of three, four, five, fifteen, and fifty pounds on the square inch.* It is difficult to say whether there be any limit to the elastic force which steam may acquire from continued heat and confinement : it is known to he even ns powerfully elastic as gunpowder, and pressures of one thousand pounds an inch have been produced.

The pressures generally adopted for high-pressure engines are from fifteen to one hundred and twenty pounds on the inch. Of course, when there is a given pressure on any one inch of the surface of a boiler, there will be the same on every other inch of surface ; and if the aperture under the weight be any number of times greater than one inch, it will just require so much the more weight to keep it closed. The standard by which the pressure is reckoned and calculated is, however, always the square whose side is one inch.

By placing a movable weight upon an aperture of given size in this manner, the engineer not only ascertains the amount of the elastic force of the steam tending to burst the boiler, but he also constructs a *safety-valve* by which to avert the danger of an explosion of the boiler.

Dr Desaguliers relates a circumstance which happened very early in the history of the steam-engine, when, for want of proper precautions of this nature, “ the steam burst the boiler with a great explosion, and killed the poor man who stood near, with the pieces that flew asunder, there being otherwise no danger, by reason of the safety-valve being made to lift up and open upon occasion.” Now, a given weight of lead or iron laid on a hole in the top of a boiler so as to close it, is a sufficient and common form of safety valve ; for when ever the pressure of the steam becomes sufficient to raise the weight, it escapes through the opening into the air without doing any mischief. A largo weight of lead, simply placed on the opening, is a very common and simple mode of providing for the safety of the apparatus.

But this plan becomes inconvenient when the pressure is high and the weight great, because it then becomes so high as to be unsteady; and, in order to remedy the in convenience, what is called a *valve* is used, separate from, and in addition to, the weight,

as shown in the accompanying dia

gram, fig. 48. A valve-seat *a b,*

formed of cast brass, is fixed in the

aperture, and is accurately fitted

by the valve itself c *d,* the edges

of which, at c and *d,* are carefully

turned and tapered, so as to fit the

neck of *a b,* and ground in its place

with emery powder, which makes it perfectly steam-tight. A spindle protrudes downwards from the valve through a guide which keeps it in a straight line, and pre vents it from falling on one side of the valve after having been raised. This same spindle, rising upwards, carries upon a crossbar a series of large cylindrical weights which may be increased or diminished in number as the case may require.

It is a practical fault of this valve that the tall erect spindle may easily become bent or injured by accident, and also that the weight upon it may too easily be handled, so as wantonly to be increased; hence, a safety valve, with an internal weight, has been contrived in the following shape. A con

ical valve is placed in its

seat in every respect as

formerly, only the spindle

does not rise up but

hangs down among the

steam, terminating in a

chain and weight.

In all of these modifi cations the weight on the safety-valve becomes large and cumbrous when the pressure is high ; and a contrivance was devised very early in the history of steam to ob­viate the inconvenience of this plan, under the name of the lever safety-valve. Instead of placing a great series of weights on the valve itself, a single weight is hung on the end of the longer arm of a lever so as to produce an effect proportional to its distance, and this lever being graduated, shows the amount of the effect which is thus produced. In the figure, the valve, valve-rod, and spindle are all arranged as for

merly ; but a lever *g k*

rests on the top of a small

hemispherical button on

the valve; and the one end

*g* being a fulcrum, the

weight W is suspended by a ring from any point of the lever. When, at the point 4, as in the figure, its effect on the valve is four times as great as if directly upon it. The effect of the lever’s own weight will, in this case, be