A mass of fusible metal placed at the bottom of the tube will become fluid very nearly as soon as the flue takes the temperature of its fusion. To show when the metal at the bottom of the tube becomes fluid, a stone is at­tached with a cord and weight, or with a lever and weight. The weight and longer arm of the line, de­scending, may be made to ring a bell, or turn a cock, or open a valve, permitting just enough of steam to issue, to give the alarm. A projection on the lower end of the rod prevents it from being drawn from the metal until this latter is fused, and by widening the lower part of the tube the metal is kept from being drawn out by the rod. BB, fig. 246, is part of the boiler plate ; *m* the fusible metal in a tube ; *r* the rod to which it is, ns it were, soldered, and when the metal melts, the weight W will descend and give the alarm, either by striking a bell, opening a steam whistle or trumpet, or raising a valve. This apparatus of Pro­fessor Bache’s is a valuable addition to the mechanism of steam.

The common alarms, the steam whistle, and the steam trumpet, may be made to give noisy in­dications of an excessive pressure of steam. A small box on the steam chest is to cover a lock­up safety-valve, loaded at the highest pressure the boiler should endure. On this box is to be placed a steam whistle or a steam trumpet, so that an alarming noise will be the consequence of any excessive pressure ; for the steam issuing through the aperture of the instru­ment will give it voice with an intensity proportioned to the pressure.

In figs. 247, 248, a steam whistle is represented. A *a* is a tube leading from the boiler ; in it is a stopcock. On the top of the tube is a hollow piece 66, surrounded by a thin cup cc, and carrying, by a pillar fixed on its top, another inverted cup E. When the stopcock is opened/the steam enters the cup *cc* through holes in the foot of the hollow piece *bb*, and rushing out at the nar­row orifice *dd,* between the cup c and hollow piece, strikes on the edge of the cup E, and produces an ex­ceedingly loud and shrill sound. No stopcock is, of course, required when this alarm is placed on the box of a safety-valve, in the manner stated nbove.

*On the Proportions of Boilers.—*That a boiler when constructed shall be capable of generating a sufficient quantity of steam, without burning an excessive quantity of fuel, without incurring an excessive expense in con­struction, and without endangering the durability of the metal, subject to the intense heat of the fire, is a prob­lem of engineering of some difficulty, especially when it is attempted to obtain a maximum of effect at a mini­mum of means, whether the minimum desired be that of weight, bulk, or expense. There are some simple rule\* deducible from the best practical results that have come under our examination.

The quantity of water to be evaporated in a common steam-engine, is generally reckoned at one cubic foot an hour for each horse power. But if allowance be made for accidental leakage of the boiler, for blowing off at the safety-valves, for priming, and other accidents, an addition of one-fifth part may be provided for. The standard for calculating is, however, one cubic foot of water for each horse power.

The area of the grating in the furnace on which the fuel is laid, is an important element of efficiency in a steam-engine boiler. Here practice somewhat varies. The bars are generally about one inch wide on the top and the interstice from 1/4 to 1/2 an inch. These apertures supply oxygen to the fuel, and regulate the combustion, which is only perfect when the supply of air to the incandescent fuel is ample. It is found that a supply of air, such as will pass through each square foot of the area of the grate of the fire, is adequate to the effectual combustion of so much fuel as will, in a proper boiler, evaporate one cubic foot of water an hour, and supply one horse power in a steam-engine. Thus, a fire grate 6 feet long by 6 feet wide, containing 6 × 6 = 36 square feet, is found to give an ample sup­ply of air for the combustion of as much fuel as will supply an engine of 36 horse power, evaporating 36 cubic feet of water an hour. But although this is a safe and excellent proportion for ordinary practice, yet it has been found, that with a quick draught a smaller amount of fire surface is adequate to the effect required. So low a proportion of fire grate as 2/3ds of a foot, and even 1/2 of a square foot to each horse power, has been employed by eminent engineers, and has succeeded, while others recommend a much larger allowance even than one square foot. It is certain that the larger area of fire-grate is conducive to economy and durability. The standard of surface is, therefore, to be taken at the most desirable proportion, and only to be deviated from where limited space, as in locomotive-engine and steam-ship boilers, renders this rule inapplicable. This standard is one square foot of area of grate for each horse power.

The next condition on which the success of the boiler problem depends, is the extent of the surface of the boiler acted on by the fire, so as to apply its heat to the water. This is also a subject on which practice varies widely ; so widely indeed as from 8 square feet to 36 square feet per horse power. Eight square feet re­quire a clean thin copper boiler, and a very direct impact of the hottest part of the flame, with the loss of a portion of the heat ; but 36 square feet, on the con­trary, imply the possession of profuse space, and a desire to economise to the very utmost the powers of the fuel. The standard of practical effect with the usual iron boilers, in ordinary circumstances, is fifteen square feet of heating surface for each horse power.

Of this surface, about one-third is horizontal, and two- thirds are vertical surface ; and of these, the horizontal surface is imagined to be twice as effective as the verti­cal surface. Arguing on this supposition, some have given it as a rule to calculate *each vertical foot as only half an effective foot* of heating surface, and so to make nine or ten square feet of effective heating surface the standard of boiler power. But this rule, though giving the same result as the former, proceeds on a suppo­sition not yet established, and which does not always coincide with the fact. It will be easily seen that 5 feet of horizontal surface, added to 10 feet of vertical surface, making, according to the one mode of calcula­tion, 15 feet of surface, divided in the proportion of two- thirds vertical and one-third horizontal surface, forms an exact equivalent to the other mode—of reckoning the 10 feet of vertical surface only equal to 5 effective feet of surface, and adding to the said 5 effective feet of surface the 5 feet of horizontal surface, making in all 10 feet called effective feet of heating surface..

The next essential consideration is the area of the chimney and flues. It has already been given as a standard, that the fire grate should have the area of one square foot for each horse power. Now, this area for the admission of air should be accompanied with a suffi­cient passage to carry off’ the gaseous products, and hot