ant. These two gauges are shown in the accompanying drawings.

Fig. 231. Fig. 232. Fig. 233.

In figs. 231,232, G is the window of very thick glass, set in a brass frame with a cement of red and white lead, after which, the frame is firmly bolted on the front of the boiler, at the aperture to which it is fitted. *gg,* fig. 233, is the tube glass-gauge, communicating with the water below and the steam above. There are shown in the same figure two other kinds of gauges. W*w* is a tube open at both ends, regulated at the external termination by a stop­cock, but passing into the boiler, so that the other end descends below the surface of the water in the boiler. Another gauge-tube S*s* is of similar construction, and is placed higher up, so that the end S is open in the boiler among the steam. By this means the engineer has it always in his power, on opening these cocks suc­cessively, to determine whether there be an excess or deficiency of water in the boiler ; for, the orifices of the tubes in the inside of the boiler are adjusted in such manner, that when the water is at the proper level, it covers the orifice of the lower one, but does not reach the orifice of the upper one. In this state steam will issue from the upper pipe, and water from the lower pipe ; but if it should be found that water issues from both, the water is too high, and if steam from both, there is too little water in the boiler. Another species of gauge is also shown in figs. 231, 232. It consists of a float A resting on the surface of the water in the boiler, to this is attached a chain, which passes over a pulley C, and carries at its other end a counterweight R. The pulley is fixed on an axle DD, which passes through the boiler and carries on its outer end an index. The index shows, by means of a dial-plate, the state of the water in the boiler.

By these means, a careful attendant may always ascer­tain the state of the water in the boiler, with sufficient ease to enable him to regulate the supply of water thrown in, or the feed of the water to the boiler, so as to replace, with cold water, the deficiency occasioned by the con­tinual conversion of the water into steam. But if by any cause the attention of the keeper should be directed from the examination of the state of the boiler, it will gradually become emptied, and will either be ex­ploded or burned out, from being made red hot. Va­rious contrivances have been attempted for the pur­pose of rendering boilers automatic; so that the very fact of the water becoming low in the boiler should of itself be the means of furnishing a fresh supply. The manner of accomplishing this is somewhat different in different circumstances ; but the following methods are the most common and the best.

A self-regulating feeding apparatus may be adapted to the boiler of a low-pressure steam-engine, in the following simple way. The water that is to feed the boiler, is to be conducted into a reservoir  *v r,* of some 18 inches dia­meter, having a long pipe to lead down from it to the bot­tom of the boiler. The top of this pipe is closed by a ta­pered plug which hangs by the rod *v* *r*, from a lever supported at *f* and having two weights, one at either end, W and *w.* The larger weight W, of stone or cast iron, rests on the surface of the water, in the boiler, and is coun­terpoised by a smaller weight *w* in such a manner, that a part of the weight W is sustained by the water ; therefore, whenever the water in the boiler falls be­low the proper point, the weight W preponderates, the arm L of the lever is pulled down by the wire W L, which passes steam- tight through a stuffing box at *s,* the end of the lever *l* ascends, and the valve *v* being withdrawn, allows the water to descend through the open end of the pipe, and replenish the boiler ; and after a time, when the supply has become sufficient to raise the water to its proper level, the weight W, and the end L of the lever, are raised, the opposite end *l* is depressed, and the valve *v* once more closed, until a further supply has become necessary, when it is given again in the same manner.

This self-acting valve is sufficiently efficient when the boiler is of low pressure, or when the reservoir is more than two feet two inches high above the surface of the water for every pound of pressure per square inch of the boiler. But it very often happens that the boiler is fed with cold water in a different manner : a force pump is attached to the steam-engine, by which each stroke of the engine sends back into the boiler a quantity of water equivalent to that which has been evaporated out of the boiler in forming the volume of steam which has given to the engine motion through that stroke by which the pump has been impelled. Now, if the size of the pump were accurately proportioned, so as to replace in the boiler at each stroke the precise quantity of water evaporated from it in the same interval of time by the engine, it is evident that no further provision for adjustment would be necessary. This quantity is exactly one cubic inch of water for each cubic foot of atmospheric steam given to the engine, or one cubic foot = six gallons per horse-power per hour. But the evaporation of the water to a steam- engine is not thus uniform, nor so easily determined. The variations of intensity in the fire cause steam more or less dense to pass over into the engine ; the steam now raises the safety-valve and escapes into the air, and now falls below the standard; the boiler, now tight, and again allowing water and steam to leak through its joints, consumes a greater or a less quantity of steam ; and thus, even with this automatic supply, there is required a regulating or governing power. A stopcock is attached to a pipe by which the feed-pump obtains its supply of water to force into the boiler, and so, by impeding or facilitating the passage of water into the boiler, the attendant may regulate the supply. We have said that this cock is attached to the pipe by which the pump obtains its supply of water, and not to the pipe by which the same pump forces its contents into the boiler it is about to supply ; and we have done so for this reason, that it is dangerous to apply such a stopcock on the pipe between the pump and the boiler, because, if the force-pump become once filled with water, and be forced down by the engine when the stopcock is wholly or nearly closed, the pipe will be burst from the incom- pressibility of the water, unless its valves should be so leaky as to allow the water to pass back into the reser­voir from which it bas been withdrawn. As however, it