that this cone A represents the power of the injector. The steam, in issuing from this cone at a high velocity (as we demonstrated before), is condensed by the water flowing in through C, and its velocity is imparted to the water in the cone B. The combined stream of water and steam are then forced into the receiving cone D, where the force of water issuing from the boiler is met and overcome.

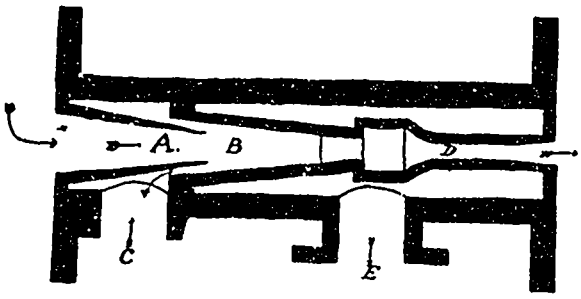

Diagram 4

The sectional areas of the cones A and D are in proportion to each other as 2·0106 is to 0·7854 (at their respective smallest diameters.)

When the water comes in contact with the steam at the outlet cone A, it is propelled along by the concentrated steam, and the water (which as you all know is nearly incompressable) is projected into the delivery cone D, and thence into and through the feed check valve and into the boiler, by the impulsive force of the steam, due to its great velocity and elasticity. To sum up the principle of the injector in a short way: It is an instrument which (by the proper proportioning of its jets) takes advantage of the superior velocity with which steam issues from a boiler, as compared with water, and is capable of producing a combined jet of steam and water, flowing through an orifice or jet at a greater velocity than that at which an opposing stream of water can flow from the same boiler which supplies the steam to operate it. All injectors (and their name is legion) work on this same principle, the only difference, so far as I know, being that some are water-lifting and some non-lifting, and some are both lifting and forcing combined.

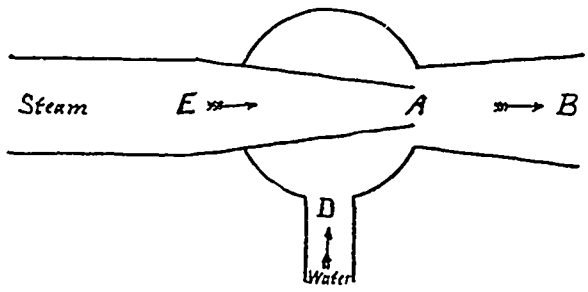

Diagram 3

In Diagram 3 we have a sketch of a lifting jet. Steam enters the pipe at E and issues at the nozzle A, and forces the air out of chamber B to the atmosphere; the air in suction pipe D immediately commences to expand itself into chamber round A, and this action goes on until there is a partial vacuum in D, and the water rises to A by the pressure of the atmosphere acting on its surface, and at A the steam is condensed, and the action takes place which has been before explained. For an injector to lift its feed water, it becomes necessary for the opening B to have considerable more area than A, as, if it were not, it would be impossible to produce a vacuum in D.

Figure 2 represents a non-lifting jet, and it will be observed that the area of the outlet of cone B is somewhat smaller than the steam cone A, and if steam be turned on at C, and issues at A, it will expand and fill the cone B, causing a pressure to back up into suction pipe C. So that with injectors of this type it is necessary for the feed water to be forced into the injector under a head, either by gravitation or from the water-works mains.

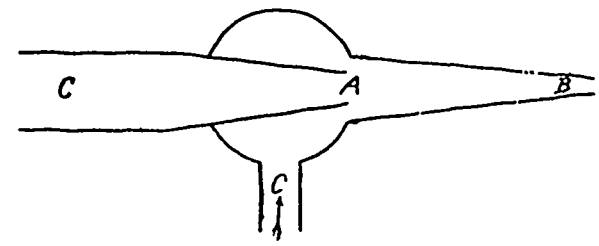

Diagram 2.

We will now briefly look into a few of the causes of failure of injectors to work.

Injectors often throw off when the temperature of water supplied to them exceeds 130° to 150°: and this is due to the fact that underneath these conditions it requires such a large quantity of water to condense and concentrate the steam issuing from nozzle A, that the velocity imparted to the water is not sufficient to overcome the opposite flow from the boiler, and, consequently, the injector kicks.

Sometimes injectors work along smoothly for hours, days, months and even years, and then all at once refuse to do their duty.

This may be due to one of several causes.

I have no doubt that some of those present have fed boilers with injectors which took their feed water from a barrel or tank, and when you have started it, and it has worked for a few minutes, and then thrown off, or kicked, as we call it, you find your water in feed tank is hot; but you say the injector started to work at first, and why not continue to do so? Simply because the injector itself may have been quite cool when it was started, and therefore it assisted in condensing the steam from nozzle A, but as it became heated gradually, and the feed water itself was too hot to cool the steam, the injector kicked, and keeps on kicking until you reduce the temperature of feed water. Again, the feed water in the tank may not have been all of the same temperature, and as the suction pipe reached down near the bottom, it worked all right until it commenced to take the water of a higher temperature which was in the top of tank when it was started, and it kicks again. The injector will always throw off when the volume of steam feeding it is not enough to give it the required velocity to overcome the opposing steam or flow from the boiler. Here too we may be inclined to say, "well, but the steam worked the injector when it was started," and that may have been so; but we must remember that the water that the injector has forced into the boiler has been, comparatively speaking, cold, and this has reduced the velocity of steam from the cone A, and the volume of water entering through feed pipe has remained constant as when the injector was started, and the necessary speed is therefore not imparted to the water with the result that injector throws off.

Then in addition to the above causes of failures, there are old-timers, well known to all engineers, viz., leaky suction pipe, no water in tank, end of the supply choked up, foreign matter in the jets of injector, hot suction pipe, etc., etc., and I have even known a check valve put on a pipe wrong end to, to prevent an injector from working. I have also known the jets to become coated with a deposit to such an extent as to alter the proportion of areas so that they would not work.