weighed. This was done at several points in each deposit, and having already determined the extent of the deposit it was an easy matter to estimate the ore in sight in each.

By this method it is believed that a very reliable estimate of the quantity of ore in the lake was obtained; certain it is that the estimate made by the writer differs materially from those that had been made by other means. It must be added in conclusion, that this lake-mine is something like the widow's cruse of oil of which we read in Holy Writ—the supply is being constantly renewed. Vast amounts of iron still exist in the surrounding sands. Vegetable acids are formed from the decay of each year's vegetation, and each year the drainage carries into the lake and deposits there a large amount of iron. This is no mere theory; one can actually see the deposition of the ore along the margin, and, moreover, it is found in actual working; if a certain spot be worked out it will in a few years again yield ore in paying quantity.

HOW TO MAKE A SIMPLE STEAM CALORIMETER.*

BY M. THOMAS PULLAN.

In these latter days of keen competition, it is desirable to take every advantage, and to correct all sources of loss from whatever cause. The fact that many boilers, particularly when forced or overworked, produce wet steam, is well known, but the amount of this moisture, or even the fact of its existence, is not always easily determined.

Many engineers have not access to the expensive instruments for determining the same, and in view of this last fact, I herewith submit a short description, with sketches, of a very simple "throttling" calorimeter, which any engineer may construct for himself, at the nominal expense of a few pipe fittings and a steam thermometer, which may be purchased for a couple of dollars.

Fig. 1 shows the calorimeter assembled in position for use, connected to a steam pipe; when possible, it should be connected to a vertical pipe, as shown. The body of the instrument may be made of a 1-inch T fitting, into the top of which is screwed the bushing, *B* (Fig. 2); into the bushing, *B*, is fitted the thermometer tube, *T*, which is made of brass, turned down, as shown, sufficiently thin to readily

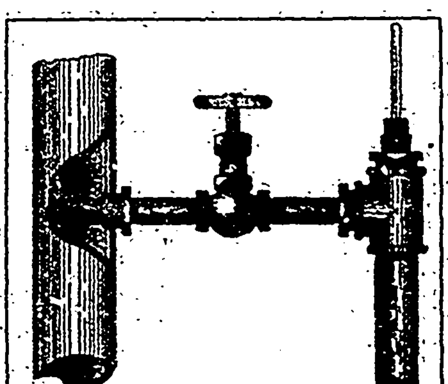

FIG. 1.

transmit heat, and the mouth of the tube is somewhat cupped. The steam pipe *S*, made of ½-inch pipe, is threaded sufficiently long, so that after having been screwed into the bushing, *D*, it will accommodate a ½-inch cap, *C*, which is screwed on the end, making a steam-tight joint with the bushing, *D*. Into the centre of the cap is drilled a small hole, about $\frac{1}{16}$ inch in diameter, countersunk on both sides, the function of which is to "throttle" the steam.

Care should be taken in obtaining, as near as possible, the best specimen of steam in the supply pipe, so it is advisable to connect up, as shown in Fig. 1, by inserting the feed pipe, *S*, the end of which is perforated, into the centre of the supply pipe. If it is simply screwed in, as is ordinarily done, some of the condensed steam, which invariably exists, would, in trickling down the side, enter the calorimeter and cause an error. The exhaust pipe, which leads from the bottom of the instrument, may be of any convenient length. Fig. 2 shows other views of the thermometer tube and throttling nozzle.

This type of calorimeter, termed "throttling," was developed by Prof. R. C. Carpenter, of Cornell University, and the principle upon which it operates is as follows:

Some of the heat contained in high pressure steam is liberated when the pressure is lowered, and that heat is utilized in evaporating any water the steam may contain, and in raising the temperature of the steam above that due to its pressure. Thus, for example, the total heat in 1 lb. of steam at 80 lbs. absolute pressure is 1,177 B. T. U. (British Thermal Units), and that in 1 lb. at 20 lbs. absolute pressure

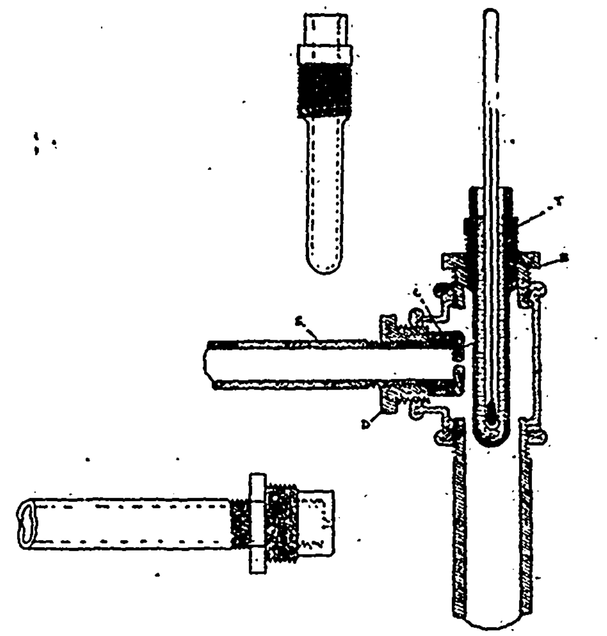

FIG 2

is 1,151 B. T. U. If, now, steam were allowed to expand without doing work on any body except itself, from 80 lbs. to 20 lbs. pressure, 26 B. T. U. would be liberated for each pound of steam. Since, at 20 lbs. pressure 954 B. T. U. are required to evaporate 1 lb. of water, we should have additional heat sufficient to evaporate 26÷954, or .027 lbs.

Now, if the original steam contained less than 2.7 per cent. of moisture, a thermometer placed in the steam would show a temperature higher than that due to a pressure of 20 lbs., which is 228° F. In such a case it would be possible to compute the percentage of moisture in the steam; but if the steam contained more than the above percentage of moisture, the heat would not be sufficient to evaporate it, and the reading of the thermometer would be equal to that of the boiling point of the given temperature; thus no computation of the moisture contained in the steam could be possible. That is, a throttling calorimeter cannot be used if the steam contains much over 2.5 per cent. of moisture, but it is very convenient and accurate within its limits of operation.

To operate the instrument, connect up as shown and fill the thermometer tube with some heavy oil, cylinder oil probably being the best. Now, having inserted the thermometer, open the valve and allow steam to flow until the temperature has become constant, which will be but a short while; when the conditions are such, read the thermometer, the operation then being complete.

The quality of the steam may be then readily found by substituting in the following formula:

$Q = [H - S + .48\,(T - 212)] \div L$, where Q=quality of steam; H= total heat at atmospheric pressure; S=temperature of steam in boiler at absolute pressure (gauge pressure + 14.7 lbs.); T=temperature observed in calorimeter, that is, reading on thermometer; L= latent heat of steam in boiler at absolute pressure.

Values of *H*, *S* and *L*, may be found by consulting steam tables found in all mechanical handbooks, and are also furnished gratis by some builders of boilers. The percentage of moisture is, of course, $100 - Q$.

SAFETY VALVE PROBLEM.

In our July issue we printed a solution of a safety valve problem in which the weight required on the lever was incorrectly stated. The conditions were: lever, 36 inches; diameter of valve, 3 inches; fulcrum, 3 inches; pressure 125 lbs. The required weight on the lever is 73.625 lbs. The formula for solving such problems is:—

Area of valve = A = 7.068.
Length from fulcrum to weight = L = 36".
Length from fulcrum to valve = l = 3".
Weight of ball = W.
Load on safety valve = area x pressure.
Steam pressure = 125 lbs. = p.
Weight of valve and lever not taken into account.

$$W = \frac{A \times p \times l}{L}$$

$$W = \frac{7.068 \times 125 \times 3}{36}$$

$$W = 73.625 \text{ lbs.}$$

* From the *American Electrician*.