

withdrawal for inspection and for removal of scale. The heating element in Fig. 8 is adapted to use of either steam or hot water inside the tubes.

Another method of transferring heat from a house heating boiler to the domestic water is illustrated in Fig. 9. The water heater usually is a cast-iron vessel within which there is a spiral copper coil similar to the

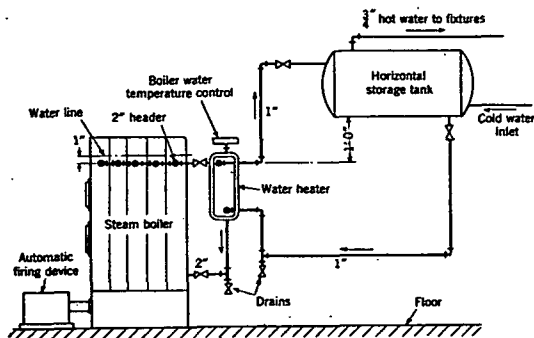


FIG. 9. INDIRECT WATER HEATER MOUNTED ON SIDE OF BOILER

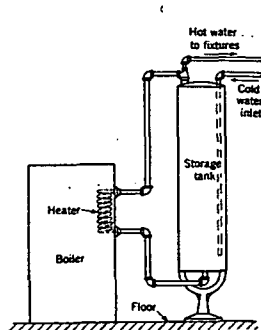


FIG. 10. INDIRECT WATER HEATER PLACED IN BOILER

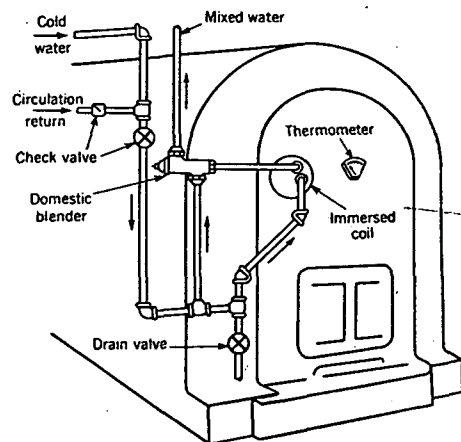


FIG. 11. HEATER INSERTED THROUGH HEAD OF BOILER

one shown in dotted lines in Fig. 10. Steam or water from the heating boiler circulates into the vessel around this coil and returns to the boiler, while domestic water from the storage tank circulates through the coil and receives the heat. The storage tank should be installed with the bottom of the tank as far above the boiler as possible. Horizontal storage tanks smaller than 18 or 20 in. diameter are not recommended because

of the difficulty of preventing the hot and cold water from mixing, and especially is this an important consideration when large quantities of water are withdrawn. In Fig. 10 the heat transfer surface is placed inside the boiler instead of in a separate vessel, but otherwise the operation is similar to that of Fig. 9. This arrangement with vertical tank is commonly used for small domestic installations.

An adaptation of the scheme shown in Fig. 10 suited to larger boilers is shown in Fig. 11. In this case the copper heat transfer surface is in the form of a number of straight tubes with rear U bends or a floating head, inserted through the front head of a horizontal fire-tube boiler. The heater may be above the water line of a steam boiler, though it operates more satisfactorily when below the water line since clogging of the water tubes may thereby be delayed.

In Fig. 11 a thermostatic three-way mixing valve or blender is arranged to maintain a uniform temperature of the hot water flowing to the fixtures. These heaters are widely used without storage tanks since the intimate contact and efficient circulation of the water in this arrangement permit utilizing to a great extent the storage of heat in the water of the boiler. A physical limitation for this type of heater is the desirability, if not the necessity, of having the head of the boiler free from any smoke box or breeching, since otherwise the water piping to the heater would be subject to the heat and corrosive influence of the products of combustion.

In order to reduce clogging by precipitated solids, water heating plants sometimes develop steam in a closed circuit, transferring the heat through a tubular heater to the domestic water. The water in the primary heater, exposed to the high temperature of the fire is repeatedly used and hence has no appreciable tendency to deposit scale, while the domestic water, heated by steam at a much lower temperature than that of the fire, also exhibits a much reduced tendency to separate its dissolved salts.

COMPUTING GRATE AREA FOR COAL-FIRED HEATER

The grate area required for a small coal-fired water heater may be calculated by Equation 1.

$$G = \frac{W (t_2 - t_1) \times 100}{H \times E \times C} \quad (1)$$

where

G = grate area, square feet.

W = weight of water, pounds per hour.

$t_2 - t_1$ = temperature difference between entering and leaving water, degrees Fahrenheit.

H = heating value of coal, Btu per pound.

C = weight of coal burned, pounds per hour per square foot of grate.

E = efficiency, per cent.

In a small heater 4.5 lb is a conservative value for C , and an efficiency of 60 per cent would represent excellent performance.

Example 9. What grate area is required for a coal-burning water heater warming 100 gal per hour of water from 50 to 180 F, when the combustion rate is 4.5 lb per hour