

the cast-iron sections is the same as in heating boilers, but internally the cores are changed to enable the sections to withstand the city water pressure. In small capacity water heaters, efficiency is not considered so important as low first cost and ability to maintain a fire at a low rate of combustion, and consequently such heaters are generally built with a *dry* section or fire-brick lining at the base of the fire-pot to prevent too much chilling of the fuel. While mud and scale will eventually clog the water ways of any direct-fired heater, increased life may be obtained by providing a three-way cock in the return line between the heater and the

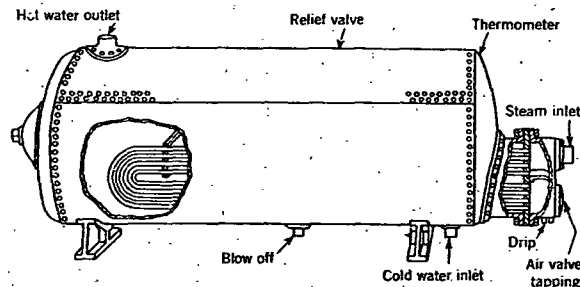


FIG. 2. - INDIRECT WATER HEATER

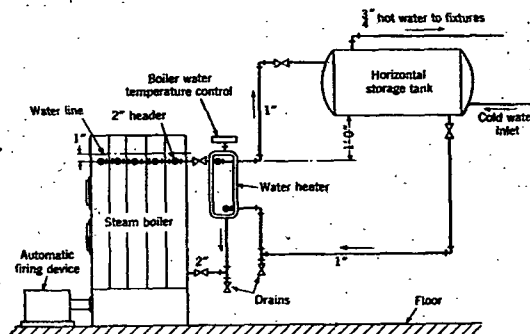


FIG. 3. INDIRECT WATER HEATER MOUNTED ON SIDE OF BOILER

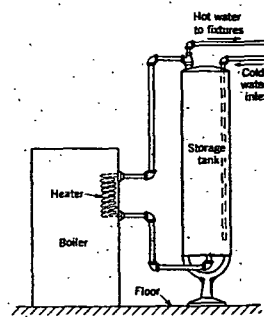


FIG. 4. INDIRECT WATER HEATER PLACED IN BOILER

bottom of the storage tank, so that water can be blown through the heater or the tank separately at full line pressure to clean out loose sediment. Clean-out openings in the bottom of the heater are advantageous if used by operators of water heaters for periodic cleaning out of sediment.

Oil-burning direct-fired water heaters usually are of steel and operate with higher flame temperature and better efficiency than commensurate sized coal-burning heaters. They have the same tendency as coal boilers to *lime up*, and the water passages should be large in cross-section and accessible for periodic cleaning.

Gas-burning direct-fired water heaters may be of the instantaneous or storage type. Instantaneous heaters are generally constructed of spiral water tubes of copper around which the products of combustion circulate

upward from high capacity burners. Storage-type heaters may include in one unit an insulated storage tank, a combustion chamber, flues, burner equipment and controls, or may consist of a separate storage tank and external direct-fired water heater, which may be a so-called *side-arm* heater for small capacity or a gas-fired boiler for larger capacity. Gas boilers used for direct hot water supply must be able to withstand the city water operating pressure. While direct-fired gas heaters are used generally for residences and small installations of 100 gal storage capacity or less, indirect heaters are recommended for larger installations.

In the indirect method either steam or hot water is used for heating the water. With steam the water to be heated is preferably circulated around the outside of the steam tubes which are submerged within a tank. A typical indirect heater using steam is shown in Fig. 2. The coils usually are of copper and are U shaped to permit expansion and contraction. The shell may be of steel, copper, or with a special inside protective lining. Where straight heating tubes are used, one end of the tube is usually expanded into a *floating head* to take care of expansion. The coils should be capable of easy withdrawal for inspection and for removal of scale. Instead of steam the heating medium may also be hot water inside the tubes.

Another method of transferring heat from a heating boiler to the domestic water is illustrated in Fig. 3. The water heater is generally a cast-iron shell within which there is located a spiral copper coil. Hot water from the boiler circulates inside the shell and around the coil and returns to the boiler, while domestic water from the storage tank circulates inside the coil. 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. 4 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. 3. This arrangement with vertical tank is commonly used for small domestic installations.

Sometimes the heating element is located inside of the larger type fire tube boilers and small residential boilers. In this case the heat transfer surface is in the form of a number of straight copper tubes with rear U bends or a floating head, inserted through a special opening in the boiler. While the coil may be located in the steam space above the water line of a steam boiler, it operates more satisfactorily when below the water line since clogging of the water tubes may thereby be delayed. This method is widely used without storage tanks since the intimate contact and efficient circulation of the water in this arrangement permit the utilization of the heat stored in the water of the boiler. A thermostatic three-way mixing valve is frequently used to maintain a uniform temperature of the hot water supply to the plumbing fixtures.

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 precipitate its dissolved salts.