tively. The heating value of the fuel and the temperature rise should be determined to suit local conditions.

## CONTROL OF SERVICE WATER TEMPERATURE

Coal-fired boilers are usually controlled by an immersion thermostat located in the heated water, which opens or closes draft dampers at the boiler to adjust the rate of fuel combustion. With oil- or gas-fired boilers the immersion thermostat controls the oil burner motor or the automatic gas valve. The gas pilot flame usually burns continuously. With electric heaters the immersion thermostat operates a switch on the source of energy.

When steam or hot water is the medium for heating the water in the tank, immersion thermostat controls a valve in the steam or hot water supply line. In small residence installations, using water as the carrier, a combined immersion thermostat and butterfly valve all in one simple fitting may be installed in the transmitting circuit to prevent overheating of the service water.

In residences heated by pump circulated hot water, the house temperature is controlled by operating the circulating pump intermittently, while domestic hot water is warmed by transfer from the house boiler, independent of the pump operation. The domestic water is heated from the heating boiler the year 'round. Under such an arrangement, to prevent overheating the house by thermal circulation when the pump is not running, it is usual to insert a weighted check-valve in the house heating main, so that no circulation to the house heating system can occur unless the pump operates. In summer the fire may be controlled to maintain a boiler water temperature lower than when heating and generally about 20 F warmer than that desired in the domestic hot water system.

In buildings which have restaurants it is generally desirable to install two separate service hot water systems so that water at about 180 F minimum may be available for dish washing, while water at 140 F maximum may be used for lavatory and bath purposes.

The immersion thermostat in a hot water storage tank should be located no higher than the center of the tank, and possibly should be even closer to the bottom since water in a tank stratifies proportionally to the temperature. When hot water is removed, the cold water entering to replace it quickly reduces the temperature in the lower parts of the tank.

## SOLAR WATER HEATERS

Solar heaters utilize the energy of the sun for heating hot water. The successful operation of such heaters requires the availability of sunshine practically every day in the year, which has limited their use to Florida and the southern portions of California. When supplemented with some other means of gas, coal or oil water heating, solar heaters may be used in climates where sunshine may be more or less intermittent. They have been used in summer homes as far north as Chicago. When properly installed and proportioned, solar water heaters render satisfactory service especially in climates where the outside temperatures are high and extremely hot water is not necessarily desirable. Such installations consist essentially of a storage tank, heating coil and hot box. The coil is installed in the hot box and is arranged to circulate water to and from the storage tank. The advantage in the use of this type of heater is the fact that it requires no fuel. The same materials should be used for the coil,



circulation lines and tank. A copper coil is more efficient in absorbing heat in the box but galvanized iron or steel may be substituted depending on the local water conditions, cost and other considerations.

The storage tank must be able to store sufficient heated water for the night period of about 16 hours when the coil is not functioning or is operating under such poor sun conditions as to make its heating effect negligible. Due to the fact that the *no sun* period includes the night period when little or no hot water is used, an available storage of 50 per cent of the average daily usage is considered adequate. Since about 25 per cent of stored hot water cannot be drawn out of a storage tank before the incoming cold water reduces the temperature of all of the

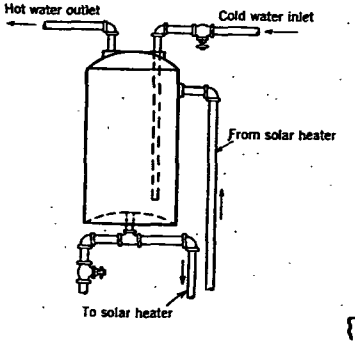


FIG. 5. SOLAR HEATER TANK CONNECTIONS

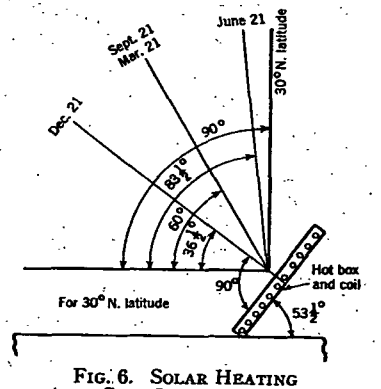


FIG. 6. SOLAR HEATING COIL INCLINATION

water in the tank to an unsatisfactory point for usage, the equation for calculating the storage capacity of the tank becomes:

$$S = \frac{Q \times 0.50}{0.75} = 0.666Q \qquad (4)$$

*where*

$S$ = storage capacity of tank, gallons.
$Q$ = average daily usage, gallons.

Thus for a family of four persons using an average of 40 gal of hot water per person per day the size of the tank would be 4 persons x 40 gal x 0.666 or 106 gal, and the nearest standard size of tank to this theoretical capacity would be used. The tank should be well insulated to prevent undue loss of heat during the 16-hour period when the coil is inoperative, and it should be located as high as possible in the building (under the peak of the roof if such exists) so as to secure a maximum circulation head from the coil. The hot water supply to the house, as shown in Fig. 5, is located at the top of the tank, which serves to air vent the tank by blowing air out through the hot water faucets in small bubbles as fast as it accumulates.

The coil should be of the return-bend type, square or slightly rectangular in form, and should have the pipes running east and west, with the coil on the south side of the building where it can receive the full sun effect all day long without shadows from the building itself or from adjacent obstructions such as trees or other structures. The coil should