In order to achieve satisfactory heating at the lowest cost, careful consideration should be given to oil, air and draft adjustment. The oil adjustment should be determined from the total heat requirements to be met. The heat loss of the building plus an allowance for piping plus 20 to 25 per cent for pick-up establishes the maximum output required from the boiler. Fig. 1 indicates the oil required in gallons. Piping allowances will usually vary between 25 and 10 per cent, decreasing with an increase in the size of the building.

With the oil rate thus fixed, the air and draft should be set to give efficient combustion (that is, 10 to 12 per cent CO_2). The furnace draft should be set reasonably low and should be maintained constant by means of an automatic draft regulator. Without this the air supply will fluctuate, causing uneven performance. A check should be made to insure that ignition will be satisfactory under all conditions. An oil burner of the continuous type might dispense with all or part of the pick-up allowance due to the nature of its operation. Careful adjustment will provide ample heat output under all conditions, will minimize the load on the boiler, and will establish the most favorable conditions for intermittent operation.

An essential element in the satisfactory operation of domestic oil burners is the provision for maintenance and service for the burners. What might be called *emergency service* for mechanical or electrical failure of the burner has rapidly diminished during the last few years until a level has been reached where groups of 100 to 1000 burners in a community consistently will require an average of not more than one call per burner per heating season. Maintenance service is coming into general practice where, for a fixed annual payment, regular inspection is made of the burner, and faulty operation corrected before the burner becomes inoperative. This service may contemplate entire overhauling of the burner during the summer, and may include annual cleaning of the boiler flues with a specially designed vacuum cleaner.

Domestic Hot Water Supply

Provision may be made for heating domestic water through exchange heaters attached to the boiler, in which water is maintained at a fixed temperature or steam at a set pressure during the entire year. The flow of water or steam to the radiators is controlled by electrically-operated valves, which remain closed during warm weather and open (through the functioning of the room thermostat) when heat is required in the house. The room thermostat either causes heat to be produced by starting the burner when the room temperature drops to a predetermined point, or closes the circuit of the motor by operating a valve in the flow line of the heating system, the motor opening the water or steam valve and permitting water or steam immediately to flow to the radiators. When the flow in a water heating system is sluggish, the room thermostat also can start the motor of a circulation pump, thereby decreasing the time required to bring the room temperature up to the desired point.

It is usual in small steam heating systems to dispense with the motor-operated valve and by means of an aquastat maintain the boiler water at a constant temperature but well below the steaming temperature (*i.e.*,

140 to 180 F). The lowest temperature setting that will produce sufficiently hot water will be the most economical. The aquastat will always function in such a way as to maintain this temperature except when the room thermostat calls for heat, which means that a call for steam can be more quickly obtained.

Another type of control valve available for hot water systems is thermostatically operated so as to prevent a flow of water to the heating system until the call of the room thermostat for heat raises the water temperature above that normally required for domestic hot water. It should be noted that, except in the case of the graduated burner, the water temperature in the heating system will nearly always reach its maximum, thereby depriving this system to some degree of its natural advantage of modulation.

COMMERCIAL OIL BURNERS

Liquid fuels are used for heating apartment buildings, hotels, public and office buildings, schools, churches, hospitals, department stores, as well as industrial plants of all kinds. Contrary to domestic heating, convenience seldom is a dominating factor, the actual net cost of heat production usually controlling the selection of fuel. Some of the largest office buildings have been using oil for many years. Many department stores have found that floor space in basements and sub-basements can be used to better advantage for merchandising wares, and credit the heat producing department with this saving.

Wherever possible, the boiler plant should be so arranged that either oil or solid fuel can be used at will, permitting the management to take advantage of changes in fuel costs if any occur. Each case should be considered solely in the light of local conditions and prices.

Burners for commercial heating may be either large models of types used in domestic heating, or special types developed to meet the conditions imposed by the boilers involved. Generally speaking, such burners are of the mechanical or pressure atomizing types, the former using rotating cups producing a horizontal torch-like flame. As much as 350 gal of oil per hour can be burned in these units, and frequently they are arranged in multiple on the boiler face, from two to five burners to each boiler.

The larger installations are nearly always started with a hand torch, and are manually controlled, but the use of automatic control is increasing, and completely automatic burners are now available to burn the two heaviest grades of oil. Nearly all of the smaller installations, in schools, churches, apartment houses and the like, are fully automatic.

Because of the viscosity of the heavier oils, it is customary to heat them before transferring by truck tank. It also has been common practice to preheat the oil between the storage tank and the burner, as an aid to movement of the oil as well as to atomization. This heating is accomplished by heat-transfer coils, using water or steam from the heating boiler, and heating the oil to within 30 deg of its flash point.

Unlike the domestic burner, units for large commercial applications frequently consist of atomizing nozzles or cups mounted on the boiler front with the necessary air regulators, the pumps for handling the oil