One control system provides an instrument actuated by two temperature bulbs, one placed in the outdoor air and the other in a designated part of the heating system. The control is actuated by both bulbs and is designed to maintain the heating medium at a variable temperature to suit the variations in outdoor temperature, the lower the outdoor temperature the higher the temperature of the heating medium.

Protective Devices

Owing to the comparative intensity of heat production with a burner, a boiler with limited water storage above the crown sheet might pass steam to the radiator system so rapidly, at starting, that the sheet would be uncovered, with probable damage to the boiler structure. A low-water safety can be so wired into the system that the burner will be stopped before the water level is reduced to the danger point, or a boiler feed can be installed to add water to the boiler to maintain a safe level, instead of stopping the burner. Either or both should form part of a first-class installation.

Again, with either steam or water systems, the burner control can be inter-wired with a thermostatic device having its temperature element introduced into the boiler near the top, its function being to limit the maximum temperature of water or pressure of steam so the burner will be shut off before dangerous temperatures or pressures are reached. Windows of the room in which the thermostat is located are sometimes opened to *air out* the house in the morning, and if they are not closed promptly, the burner will operate continuously and possibly develop temperature and pressure conditions that might be detrimental to the boiler. This is where the safety device can be used to offset the carelessness of the human being.

Intermittent and High-Low Operation

While the greater number of burners operate on the intermittent principle, some are designed to function on either of two extremes, a *high* and a *low* flame, under thermostatic control, thus getting away from the need of ignition devices. Others go a step further and operate with a flame that can be modulated between high and low extremes, provision being made to maintain the desired air-oil ratio for each step. The intermittent burner is better adapted to Fall and Spring conditions when, during an entire week, there is necessity for burning only eight or ten gallons of oil, and the minimum rate of the continuous burner might indicate a consumption of three or four times that amount. On the other hand, during severe weather, the intermittent burner might require a setting producing heat at a much higher rate than the boiler could absorb, while the continuous burner would generate heat at about one-third of that rate and hence permit the boiler to show a higher efficiency during that period. The two types would probably give about the same results for the entire heating season. A limitation of the high-low flame and of the graduated flame type burners is that there is a limit to the minimum size flame which can be maintained. In many instances the low flame is not less than 20 per cent of the high flame which means that the burner would overheat the building in very mild weather. Such a condition would require that the burner be stopped manually and started manually in mild weather.

In selecting a graduated flame burner, the purchaser should be satisfied that the low flame can be reduced to the required degree. This factor is frequently a very important one and may have a decided bearing on the fuel consumption.

Boilers for Domestic Oil Burners[1]

Boilers used with domestic installations may be those designed for solid fuel or those designed for liquid fuel. The latter are coming to the fore with great rapidity as they usually have greatly increased secondary surface. Many are of copper or steel tube design. Increased efficiencies of 5 per cent to 15 per cent are often obtainable with boilers designed especially for liquid fuel.

It is possible to go to extremes in providing secondary surface sufficient to reduce flue temperatures to the order of 250 F to 300 F, with the result that the added resistance through the flues may necessitate the use of a booster fan to insure sufficient draft. It is difficult to obtain satisfactory efficiencies with boilers having little or no secondary surfaces, where the hot products of combustion pass almost immediately from the combustion chamber to the flue; in fact a high efficiency is unlikely with any fuel under such conditions, and the intermittent burner is especially at a disadvantage because of its characteristic development of heat at a high rate while it is operating.

It is essential that the flame produced by an oil burner, especially where it is strongly luminous, be kept from contact with the water-backed surfaces of the combustion chamber, and to this end bricking or its equivalent must be provided in most cases. Where a burner fires through the ash-pit doorframe bricking must protect the unbacked surfaces of the ash pit. The same fire bricking constitutes the actual combustion chamber for the burner flame, and materially increases the combustion volume for a given boiler.

Many burners of the *rotary* or *spinner* type are so installed that the flame forms a disc or ring just above the grate level. Usually formed hearths are placed on the grate, providing a refractory surface underneath the flame. Where these hearths are factory-formed, or made up on the job with special templates, the burner operation should conform closely to that for which it was designed in order to obtain maximum efficiency. Refractories play an important part in the proper functioning of the burner, especially when the rate of fuel consumption is high, and many unsatisfactory installations have been brought to a high state of efficiency by rebricking.

Installation

The intelligence and care with which a burner is installed largely determine the satisfaction that will result from its operation. Two plans for the installation of burners are in general use. In the first, the dealer makes all installations. In the other, sales agencies function only to make sales, and the installation for as many as twenty such sales offices is done by a centrally located, usually factory controlled, installation force.

[1]For additional information on this subject, refer to Study of Performance Characteristics of Oil Burners and Low-Pressure Heating Boilers, by L. E. Seeley and E. J. Tavanlar (*Heating, Piping and Air Conditioning*, May 1931, p. 419).