installations. The heat output is in the range of requirements for the average or small home.

The modulating flame allows simple manual control by regulation of a metering valve, and simplifies the control equipment. Quiet combustion and the absence of moving parts contribute to quiet operation when the heating device is located in the living quarters.

The ability to operate on natural draft and gravity feed of the fuel, makes possible the use of these burners where electric current is not available or is unreliable. However, most furnaces are thermostatically controlled, and many are provided with mechanical draft.

Oil-Fired Boiler and Furnace Units

A number of types of specially designed oil-fired boiler-burner and furnace-burner units are available. Various locations of burners will be noted in such units; some having the combustion chamber and burner

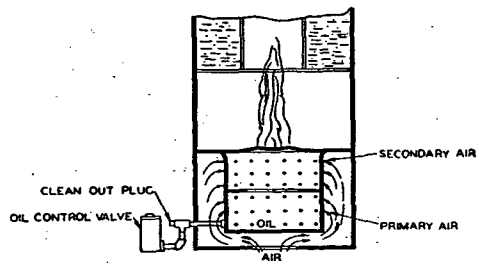

FIG. 16. VAPORIZING GRAVITY POT-TYPE BURNER

at the top, some at the bottom, and some at the center of the appliance. Typical combination units are shown in Figs. 17 and 18. The coordinated design of boiler (or furnace) and burner elements insures the optimum in operating characteristics, and the maintenance of balanced performance. This type of equipment usually has more heating surface, and better flue proportions and gas travel than conventional boilers or furnaces. Some of the better conversion installations, however, may equal the unit type in performance.

Operating Requirements for Oil Burners

The U. S. Department of Commerce, in conjunction with the oil burner and heating appliance industries, has established commercial standards for conversion burners and burner-appliance units which cover installation, construction and performance tests.[4]

Combustion Process

Efficient combustion must produce a clean flame and use a relatively small excess of air, *i.e.*, between 25 and 50 percent. This can be done only by vaporizing the oil quickly and completely, and mixing it vigorously with air in a combustion chamber hot enough to support the combustion.

A vaporizing burner prepares the oil for combustion by transforming the liquid fuel to the gaseous state by the application of heat.

In an atomizing burner, the oil is mechanically separated into very fine particles so that the surface exposure of the liquid to the radiant heat of the combustion chamber is vastly increased and vaporization thereby promoted. The result is the ability to burn more and heavier oil within a given combustion space. Because the air enters the combustion chamber with the liquid fuel particles, mixing, vaporization and burning occur all at once in the same space. This produces a luminous flame. A deficient amount of air is indicated by a dull red or dark orange flame with smoky tips.

An excessive supply of air may produce a brilliant white flame or a short ragged flame with incandescent sparks flashing through the combustion space. While extreme cases may be detected, it is not possible

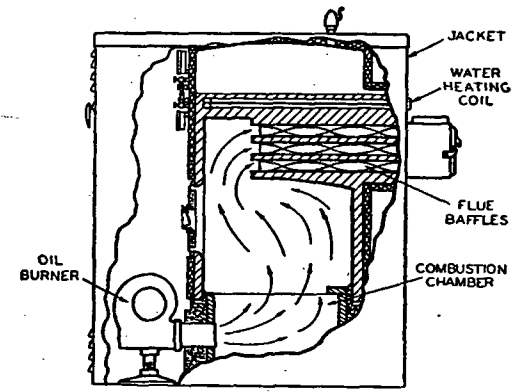

FIG. 17. TYPICAL BOILER-BURNER UNIT

to distinguish, by eye, the effect of the finer adjustment which competent installation requires.

Combustion Adjustments

The present-day oil burner with mechanical oil and air supply, properly installed and equipped with an automatic draft regulator, is capable of maintaining efficient combustion for a considerable period following the initial adjustments of oil and air. Eventually, certain changes will occur, and may be such that the amount of excess air will decrease below allowable limits. A decrease in air supply while the oil delivery remains constant, or an increase in oil delivery while the air supply remains constant, will make the mixture of oil and air too rich for clean combustion. The more efficient the adjustment, the more critical it will be. The oil and air supply rates must remain constant.

The following factors may influence the oil delivery rate: (1) changes in oil viscosity due to temperature change or variations in grade of oil delivered; (2) erosion of atomizing nozzle; (3) fluctuations in by-pass relief pressures; and (4) possible variations in methods of atomization. Any change due to partial stoppage of oil delivery will increase the proportion