

the chamber shall be as nearly air tight as is possible, except when the particular burner requires a secondary supply of air for combustion.

It is evident that the atomizing burner is dependent upon the surrounding heated refractory or fire brick surfaces to vaporize the oil and support combustion. While the importance of the combustion chamber is obvious, its design has been troublesome. Unsatisfactory combustion may be due to inadequate atomization and mixing. A combustion chamber can only compensate for these things to a limited extent. If liquid fuel continually reaches some part of the fire brick surface, a carbon deposit will result. Fundamentally, the combustion chamber should enclose a space having a shape similar to the flame but large enough to avoid flame contact. The nearest approach in practice is to have the bottom of the combustion chamber flat but far enough below the nozzle to avoid flame contact, the sides tapering from the air tube at the same angle as the nozzle spray and the back wall rounded. A plan view of the combustion chamber thus resembles in shape the outline of the flame. In this way as much fire brick as possible is close to the flame so it may be kept quite hot. This insures quick vaporization, rapid combustion and better mixing by eliminating dead or inactive spaces in the combustion chamber. An overhanging arch at the back of the fire pot is sometimes used to increase the flame travel and give more time for mixing and burning and sometimes to prevent the gases from going too directly into the boiler flues. When good atomization and vigorous mixing are achieved by the burner, combustion chamber design becomes a less critical matter. Where secondary air is used, combustion chamber design is quite important. With some of the vertical rotary burners considerable care must be exercised in definitely following the manufacturers instructions when installing the hearth as in this class successful performance depends upon this factor.

Combustion Adjustments

Where adjustments of oil and air have been made which give efficient combustion, the problem of maintaining the adjustments constant becomes an important one. Particularly is this true when the change causes the per cent of excess air to decrease below allowable limits of the burner. 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 (*i.e.*, 25 per cent excess air) the more critical it will be of variations. The oil and air supply rates must remain constant.

The following factors may influence the oil delivery rate: (a) changes in oil viscosity due to temperature change or variations in grade of oil delivered, (b) erosion of atomizing nozzle, (c) fluctuations in by-pass relief pressures and (d) possible variations in methods 2b (3) and 2b (4) listed in the previous classification table. Note that any change due to partial stoppage of oil delivery will increase the proportion of excess air. This will result in less heat, reduced economy and possibly a complete interruption of service but usually no soot will form.

The following factors may influence the air supply: (a) changes in combustion draft due to a variety of causes (*i.e.*, changes in chimney draft because of weather changes, seasonal changes, back drafts, failure or inadequacy of automatic draft regulator, use of chimney for other

purposes, possible stoppage of the chimney and changes in draft resistance of boiler due to partial stoppage of the flues), and (b) changes in air inlet adjustments to the fan.

It is recognized that a secondary source of air due to leakage in the boiler setting is present in many installations and it is highly desirable that this leakage be reduced to a minimum. Obviously the amount of air leakage will be determined by the draft in the combustion chamber. It is important that this draft should be reduced as low as is consistent with the proper disposal of the gases of combustion. When using mechanical draft burners with average conditions, the combustion chamber draft should not be allowed to exceed 0.02-0.05 in. water. An automatic draft regulator is very helpful in maintaining such values.

Measurement of the Efficiency of Combustion

Efficient combustion being based upon a clean flame and certain proportions of oil and air employed, it is possible to determine the results by analyzing the gases formed by the combustion process. An Orsat apparatus is a device which measures the volume of carbon dioxide (CO_2), oxygen (O_2) and carbon monoxide (CO) in the flue gases. Except in the case of a non-luminous flame it is usually sufficient to analyze only for carbon dioxide (CO_2). A showing of 10 to 12 per cent indicates the best adjustment if the flame is clean. Most of the good installations at the present time show from 8 to 10 per cent CO_2 . Taking into account the potential hazard of oil or air fluctuations with low excess air (high CO_2) a setting to give 10 per cent CO_2 constitutes a reasonable standard for most oil burners. This is particularly true of non-luminous flame burners which will not function properly with less than 10 per cent CO_2 .

Controls

Oil burner controls may be divided into two parts: (a) devices to regulate burner operation so the desired house heating result may be obtained, and (b) devices for the safety and protection of the boiler and burner. For control devices generally consult Chapter 37. The room thermostat has recently been improved to provide more frequent burner operation and greater uniformity of room temperature. Class (b) controls comprises a device to shut off the burner if the oil fails to ignite or if the flame should cease due to lack of oil; a device actuated by steam boiler pressure to shut off the burner when the pressure reaches some predetermined value; a device on the boiler to shut off the burner if the water level acts too low for safety or one which automatically feeds additional water to the boiler; a device on warm air furnaces to shut off the burner if the air temperature gets too high; a valve in the oil supply line which automatically closes in the event of fire in or near the cellar; and a device to keep the temperature of the boiler water within certain limits when it is being used to heat domestic hot water. These devices are all tested and approved by the Underwriters' Laboratory of Chicago, Ill., before they are offered to the purchaser. The selection of class (b) devices is made by the oil burner manufacturer.

Fuel Oil Gages

To insure a constant supply of fuel oil and to check deliveries and consumption it is essential to have accurate means of readily determining