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 2*b* (3) and 2*b* (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 the quantity of oil in the storage tank. For this purpose various types of indicating or recording gages are used, the simplest forms being the glass level gage, and a float-and-dial arrangement having a graduated dial face indicating the proportion of the tank containing liquid. Other more accurate and dependable devices are designed to operate by hydraulic action or by hydrostatic impulse. These instruments may be attached to the tank, giving a direct reading of the liquid contents; or the instrument itself may be located at a convenient point remote from the tank and connected with the tank by pipe or tubing. The quantity readings may be in gallons of liquid, height of liquid level in feet and inches, or in other desired units of measurement.

GAS-FIRED APPLIANCES

The increased use of gas for house heating purposes has resulted in the production of such a large number of different types of gas heating systems and appliances that today there is probably a greater variety of them than there is for any other kind of fuel.

Gas-fired heating systems may be classified as follows:

I. Gas-Designed Heating Systems.
  A. Central Heating Plants.
    1. Steam, hot water, and vapor boilers.
    2. Warm air furnaces.
  B. Unit Heating Systems.
    1. Warm air floor furnaces.
    2. Industrial unit heaters.
    3. Space heaters.
    4. Garage heaters.

II. Conversion Heating Systems.
  A. Central Heating Plants.
    1. Steam, hot water and vapor boilers.
    2. Warm air basement furnaces.