circulator space heaters, except that safety screens are provided over all openings into the combustion chamber to prevent any possibility of explosion from gasoline fumes or other gases which might be ignited by an open flame. They are usually provided with automatic room temperature controls and are well suited for heating either residence or commercial garages.

Conversion Burners

Residence heating with gas through the use of conversion burners installed in coal-designed boilers and furnaces represents a common type of gas-fired house heating system. In many conversion burners radiants or refractories are employed to convert some of the energy in the gas to radiant heat. Others are of the blast type, operating without refractories.

Many conversion units are equipped with a sheet metal secondary air duct which is inserted through the ashpit door. The duct is equipped with automatic air controls which open when the burners are operating and close when the gas supply is turned off. This prevents a large part of the circulation of cold air through the combustion space of the appliance when not in operation. With this duct the air necessary for proper combustion is supplied directly to the burner, thereby making it possible to reduce the excess air passing through the combustion chamber.

Conversion units are made in many sizes both round and rectangular to fit different types and makes of boilers and furnaces. They may be secured with manual, push-button, or room temperature control.

Combustion Process and Adjustments

Because of the varying composition of gases used for domestic heating it is difficult to generalize on the subject of gas burner combustion.

Little difficulty should be experienced in maintaining efficient combustion conditions when burning gas. The fuel supply is normally held to close limits of variation in pressure and calorific value and, therefore, the rate of heat supply is nominally constant. Since the force necessary to introduce the fuel into the combustion chamber is an inherent factor of the fuel, no draft by the chimney is required for this purpose. The use of a draft diverter insures the maintenance of constant low draft condition in the combustion chamber with a resultant stability of air supply. A draft diverter is also helpful in controlling the amount of excess air and preventing back drafts which might extinguish the flame. (See Chapter 8.)

Measurement of the Efficiency of Combustion

It is possible to determine the results of combustion by analyzing the gases of combustion with an Orsat apparatus. It is desirable to determine the percentage of carbon dioxide (CO_2), oxygen (O_2) and carbon monoxide (CO) in the flue gases. While ultimate CO_2 values of 10 to 12 per cent may be obtained from the combustion of gases commonly used for domestic heating, a combustion adjustment which will show from 8 to 10 per cent CO_2 represents a practical value. Under normal conditions no CO will be produced by a gas-fired boiler or furnace. Limitations as to output rating by the *A.G.A.* are based upon operation with not more than 0.04 per cent CO in the products of combustion. This is too small an amount to be determined by the ordinary flue gas analyzer.

Controls

Temperature controls for gas burners are described in Chapter 34. Some central heating plants are equipped with push-button or other manual control. The main gas valve may be of either the snap action or throttling type.

Sizing Gas-Fired Heating Plants

While gas-burning equipment usually is completely automatic, maintaining the temperature of rooms at a predetermined and set figure, there are in use installations which are manually controlled. Experience has shown that, in order to effectively overcome the starting load and losses in piping, a manually-controlled gas boiler should have an output as much as 100 per cent greater than the equivalent standard cast-iron column radiation which it is expected to serve.

Boilers under thermostatic control, however, are not subject to such severe pick-up or starting loads. Consequently, it is possible to use a much lower selection, or safety factor. A gas-fired boiler under thermostatic control is sensitive to variations in room temperatures so that in most cases a factor of 20 per cent is sufficient for pick-up load.

The factor to be allowed for loss of heat from piping, however, must vary somewhat, the proportionate amount of piping installed being considerably greater for small installations than for large ones. Liberal selection factors to be added to the installed steam radiation under thermostatic control are given in Fig. 1 of Chapter 12.

Appliances used for heating with gas should bear the approval seal of the *American Gas Association* Testing Laboratory. Installations should be made in accordance with the recommendations shown in the publications of that association.

Ratings for Gas Appliances

Since a gas appliance has a heat-generating capacity that can be predicted accurately to within 1 or 2 per cent, and since this capacity is not affected by such things as condition of fuel bed and soot accumulation, makers of these appliances have an opportunity to rate their product in exact terms. Consequently all makers give their product an hourly Btu output rating. This is the amount of heat that is available at the outlet of a boiler in the form of steam or hot water, or at the bonnet of the furnace in the form of warm air. The output rating is in turn based upon the Btu input rating which has been approved by the *American Gas Association* Testing Laboratory and upon an average efficiency which has been assigned by that association.

In the case of boilers, the rating can be put in terms of square feet of equivalent direct radiation by dividing it by 240 for steam, and 150 for water. This gives what is called the *American Gas Association* rating, and is the manner in which all appliances approved by the *American Gas Association* Laboratory are rated. To use these ratings it is only necessary to increase the calculated heat loss or the equivalent direct radiation load by an appropriate amount for starting and piping, and to select the boiler or furnace with the proper rating.