equipment and air regulation appropriate to the fuel burned. Most manufactured gases, although of lower heating value than natural gases, if burned in sufficient volume will produce equivalent results. The heating value of a mixture of gas and air (air just sufficient to burn the gas completely) is almost the same for any typical commercial gas, as is shown in Table 83.

FUEL REQUIREMENTS FOR GAS HEATING

It is a fact, based upon observation, that the user of a gas-fired central heating appliance uses more heat during the course of a year than he does when depending upon solid fuel. The extreme ease of starting and operating a gas burning appliance leads to the pilot light being lighted on the first cool day of the season. Thereafter, the system generally operates entirely under thermostatic control and is left in operation on many days when very little heat is required to keep the inside temperature at 70 to 72 deg.; days when it would be impracticable to keep a coal fire going. On many cold days, the gas unit is kept operating continuously at maximum capacity so that the premises are never permitted to cool below the temperature ordinarily maintained.

Table 85 gives an approximate idea of the fuel requirements in various climates.

TABLE 85. FUEL REQUIREMENTS FOR RESIDENTIAL BUILDINGS FOR DIFFERENT OUTSIDE TEMPERATURES

*Gas of 500 B.t.u. (Gross) per cu. ft.**

TYPE OF SYSTEM	CU. FT. PER SQUARE FOOT OF RADIATION AVERAGE OUTSIDE TEMPERATURE, OCTOBER 1 TO MAY 1						
	25°	30°	35°	40°	45°	50°	55°
Water	850	775	700	625	550	475	400
Vapor	1080	985	890	795	700	605	510
Steam	1380	1260	1140	1020	900	780	650

The figures are based on maintaining a temperature of 70 deg. fahr. over practically the entire house, or 15-hr. per day.

*(Requirements for gases of other heating values vary inversely as the heating value; e.g., for natural gas of 1000 B.t.u., consumption per sq. ft. is one-half that shown in table.)

The requirements of individual installations may vary considerably from an average of several. Generally stores, offices, factories, and other commercial buildings require less heat per season than do residential buildings provided with an equal amount of radiation.

WASTE FROM USING GAS IN COAL-BURNING APPARATUS

In coal furnaces or boilers, the path traveled by the hot gases is relatively short and the surface with which they come in contact is relatively small as compared to gas heating apparatus. A large proportion of the heat in the coal is given off by the incandescent fuel bed as radiant heat. As a gas flame radiates very little heat, the hot products of combustion must come in direct contact with the heating surfaces. For this reason the use of gas in coal-burning appliances is always wasteful and about three times as much gas will be required than if it were burned in a properly designed appliance. The gas-burning appliances have a longer fire travel and more heating surface than those burning coal and can therefore absorb more heat from the hot products of combustion in a given time.

Coal-burning boilers are constructed with large passages for the flue gas so that the draft loss through them can be kept as small as possible, thus permitting most of the chimney draft to be exerted in drawing the air through the fuel bed. When gas is burned under a boiler with such liberal passages, the draft becomes too great and the stack losses become excessive. A boiler designed for gas can have restricted passages for the products of combustion, permitting them to come into very intimate contact with the heating surfaces. The experiences of the gas companies in several large cities with conversions have been such as to discourage their use.

Warm air furnaces, designed for use with manufactured or natural gas, are available in sizes ranging from 5000 to 20,000 cu. ft. rated capacity. House-heating boilers, of the cast iron sectional type, designed especially for gas fuel, are available in single units ranging from 200 to 7500 sq. ft. of equivalent direct radiation.

CROSS-CONNECTING COAL AND GAS BOILERS

Quite frequently, when a customer has already a coal boiler in his home, it is desirable to leave the coal boiler in place, and to cross-connect the gas boiler with it. For small gas companies or any others where there is any possible chance of a shortage or failure of gas, it would seem to be good practice to encourage cross-connecting as the customer would realize very little for a second-hand coal boiler, and it is worth more to him as a safeguard against failure of his gas system than he would realize by selling it. It also produces a more secure feeling in the customer's mind when putting in gas-fired house-heating equipment, if he knows that he can burn coal at any time he has occasion to. There is almost no difference in the cost of an installation, whether it is cross-connected or displaced. Cross-connection also gives the customer a means of disposing of papers, crating and other waste material.

In hot water heating systems, it is necessary to valve off the return pipes on the coal boiler, which prevents circulation through the latter when the gas boiler is in use. Since the gas boiler holds comparatively little water and is almost always insulated, no valves are needed on the return pipes to the gas boiler. Hence, by opening the valves on the coal boiler, it may be operated independently or in conjunction with the gas boiler.

For steam or vapor installation, it is necessary to valve off all of the returns and flows on each boiler unless the gas boiler is set so that the