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 water-line in both boilers is at the same level, in which case it is necessary to valve off only the coal boiler to prevent the heating of the water in the coal boiler when it is not in use.

The gas boiler should be set as close to the coal boiler as practicable, and the flows and returns should cut into the flows and returns of the coal boiler as near to the latter as possible.

CHAPTER XIII

AUTOMATIC HEAT CONTROL

TEMPERATURE regulation is a vital function in the human body. We all carry about with us remarkably effective automatic heat control equipment. In the best functioning of many social and commercial services, automatic temperature regulation is proved to be necessary, not only to comfort and health, but also to the prevention of waste and to the perfection of manufacturing processes.

Temperature control is usually achieved by preventing overheating. It follows that *automatic heat control* is a better term than automatic temperature regulation, and it is obvious that automatic heat control in itself must always effect an economy.

All heating apparatuses must be sufficient in capacity to render acceptable service under the most arduous conditions. The most arduous conditions, especially as to extreme cold outside, are in effect only a small part of the heating season. It may surprise many people to realize that in Chicago, for instance, the most extreme cold prevails only on about six days per year. Hence there is ample ability and strong probability for overheating during the major part of each heating season unless automatic control of the heating apparatus is provided.

Ventilating systems without automatic heat control give trouble from drafts.

Rooms heated by radiators can be cooled more quickly by opening windows than by shutting radiator valves, so that it is found that great heat waste occurs through open windows and open radiator valves, unless automatic heat control is furnished.

Gas and oil heaters and similar devices using quickly responsive fuels become prohibitively expensive for fuel unless automatic heat control is used.

Service hot-water heaters must have automatic control, not only for economy and satisfaction, but also to prevent scalding the bodies of users.

Thermostats are very simple mechanisms. Almost every physical thing expands or changes under the influence of heat and so can be made into a more or less effective thermostat. Liquids can be compounded which will become gases at any reasonable temperature desired. Metals having different rates of expansion can be harnessed together so as to give a greatly increased thermostatic movement. Common air is an excellent thermostatic medium, and is used extensively.

There are two general divisions into which devices for automatic heat control may be grouped, as follows:

1. The simpler class includes the type in which the thermostats and the valves and dampers which they operate are self-contained without any outside power, gaining

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