burners inserted in them. This practice has not been generally followed by manufactured gas companies, for definite economic reasons.

The usual coal-burning appliance is designed so as to present a large amount of heating surface to the radiant heat emitted by the flame and fuel bed. Flue passages for the absorption of heat by convection are large because the draft loss, already large on account of the fuel bed resistance, must be kept within reasonable bounds. Heating surfaces in the flue passages must not be so great as to cool the stack gases to a very low temperature, since high stack temperature is required to produce sufficient draft for high rates of combustion.

When gas is burned in appliances, it may be burned either with a Bunsen (non-luminous) flame or with a luminous (radiating) flame. If a Bunsen flame is used and no attempt made to cause this flame to produce radiant heat, such as by the use of refractories; the heating surface in the combustion chamber will absorb heat much slower than it would if a solid fuel were burning in the combustion chamber with an incandescent flame and fuel bed. The next result is that the appliance cannot absorb as much heat as is necessary to produce rating.

By burning the gas with a luminous flame, or in such a manner as to heat refractory surfaces to incandescence, the heat absorbing *in the combustion chamber* of the appliance designed for coal can be made to absorb the heat they were intended to absorb. The large flue passages, however, are not efficient as heat absorbing surfaces because they do not bring the hot gases in sufficiently intimate contact with water-backed surfaces. The use of incandescent refractory surfaces, therefore, increases the heat absorbing capacity of the appliance, but we are still faced with the fact that if sufficient gas is burned to cause the appliance to deliver rated capacity, the stack temperature will be so high as to cause the loss of a great many expensive heat units. If, on the other hand, the rate of gas consumption is adjusted so as to give a low stack temperature and therefore high efficiency, the output of the appliance will be below its capacity when burning solid fuel or liquid fuel.

GAS BOILERS

Gas boilers have taken on a well-defined form just as coal boilers have. The usual boiler is sectional in construction with a number of independent burners placed beneath the sections. In most boilers each section has its own burner. Some designers fashion their sections so as to give the effect of a horizontal tubular boiler in order to accelerate water circulation. Other makers either do not incorporate the tubular feature in their designs or depend on internal baffling to give the tubular effect. In all cases the sections are placed very close together, much closer than would be possible with any soot-forming fuel. The effort of the designer is always to break the hot gas up into thin streams, so that all particles of the heat-carrying gases can come as closely as possible to the heat-absorbing surfaces. Because there is no fuel bed resistance and because the gas company supplies the motive power to draw in the air necessary for combustion (in the form of the initial gas pressure) draft losses through gas boilers are low. A gas boiler will therefore operate with a very slight draft, thus making it possible to run at very low stack temperatures.

INSTALLATION AND CONTROL OF BOILERS AND OTHER APPLIANCES

One feature of the piping installation that adds to the satisfactory service rendered by gas boilers is provision for adequate and rapid venting of the air from steam heating systems. If air leaks into the steam distribution system during the period that the gas is turned off, and then vents out slowly when the thermostat calls for heat, the result will be a further cooling of the premises between the time that the thermostat calls for heat and the time that steam reaches the radiators. A freely venting steam or vapor system gives maximum economy and minimum temperature variation. When gas boilers are attached to existing heating plants, it is good practice to check the effectiveness of the venting devices and if necessary, replace them with more effective ones that will prevent the return of air into the heating system, and also to check the tightness of the piping.

On account of the ease and effectiveness with which the fuel can be controlled, gas-burning appliances are particularly adaptable to full automatic control. Standard equipment on steam boilers quite generally includes provision for control through a thermostat, steam pressure regulation, and safety devices by means of which the gas is cut off either by lowering of the water in the boiler below a safe level, or by extinguishment of the pilot burner. Water boilers are adapted to operation under thermostatic room temperature control and are also provided with water temperature control, as well as the safety pilot feature. Warm-air furnaces can be under the control of thermostats in the spaces being heated, as well as thermostats located in the heat ducts for the purpose of preventing unpleasantly hot air reaching the heated spaces. Variations in the pressure under which the gas is supplied to the appliance are controlled by means of a gas-pressure regulator. This is a standard part of practically all makes of gas-burning heating appliances.

WARM AIR FURNACES

Gas-burning warm-air furnaces are variously constructed of cast iron, sheet metal and combinations of the two materials. If sheet metal is used, it must be of such a character that it will have the maximum resistance to the corrosive effect of the products of combustion. With some varieties of manufactured gases, this effect is quite pronounced and extremely difficult to contend with. Warm-air furnaces are obtainable in sizes from those sufficient to heat the largest residence down to sizes applicable to a single room. The practice of installing a number of separate furnaces to handle individual rooms is peculiar to mild climates, such as southern California. Small furnaces, frequently controlled by electrical valves actuated by push-buttons in the room above, are often installed to heat rooms where heat may be desired for an hour or so each day. The same fundamental principle of design that is followed in the construction of boilers; that is, breaking the hot gas up into fine streams, so that all particles are brought as close as possible to the heating surface, is equally applicable to the design of warm-air furnaces. The remarks in a previous paragraph, relative to the great desirability of using an