larger section and, like the loss due to sudden contraction, a loss of some consequence, particularly in short breechings, takes place. A sudden enlargement in a breeching may be avoided by gradually increasing the area over a length of several feet. In large masonry chimneys, the area of the flue at the region of the breeching entrance is considerably larger than the area of the breeching at the chimney, and a sudden enlargement exists.

The *draft loss through the economizer* ($h_E$) should be obtained from the manufacturer but for general purposes it may be computed from the following general equation:

$$h_E = \frac{6.6 W_n^2 N T_c}{10^{12}} \qquad (18)$$

*where*

$W_n$ = pounds of gases flowing per hour per linear foot of pipe in each economizer section.

$N$ = number of economizer sections.

An economizer in a steam plant affects the draft in two ways, (1) it offers a resistance to the flow of gases, and (2) it lowers the average chimney gas temperature, thereby decreasing the available intensity. In the case of a natural draft installation, both of these factors result in a relative increase in the height of the chimney and, in the case of a large plant, they may add as much as 20 or 30 ft to the height. The decrease in the temperature of the gases after they have passed through the economizer has an extremely important effect on the performance of a natural draft chimney and also upon the performance of a fan.

## GENERAL CONSIDERATIONS FOR DOMESTIC CHIMNEYS

The draft of domestic chimneys may be subject to a variety of influences not usually encountered in power chimneys, such as buildings in the immediate vicinity which may be higher than the chimney, trees, and even hills as well as the shape of the roof of the building which the chimney serves.

Horizontal winds have an aspirating effect as they pass across the chimney and are an aid to draft providing they remain horizontal at the chimney top. However, surrounding objects, such as trees or other buildings, may greatly affect the direction of the wind at the chimney top and may even direct it down the chimney, tending to reduce the draft or even to cause it to be negative. Although the chimney should, in general, extend well above the highest part of the roof, it is impracticable to carry it much beyond this point.

It is also important to consider the source of the air supply for proper combustion. Usually the boiler or furnace is located in the basement or cellar and perhaps, as a general thing, when the furnace room has windows or doors opening to the outside on two or more sides of the house, the leakage of air around the windows and doors will be sufficient for combustion, even though the windows and doors may be shut. However, if the leakage is not sufficient to prevent an appreciable drop of pressure in the furnace room below that of the air outside, the chimney draft will be reduced by the difference between the atmospheric pressure outside and





that inside the boiler room. In case the boiler room is fairly tight against leaks, as is desirable from the standpoint of dust, and is open to the outside on only one side of the house, then the draft will be affected in windy weather even with windows or doors open. If the wind is blowing toward the boiler room the draft will be increased, but if blowing in the opposite direction the draft may be seriously decreased.

It is not to be assumed that increasing the cross-section area of a chimney will always effect a cure for poor draft. The opposite result may be experienced because of the cooling effect of the larger area. This reduces the theoretical draft and the velocity of the gases, and affords a greater opportunity for counter currents in the chimney. The only practical remedy for a chimney with bad draft, when the chimney is of the proper size and is affected by conditions beyond the control of the owner, is to resort to mechanical draft. This can usually be done at small expense if operated only when necessary.

## CHIMNEYS FOR GAS HEATING

The burning of gas differs from the burning of coal in that the force which supplies the air for combustion of the gas comes largely from the pressure of the gas in the supply pipe, whereas air is supplied to a bed of burning coal by the force of the chimney draft. If, with a coal-burning boiler, the draft is poor, or if the chimney is stopped, the fire is smothered and the combustion rate reduced. In a gas boiler or furnace such a condition would interfere with the combustion of the gas, but the gas would continue to pass to the burners and the resulting incomplete combustion would produce a dangerous condition. In order to prevent incomplete combustion from insufficient draft, all gas-fired boilers and furnaces should have a back-draft diverter in the flue connection to the chimney.

A study of a typical *back-draft diverter* shows that partial or complete chimney stoppage will merely cause some of the products of combustion to be vented out into the boiler room, but will not interfere with combustion. In fact, gas-designed appliances must perform safely under such a condition to be approved by the *American Gas Association* Laboratory. Other functions of the back-draft diverter are to protect the burner and pilot from the effects of down-drafts, and to neutralize the effects of variable chimney drafts, thus maintaining the appliance efficiency at a substantially constant value.

As is the case with the complete combustion of almost all fuels, the

TABLE 2. MINIMUM ROUND CHIMNEY DIAMETERS FOR GAS APPLIANCES (INCHES)

| Height of Chimney Feet | Gas Consumption in Thousands of Btu per Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 100 | 200 | 300 | 400 | 500 | 750 | 1000 | 1500 | 2000 |
| 20 | 4.50 | 5.70 | 6.60 | 7.30 | 8.00 | 9.40 | 10.50 | 12.35 | 13.85 |
| 40 | 4.25 | 5.50 | 6.40 | 7.10 | 7.80 | 9.15 | 10.25 | 12.10 | 13.55 |
| 60 | 4.10 | 5.35 | 6.20 | 6.90 | 7.60 | 8.90 | 10.00 | 11.85 | 13.25 |
| 80 | 4.00 | 5.20 | 6.00 | 6.70 | 7.35 | 8.65 | 9.75 | 11.50 | 12.85 |
| 100 | 3.90 | 5.00 | 5.90 | 6.50 | 7.20 | 8.40 | 9.40 | 11.00 | 12.40 |