For all practical purposes, the value of πt may be taken as a constant regardless of the size of the structure. Hence, in general, the volume, and consequently the cost, of a chimney structure may be based on the factor HD as a criterion. Therefore, the value of the chimney gas velocity which will result in the least value of HD for any one set of operating conditions will produce a structure which will be the most economical to use, because its cost will be least.

The problem is to deduce an equation for the chimney gas velocity which will result in a combination of a height and a diameter whose

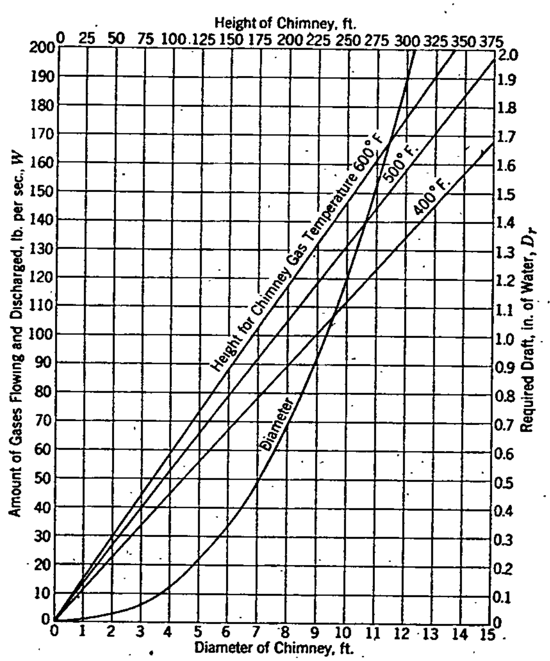

FIG. 6. ECONOMICAL CHIMNEY SIZES[a]

[a]Diameter values also for gas temperatures of 400, 500 and 600 F

product HD will be least. The solution is obtained by equating the product of Equations 6 and 7 to HD, differentiating this product with respect to V and equating the resulting expression to zero. This procedure results in the following expression:

$$V_e = \left(\frac{0.772 T_c \left(\frac{W_o}{T_o} - \frac{W_c}{T_c} \right) \sqrt{\frac{W T_c}{B_o W_c}}}{f W_c} \right)^{2/5} \quad (9)$$

where V_e = economical chimney gas velocity, feet per second.

Equation 9 gives the economical velocity of the chimney gases for any set of operating conditions, and represents the velocity which will

result in a chimney the size of which will cost less than that of any other size as determined by any other velocity for the same operating conditions. After the value of the economical velocity has been determined, the corresponding height and diameter can then be determined from Equations 6 and 7, respectively, and the economical size will then be attained. Equations 6, 7 and 9 may be simplified considerably for average operating conditions in an average size steam plant by assuming typical conditions.

Average chimney gas temperature, 500 F	$T_c = 960$
Mean atmospheric temperature, 62 F	$T_o = 522$
Average coefficient of friction, 0.016	$f = 0.016$
Average chimney gas density, 0.09	$W_c = 0.09$
Sea level elevation, with barometer of 29.92	$B_o = 29.92$

Substituting these values in Equations 9, 7 and 6, respectively, and reducing, the results are substantially:

$$V_e = 13.7 W^{1/5} \quad (10)$$

$$D = 1.5 W^{2/5} \quad (11)$$

$$H = 190 D_r \quad (12)$$

Fig. 6 gives the economical chimney sizes for various amounts of gases flowing and for required draft intensities as computed from Equations 10, 11 and 12. They are based on the operating factors used in reducing Equations 6, 7 and 9 to their simpler form. The sizes shown by the curves in the chart should be used for general operating conditions only, or for installations where the required data necessary for an exact determination are difficult or impossible to secure. Whenever it is possible to secure accurate data, or the anticipated operating conditions are fairly well known, the required size should be determined from Equations 6, 7 and 9. The recommended minimum inside dimensions and heights of chimneys for small and medium size installations are given in Table 1.

GENERAL EQUATION

The general draft equation for a steam producing plant may be stated as follows:

$$D_t - h_f = h_F + h_B + h_{Bd} + h_C + h_{Br} + h_V + h_O + h_E + h_R \quad (13)$$

where

D_t = theoretical draft intensity created by pressure transformer, inches of water.
h_f = draft loss due to friction in pressure transformer, inches of water.
h_F = draft loss through the fuel bed, inches of water.
h_B = draft loss through the boiler and setting, inches of water.
h_{Br} = draft loss through the breeching, inches of water.
h_V = draft loss due to velocity, inches of water.
h_{Bd} = draft loss due to bends, inches of water.
h_C = draft loss due to contraction of opening, inches of water.
h_O = draft loss due to enlargement of opening, inches of water.
h_E = draft loss through the economizer, inches of water.
h_R = draft loss through recuperators, regenerators, or air heaters, inches of water.