air change method to factories and industrial and commercial buildings because of wide variations in the type and percentage of fenestration which is the principal source of air leakage in such buildings.

INFILTRATION DUE TO TEMPERATURE DIFFERENCE

The air exchange due to temperature difference, inside to outside, is a chimney effect, causing air to enter through openings at lower levels and to leave at higher levels[5]. Although it is not appreciable in low buildings, this loss should be considered in tall, single story buildings with openings near the ground level and near the ceiling. Also in tall, multi-story buildings it may be a considerable item unless the sealing between various floors and rooms is quite perfect.

In tall buildings, temperature difference or chimney effect will produce a head that will add to the effect of the wind at lower levels and subtract from it at higher levels. On the other hand, the wind velocity at lower levels may be somewhat abated by surrounding obstructions. Furthermore, the chimney effect is reduced in multi-story buildings by the partial isolation of floors, thereby preventing free upward movement, so that wind and temperature difference may seldom cooperate to the fullest extent. Making the rough assumption that the *neutral zone*[6] is located at mid-height of a building, and that the temperature difference is 70 F, Equations 1 and 2 may be used to determine an equivalent wind velocity to be used in connection with Tables 1 and 2 that will allow for both wind velocity and temperature difference:

$$V_e = \sqrt{V^2 - 1.75\,a} \qquad (1)$$

$$V_e = \sqrt{V^2 + 1.75\,b} \qquad (2)$$

where

V_e = equivalent wind velocity to be used in conjunction with Tables 1 and 2.

V = wind velocity upon which infiltration would be determined if temperature difference were disregarded.

a = distance of windows under consideration from mid-height of building if *above* mid-height, feet.

b = distance if *below* mid-height, feet.

The coefficient 1.75 allows for about one-half the temperature difference head.

For buildings of unusual height, Equation 1 would indicate negative infiltration at the highest stories, which condition may, at times, actually exist.

Sealing of Vertical Openings

In tall, multi-story buildings, every effort should be made to seal off vertical openings such as stair-wells and elevator shafts from the remainder of the building. Stair-wells should be equipped with self-closing doors, and, in exceptionally high buildings, should be closed off into sections of not over 10 floors each. Plaster cracks should be filled. Elevator enclosures should be tight and solid doors should be used.

If the sealing of the vertical openings is made effective, no allowance

[5]A.S.H.V.E. Research Reports No. 994—Wind Velocities Near a Building and Their Effect on Heat Loss, by F. C. Houghten, J. L. Blackshaw and Carl Gutberlet (A.S.H.V.E. Transactions, Vol. 40, 1934, p. 387). No. 1069—Heating Requirements of an Office Building as Influenced by the Stack Effect, by F. C. Houghten and Carl Gutberlet (A.S.H.V.E. Transactions, Vol. 43, 1937, p. 437). Flue Action in High Buildings, by H. L. Alt (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, May, 1932, p. 376). Influence of Stack Effect on the Heat Loss in Tall Buildings, by Axel Marin (A.S.H.V.E. Transactions, Vol. 40, 1934, p. 377).

[6]Neutral Zone in Ventilation, by J. E. Emswiler (A.S.H.V.E. Transactions, Vol. 32, 1926, p. 59).

need be made for the chimney effect. Instead, the greater wind movement at the greater heights makes it advisable to install additional heating surface on the upper floors above the level of neighboring buildings, this additional surface being increased as the height is increased. One arbitrary rule is to increase the heating surface on floors above neighboring buildings by an amount ranging from 5 per cent to 20 per cent. This extra heating surface is required only on the windward side and on windy days, and hence automatic temperature control is especially desirable with such installations.

In stair-wells that are open through many floor levels although closed off from the remainder of each floor by doors and partitions, the stratification of air makes it advisable to increase the amount of heating surface at the lower levels and to decrease the amount at higher levels. One rule is to calculate the heating surface of the entire stair-well in the usual way and to place 50 per cent of this in the bottom third, the normal amount in the middle third and the balance in the top third.

Infiltration and Air for Combustion

Infiltration in residences normally supplies the air required for combustion by fuel burning appliances, but in some residences weatherstripping, sealing and caulking may reduce infiltration to the point that special openings must be provided to supply adequate air to the heating appliances.