Air at any temperature and moisture content may be considered as having a certain definite total heat in thermal units per unit weight as calculated from some arbitrary base, such as zero moisture and zero temperature. By using the psychrometric chart, on which are given wet-bulb temperatures and corresponding total heats, it is possible to determine the total heat to be removed in the process of dehumidification by subtracting the total heat of the cooled air with its reduced moisture content from that of the air in its initial condition as indicated on the chart.

This process is simplified greatly by taking into account the fourth psychrometric principle, by observing the fact that the wet-bulb temperature of the air may be used as the measure of the total heat which the air contains. Thus, by referring to the chart, having given air of known temperature and known moisture content, a corresponding wet-bulb temperature is obtained. Then, under standard barometric conditions, the quantity desired is determined by reference to the curve of total heat. For example, air at 85½ F with 80 per cent relative humidity has exactly the same total heat as air at 101 F and 40 per cent relative humidity, because in both cases the wet-bulb temperature is 80 F. This wet-bulb temperature represents about the maximum wet-bulb temperature ever encountered in the Temperate Zone under extreme conditions, and is nearly the maximum found in the Tropics. A normal high wet-bulb temperature for the Temperate Zone may be taken at 75 F in calculating requirements for air cooling, as this is seldom exceeded, except for short periods.

RATE OF EVAPORATION

In problems of air conditioning and drying, as well as in other industrial applications of evaporation, such as cooling towers, for example, it is desirable to determine the rate of evaporation. There are two distinct cases of evaporation. The *first* case is that in which the source of heat is primarily from the water itself and in which the air temperature may even be raised. The *second* is that in which the heat for evaporation is obtained entirely from the air itself, in which case the air is cooled and the temperature of the water remains substantially constant at the wet-bulb temperature. Both cases, however, may be reduced to a common basis of calculation. It has been found that the increase in the rate of evaporation is nearly in direct proportion to the increase in the air velocity, and that it is in direct proportion to the difference in vapor pressure between the vapor pressure of the water and the pressure of the vapor in the air.

The general formula covering the experimental data may be expressed as follows:

$$\frac{dw}{dt} = (a + bv)\,(e' - e) \qquad (6)$$

where

$\frac{dw}{dt}$ = rate of evaporation.
a = the rate of evaporation in still air.
b = the rate of increase with velocity.

e' = the vapor pressure of the liquid.
e = the vapor pressure in the atmosphere.
v = velocity.

The only difference between case *one* and case *two* is that in case *one* the vapor pressure of the liquid is one of the known or assumed factors, being dependent upon the known temperature of the liquid, while in case *two*, e' is the vapor pressure corresponding to the wet-bulb temperature of the air.

This wet-bulb or evaporation temperature is dependent upon the dry-bulb temperature and the moisture content, or upon the total heat of the air as indicated in the previous paragraph.

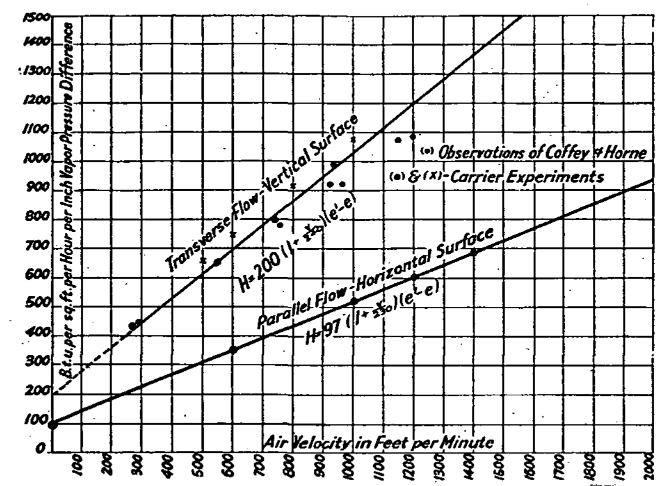

FIG. 3. HEAT TRANSMITTED BY EVAPORATION

The effect of air velocity depends upon whether the flow of air is parallel to the surface or perpendicular to the surface elements. For a flow of air *parallel* to a horizontal surface

$$w = 0.093\left(1 - \frac{v}{230}\right)(e' - e) \quad \text{(approximately)} \qquad (7)$$

where

w = pounds evaporated per square foot per hour.
v = velocity of atmosphere over surfaces in feet per minute.
e' = vapor pressure of the water corresponding to its temperature.
e = vapor pressure in the surrounding atmosphere.

For *transverse* flow, as across a tubular surface, the rate of evaporation is nearly doubled.

These relationships are indicated graphically on the chart, Fig. 3.

Since the difference in vapor pressures is substantially proportional to the difference between the wet- and dry-bulb temperatures (*i.e.*, the wet-