will both register 50°. If this air is heated, both thermometers will rise, but the wet-bulb temperature will rise more slowly and the relative humidity will be rapidly reduced: the dew-point remains constant at 50°, since any given number of grains of moisture per cubic foot has a fixed and definite dew-point or temperature of saturation.

If a cubic foot of air at a temperature of 87°, containing 4.076 grains per cubic foot with the wet-bulb temperature at 65°, is passed through a fine spray of recirculated water, it will absorb moisture; the dry-bulb temperature will immediately begin to fall, but the wet-bulb temperature will remain absolutely constant at 65° until the dry-bulb temperature has dropped to the wet-bulb temperature, namely, 65°. As the absorption takes place the dew-point will be gradually rising from 50° to 65°, when saturation is obtained. At ordinary temperatures the absorption of one grain of moisture per cu. ft. lowers the dry-bulb temperature approximately 8½°.

Sensible, Latent and Total Heat

The total heat of air is composed of the sensible heat or heat due to the temperature of the air as indicated by the thermometer, and the latent heat or heat of vaporization of the moisture or vapor in the air. The total heat is a constant quantity for any certain wet-bulb temperature irrespective of any change in the dry-bulb temperature. This fact has been termed by W. H. Carrier * "One of the four fundamental phychrometric principles," and expressed as

> **"The true wet-bulb temperature of the air depends entirely on the total of the sensible and the latent heat in the air and is independent of their relative proportions. In other words, the wet-bulb temperature of the air is constant, providing the total heat of the air is constant."**

Thus, if sufficient moisture is introduced into a certain quantity of air, the dry-bulb temperature of the air will be lowered until it is the same as the wet-bulb temperature. This is simply an exchange from sensible heat into latent heat required to vaporize the moisture, keeping the total heat the same. If a further lowering of the temperature takes place, the wet-bulb temperature will lower and the corresponding total heat will be less. If the air should be heated without the addition of more moisture, the dew-point temperature of the air would remain constant but the wet-bulb, as well as the dry-bulb temperature would increase, and the total heat of the air would increase a corresponding amount. The two Psychrometric Charts, Figs. 6 and 7, will be found especially convenient for determining the total heat of the air for any wet-bulb temperature.

Psychrometric Charts and Tables

Psychrometric Charts giving the properties of air as calculated by W. H. Carrier and published in his paper entitled "Rational Psychrometric Formulae," which was presented before the A. S. M. E. at the 1911 annual meeting, are shown in Figs. 6 and 7. These two charts are to be used when calculations are being made in terms of pounds of air, while the chart, Fig. 5, should be used for cubic feet of air. For most purposes of calculation it will be found preferable to use the pound as a unit.

The various curves shown on these charts will be found especially valuable in making air calculations. The grains of moisture per pound of dry air are read by passing directly from the dew-point, or intersection of the wet- and dry-bulb temperatures, to the scale on the left edge of the chart. The B. t. u. required to raise one pound of dry air one degree when saturated with moisture, as also the vapor pressure, may be determined by passing vertically from the dew-point to the proper curve, and then to the corresponding scale on the left edge of the chart. The total heat, in B. t. u., above zero degrees contained in one pound of dry air saturated with moisture may be found by passing vertically from the wet-bulb temperature to the total heat curve and then to the left edge of the chart. The volume of air in cubic feet per pound may be found by passing vertically from the dry-bulb temperature to either of the two volume curves and then to the left edge of the chart. One curve gives the volume of dry and the other of saturated air.

* "Rational Psychrometric Formulae." Am. Soc. Mech. Engrs., Dec., 1911.

Example. As an example of the use of this chart we will assume air at 75° dry-bulb temperature and 60 per cent. relative humidity. From the chart we find that the wet-bulb temperature will be 65.25°, the dew-point 60°, the grains of moisture per pound of dry air 77; the heat required to raise one pound of dry air saturated at 60° through one degree is 0.24664 B. t. u.; and the vapor pressure of air saturated at 60° is 0.523 inches of mercury. Passing vertically from the wet-bulb temperature of 65.25° to the **total heat** curve and thence to the scale on the left, we find the total heat above zero in one pound of dry air when saturated at 65.25° to be 29.75 B. t. u. This, then, is also the measure of the heat in a pound of air at 75° and 60 per cent. relative humidity, since the wet-bulb temperature is the same.

The cubic feet per pound of air may be found by passing vertically from the dry-bulb temperature to either of the two volume curves, depending on whether the volume of dry or of saturated air is desired. To determine the volume of one pound of partly saturated air as here assumed, we will have from the chart,

Cu. ft. per lb. at 75° sat. = 13.88
Cu. ft. per lb. at 75° dry = 13.48

.40 = Moisture
.60 = Rel. humidity

.24
13.48

Cu. ft. per lb. at 75° and 60% = 13.72

The Psychrometric Chart, Fig. 5, and the following tables are taken from the catalog of the Carrier Air Conditioning Company of America. They show the grains of moisture per cubic foot of saturated air at various temperatures, as well as the relative humidity, the dew-point temperature and the grains of moisture per cubic foot of air for different temperatures as determined by the wet and dry-bulb of the sling psychrometer.

As an example of the use of the chart, Fig. 5, we will assume a case where the dry-bulb temperature is 80° and the wet-bulb thermometer reads 70°, or a 10° depression. From the intersection of the corresponding lines through these two temperatures we find the relative humidity to be 62 per cent. Passing horizontally to the left from this point of intersection to the wet-bulb temperature line (called the saturation curve) we find the dew-point temperature to be 64.5°. If the temperature of the air should be reduced, both the dry and wet-bulb readings will be lowered until they both read 64.5°, when the air will be saturated. The grains of moisture contained in each cubic foot of this air will be found by continuing to the left on the horizontal line through the 64.5° dew-point to the left edge of the chart, where we have a reading of 6.65 grains. If the temperature of the air be further reduced, part of the moisture content will be condensed, the dew-point or saturation temperature will be lowered, and the grains of moisture per cubic foot will be correspondingly less.

In case more accurate readings are desired than can be determined from a chart on as small a scale as Fig. 5, the psychrometric tables may be used.