density and specific heat of the atmosphere. These relations have already been discussed by the author in a paper on Rational Psychrometric Formulae, presented before The American Society of Mechanical Engineers in 1911.

It is the writer's object in the present paper to explain more in detail these relations, to give more convenient and accurate formulae for the determination of the exact relation and to discuss the practical bearing of wet bulb temperature and vapor pressures in the art of air conditioning and upon the drying and moistening of hygroscopic materials.

It is well known that the weight of a cubic foot of saturated water vapor is a very definite quantity, dependent entirely upon its temperature, and that this water vapor acts substantially as a gas, producing a definite pressure, known as the vapor pressure. It obeys in this respect approximately the law of gases with reference to temperature, vapor pressure and weight or density. The vapor pressure and density increase very rapidly with the temperature, as exhibited in the well-known tables giving the properties of steam. The admixture of air under various barometric pressures as it occurs under ordinary atmospheric conditions does not in any way affect the weight per cubic foot or the pressure of the saturated vapor, but acts precisely the same as in a mixture of two gases. The combined pressure is equal to the total or barometric pressure; that is, the total weight of pure air in a mixture of a cubic foot of saturated vapor and air is less than the weight contained in a cubic foot of dry air just in proportion as the partial pressure of the air in the mixture is less than the total barometric pressure. This relation is expressed numerically as follows:—

$$W = \frac{S\,e}{P\text{-}e} = \frac{G_w}{G_a}$$

where W = the weight of water vapor contained in a pound of pure air, that is, it is the ratio of the weight of water;

G_w = to the weight of air;

G_a = in a given volume of the mixture;

P = the barometric pressure;

e = the vapor pressure of the water vapor;

$P\text{-}e$ = the partial pressure of the air;

S = the specific weight of water vapor, (i.e., the ratio of the weight of a cubic foot of water vapor at a given pressure and temperature compared with the weight of a cubic foot of air at the same pressure and temperature).

From this relationship it is possible to find:

1st, The weight of moisture contained in or rather associated in space with a pound of pure air;

2nd, The ratio of the weight of pure air contained in a cubic foot of the mixture compared with the weight of a cubic foot of air at the same temperature and barometric pressure but containing no moisture;

3rd, The weight of moisture contained in a cubic foot of air.

In the last two determinations we also require the relation determining the weight of pure air at any given temperature and pressure, which is the well known relation

$$W_a = \frac{1}{V} = \frac{P}{3772T}$$

where W_a = the weight of one cubic foot of air;

V = the volume of one pound of air;

P = the barometric pressure or partial pressure in inches of mercury to which the air is subjected;

T = the absolute temperature in degrees fahrenheit.

When unsaturated air is brought in contact with water three physical changes take place simultaneously:—*first,* the water temperature is ultimately reduced to a definite temperature known as the wet bulb temperature; *second,* a certain amount of water is evaporated, increasing the vapor pressure and the water vapor content in the air; *third,* the air is cooled a corresponding amount, owing to the fact that finally the *latent heat of evaporation must be taken from the air as the only source of heat.* If this process is continued to the point of complete saturation of the air and no heat is received from the water or any other external source, then the air temperature will drop to a *definite point* which is the true wet bulb temperature or evaporation temperature of the air.

Thus the wet bulb temperature and the dry bulb temperature at this point of saturation are both the same, and the wet bulb temperature is substantially the same before the air has become saturated as after it has become saturated. In other words, the wet bulb temperature does not change during the process of saturation, but the dry bulb temperature decreases and the moisture content increases to some definite point at which the air is completely saturated. This fact has been determined by careful practical and laboratory experiments.

This is precisely the action that takes place in air conditioning