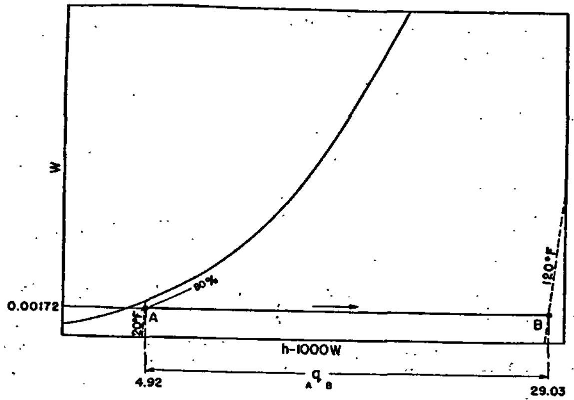

FIG. 2. ILLUSTRATION OF USE OF GOFF DIAGRAM IN SOLUTION OF EXAMPLE 6

Cooling

The process of cooling moist air is also represented by a horizontal line on the Goff Diagram. The line may extend across the saturation curve into the two-phase region, nevertheless, the length of the line between the initial and final states is the quantity of heat removed, or refrigeration supplied, per pound of dry air. By following the final isotherm downward to the right to the saturation curve and reading the ordinate there, the weight of water vapor per pound of dry air in the vapor phase is determined. The difference between the initial humidity ratio and this ordinate is the weight of condensed phase per pound of dry air in the final state.

Example 7. Air at 95 F and 50 per cent saturation is cooled to 70 F. Find the refrigeration required to process 20,000 cfm of uncooled air.

Solution. From the data in Table 1: the initial humidity ratio is 0.50 × 0.03673 = 0.01837 lb_w/lb_a; the initial enthalpy is 22.827 + 0.50 × 40.49 = 43.072 Btu/lb_a; the humidity ratio at saturation at the final temperature is 0.01582 lb_w/lb_a; the quantity of liquid formed is 0.01837 − 0.01582 = 0.00255 lb_w/lb_a; the enthalpy of the final two-phase mixture is 34.09 + 0.00255 × 38.11 = 34.187 Btu/lb_a.

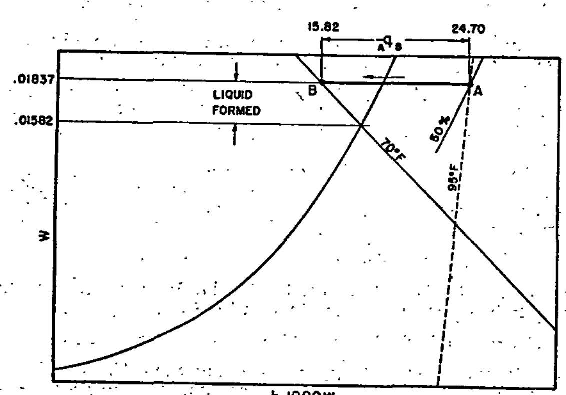

FIG. 3. ILLUSTRATION OF USE OF GOFF DIAGRAM IN SOLUTION OF EXAMPLE 7

It may be supposed that the air is cooled between two sections of a duct. The quantities of energy convected across the two sections per pound of dry air crossing them are the two enthalpies calculated. Conservation of energy requires that the difference between these two enthalpies be the quantity of heat removed, or refrigeration supplied, between the two sections. Therefore,

$$-{}_Aq_B = 43{,}072 - 34.187 = 8.885 \text{ Btu/lb}_a$$

The initial volume is 13.980 + 0.50 × 0.822 = 14.391 cu ft/lb_a. Since 20,000 cfm of air is to be processed, the total refrigeration required is

$$-{}_AQ_B = 8.885 \times 20{,}000 \div 14.391 = 12{,}348 \text{ Btu per min}$$

On the Goff Diagram the process is represented by the horizontal line AB, Fig. 3, whose length is the quantity of refrigeration required per pound of dry air.

Adiabatic Mixing of Two Air Streams

A typical air conditioning process requiring special analysis is the adiabatic mixing of two air streams. Referring to Fig. 4, let m_1, m_2, m_3 denote the weights of dry air convected across sections F_1, F_2, F_3, respectively,

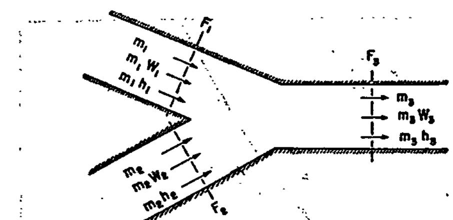

FIG. 4. ADIABATIC MIXING OF 2 AIR STREAMS

per minute. Then m_1W_1, m_2W_2, m_3W_3 and m_1h_1, m_2h_2, m_3h_3 will denote the weights of water and the quantities of energy similarly convected. If the mixing is adiabatic, it must be governed by the three equations,

$$\begin{aligned} m_1 + m_2 &= m_3 \\ m_1W_1 + m_2W_2 &= m_3W_3 \\ m_1h_1 + m_2h_2 &= m_3h_3 \end{aligned} \qquad (8)$$

Elimination of m_3 gives,

$$\frac{h_2 - h_3}{h_3 - h_1} = \frac{W_2 - W_3}{W_3 - W_1} = \frac{m_1}{m_2} \qquad (9)$$

according to which: *on the Goff Diagram the state point of the resulting mixture lies on the straight line connecting the state points of the two streams being mixed and divides the line into two segments which are in the same ratio as are the weights of dry air in the two streams.*

Example 8. Outside Air at 0 F and 80 per cent saturation is to be mixed adiabatically with recirculated Inside Air at 70 F and 20 per cent saturation in the ratio of one pound of dry air in the former to seven in the latter. Find the temperature and degree of saturation of the resulting mixture.

Solution. The humidity ratio W_3 and the enthalpy h_3 of the resulting mixture must satisfy Equation 9, namely,

$$\frac{0.003164 - W_3}{W_3 - 0.000630} = \frac{20.270 - h_3}{h_3 - 0.668} = \frac{1}{7}$$