passes through the state point of the Inside Air and intersects the saturation curve at the apparatus dew-point.

According to Equation 11 the enthalpy h_s and humidity ratio W_s at the apparatus dew-point must satisfy the equation

$$7148.8W_s - h_s = 7148.8 \times 0.01122 - 31.514 = 48.681$$

At 58 F the left-hand member has the value 48.513; at 59 F its value is 50.641; by interpolation the apparatus dew-point is 58.08 F.

It would be a mistake to assume that the refrigeration to be supplied is equal to the net energy to be removed; for in general water is to be removed simultaneously and unless this is removed as liquid at 32 F it will automatically take some energy with it. Thus, unless the water is removed as solid (ice) the refrigeration to be supplied will be somewhat less than the net energy to be removed.

Example 13. Referring to the cooling load problem of Example 12, suppose that the conditioning process consists of cooling a portion of the *inside air* to the apparatus dew-point temperature, separating out the liquid thus formed, and returning the resulting saturated mixture to the conditioned space. Find the quantity of *inside air* that must be processed in this manner and the corresponding quantity of refrigeration required.

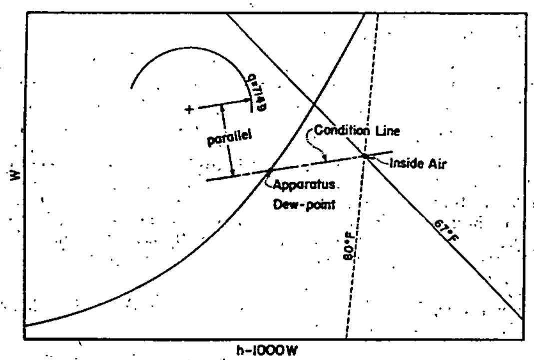

FIG. 9. ILLUSTRATION OF USE OF MOLLIER DIAGRAM IN SOLUTION OF EXAMPLE 12

Solution. During the cooling operation the enthalpy of the Inside Air is reduced to the value,

$$h = 25.17 + (0.01122 - 0.01033) \times 26.20 = 25.193$$

where 25.17 and 0.01033 are the values of enthalpy and humidity ratio at saturation at the apparatus dew-point temperature and 26.20 is the specific enthalpy of liquid water at that temperature. It follows that the quantity of refrigeration required is 31.514 − 25.193 = 6.321 Btu per pound of dry air.

The *inside air* being processed leaves the store with an enthalpy of 31.514 and is returned with an enthalpy of 25.17; it therefore removes energy of amount 6.344 Btu per pound of dry air. This means that the weight of dry air involved in the process is 114,510/6.344 = 18,050 lb per hour and that the total refrigeration to be supplied is 18,050 × 6.321 = 114,090 Btu per hour, or 9.508 tons.

The quantity of liquid separated out during the conditioning process is 18,050 × (0.01122 − 0.01033) = 16.018 lb per hour as required. In leaving the apparatus it takes with it energy of amount 16.018 × 26.20 = 420 Btu per hour. This plus the refrigeration accounts for the total energy removal of 114,510 Btu per hour as required.

On the Mollier Diagram, Fig. 10, the cooling operation is represented by line AB whose length is the quantity of refrigeration per pound of dry air; the separation of the liquid

formed in the cooling operation is represented by line BC whose projection on the ordinate axis is the quantity of liquid so separated per pound of dry air. Point C is the apparatus dew-point and lies on the condition line as required.

In practice it may not be feasible to choose the apparatus dew-point as the point on the condition line to which to condition the *inside air* because to do so would require an excessive number of air changes in the given space. Or it may be that the condition line does not cross the saturation curve at all so that the apparatus dew-point as defined does not exist. Finally, it is rarely possible to obtain complete saturation in conventional air conditioning apparatus. Nevertheless the requirements of the cooling load problem can be exactly met if the conditioned air is brought to *any* point on the condition line of the problem.

Heating Load

The condition line is also useful in the analysis of heating load problems as may best be illustrated by means of an illustrative example.

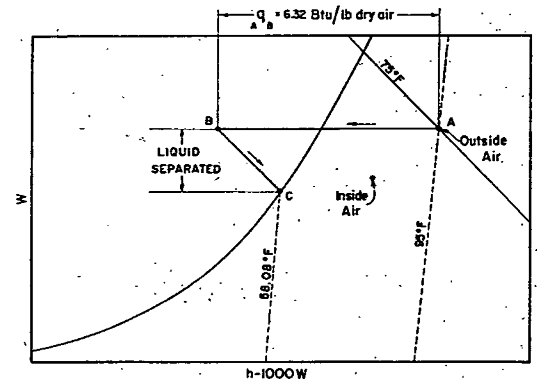

FIG. 10. ILLUSTRATION OF USE OF MOLLIER DIAGRAM IN SOLUTION OF EXAMPLE 13

Example 14. A certain space is to be maintained at 70 F and 50 per cent saturation with outside conditions at 0 F and 80 per cent saturation. The normal heat transmission through walls, partitions, floor, roof, glass and doors is estimated at 75,000 Btu per hour. Energy gained from lights and appliances is estimated at 15,000 Btu per hour. Energy and water gains from occupants are to be disregarded in the calculations. Double doors and windows are used so that infiltration is negligible. The ventilation requirement is 30,000 cu ft per hour of *outside air*.

The requirements of the problem are to be met in the following manner; preheat the *ventilating air*; mix it adiabatically with recirculated *inside air*; saturate the mixture adiabatically with recirculated spray water; heat the resulting mixture to 105 F and return it to the conditioned space as *supply air*.

Analysis. Every pound of dry air admitted to the system (air conditioned space plus air conditioning apparatus) with the *ventilating air* displaces a pound of dry air from the system with *inside air*. Since the *ventilating air* is not admitted directly to the space, then for every pound of dry air withdrawn with *inside air* there is a pound of dry air returned with *supply air*. This has to have the net effect of adding energy of amount 60,000 Btu per hour and water of amount *zero* pounds per hour. Thus the ratio q determining the direction of the condition line is infinite, which means that the condition line is horizontal as indicated by the protractor on the Mollier Diagram.

The properties of *inside air* are: $h = 25.451$, $W = 0.007910$. Since the state point of the *supply air* must be on the condition line at 105 F, its properties are: $h = 33.986$,