mission coefficient is different, provided the structure has thermal and physical properties similar to one of those listed in Tables 9 and 10.

3. Adjustments can be made, according to instructions given in the footnotes, for room and outdoor conditions different from those on which the tables are based.

Examples of Use of Equivalent Temperature Tables

Example 5: Given: A roof is constructed of 6 in. of stone concrete with 2 in. of insulating board and tar felt roofing $\frac{3}{8}$ in. thick, and is exposed to the sun. The location is the central part of the United States. Find the rate of heat flow into building at 2:00 p.m. during July for an outdoor design temperature 95 F, and an inside temperature 80 F.

Solution: From Table 9 in 2 p.m. column for 6 in. concrete plus 2 in. insulation, find the total equivalent temperature differential 34 deg. The overall heat trans-

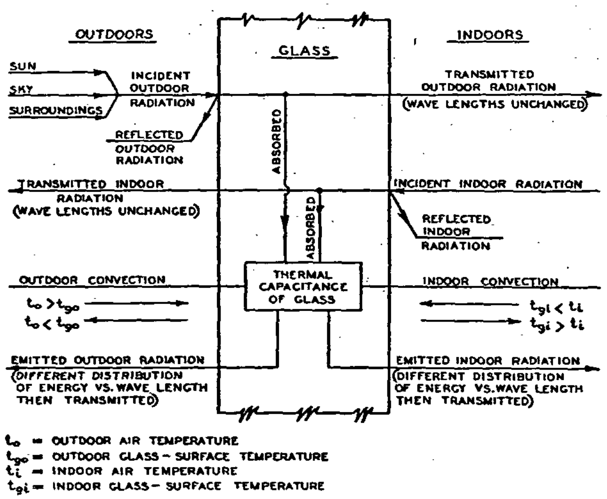

FIG. 2. INSTANTANEOUS HEAT-BALANCE CONDITIONS ON A GLASS SECTION

mission coefficient for summer is taken from Table 11 and is found to be 0.13. The heat flow rate equals 34 × 0.13 = 4.42 Btu per (hr) (sq ft).

Example 6: For the conditions of *Example 5*, find the rate of heat flow into building at 2:00 p.m. during July for design temperatures of 105 F (outdoor) and 78 F (indoor). Daily range of temperature 30 deg, *i.e.*, outdoor temperature minimum of 75 F which occurs at 4:00 or 5:00 a.m.; this being 30 deg less than the maximum.

Solution: Make correction in equivalent temperature differential in accordance with Note 5 in Table 9 as follows:

The correction for 27 deg design temperature difference is $(27 - 15) = +12$.

The correction for 30 deg daily range is $\left(-\frac{30 - 20}{2}\right) = -5$.

Net total correction is $+12 - 5 = +7$.

The heat flow rate at 2:00 p.m. therefore is $(34 + 7) \times 0.13 = 5.32$ Btu per (hr) (sq ft).

A method of determining *heat flow rates*, when structure is not given in Tables 9 or 10, is illustrated in *Example 7* which follows.

Example 7: A 4 in. stone concrete roof covered with an average depth of 4 in. cinder concrete ($k = 4.9$) on which is placed a $\frac{3}{8}$ in. thick felt roof with $\frac{1}{2}$ in. pitch and slag surface, is exposed to the sun. The location is the central part of the United States. Design temperatures are: outdoor 95 F; daily range 20 deg; indoor temperature 80 F. Find the heat flow rate at 2:00 p.m. for a day in July.

Solution: For the purpose of selecting the *equivalent temperature differential*, this construction is assumed to be equal approximately to an uninsulated 6 in. concrete roof, for which the equivalent temperature is found to be 38 deg in the 2:00 p.m. column of Table 9. Calculate the overall heat transmission coefficient U (see Equation 3 of Chapter 9) of the roof as follows:

$$U = \frac{1}{\frac{1}{1.2} + \frac{4}{12} + \frac{4}{4.9} + \frac{0.375}{1.33} + \frac{0.50}{1.00} + \frac{1}{4.0}} = 0.33.$$

The heat flow rate is then 38 × 0.33 equals 12.5 Btu per (hr) (sq ft).

TABLES FOR CALCULATING SOLAR HEAT GAIN THROUGH GLASS AREAS

Basic Principles

In order to set forth the principles involved in calculating heat flow through glass areas, the general instantaneous heat-balance relation will be presented. It will be shown schematically in Fig. 2. The net heat gain for the indoor space is the result of several contributing phenomena. Some observations concerning the behavior of glass with respect to radiant energy will lead to a better understanding of the heat-balance relation. To various degrees glass transmits radiation having wave lengths between 0.29 and 4.75 microns. Of the portion not transmitted, part is absorbed, and the remainder is reflected. Outside these limits glass is opaque, absorbing approximately 94 percent and reflecting 6 percent. Only a negligible amount of radiant energy from a surface at 450 F has a wave length shorter than 4.75 microns. It is therefore convenient to treat all forms of solar radiant energy separately from radiant energy from other sources, so long as the temperature of these sources is not over approximately 450 F.

The complete heat-balance for a glass section can be expressed for a unit time interval as follows:

$$\begin{bmatrix}\text{Total heat flow,}\\ \text{through glass section}\end{bmatrix} = \begin{bmatrix}\text{Transmitted,}\\ \text{solar radiation}\end{bmatrix} \pm \begin{bmatrix}\text{Heat flow by convective}\\ \text{and radiative exchanges at}\\ \text{the indoor surface}\end{bmatrix} \quad (2a)$$

The second term of the right side of Equation 2a can also be expressed by a heat balance equation as follows:

$$\begin{bmatrix}\text{Heat flow by convective}\\ \text{and radiative exchanges}\\ \text{at the indoor surface}\end{bmatrix} = \begin{bmatrix}\text{Absorbed}\\ \text{solar}\\ \text{radiation}\end{bmatrix} \pm \begin{bmatrix}\text{Radiative exchanges be-}\\ \text{tween outer surface of glass}\\ \text{and outdoor surroundings}\end{bmatrix}$$

$$\pm \begin{bmatrix}\text{Convective exchanges}\\ \text{between outer surface of}\\ \text{glass and outdoor air}\end{bmatrix} \pm \begin{bmatrix}\text{Heat storage}\\ \text{within the}\\ \text{glass section}\end{bmatrix} \quad (2b)$$

Equations 2a and 2b can be combined and expressed in symbolic terms by Equation 2c. Tabular values of the two bracketed terms of Equation 2a are presented later in this section for various types of glass for specific design conditions.

$$(q/A) = [\tau_D I_D + \tau_d I_d] + [\alpha_D I_D + \alpha_d I_d + \epsilon_{go} R_s - \epsilon_{go} R_{go} - f_{co}(t_{go} - t_o) - S], \quad \text{Btu per (hr) (sq ft)} \quad (2c)$$