which is a simple form analogous to the steady-state equations of Chapters 5 and 6. In steady-state calculations for heating loads, the design outdoor temperature is a constant; here, t_p varies with time, wall construction, wall orientation, and heat-transfer boundary conditions expressed as sol-air temperature data.

To make Equation 9 of maximum practical convenience, there are needed, for representative wall and roof constructions and for sample weather-design conditions, data giving values of U and t_p for a design-day cooling cycle.

The available information on these quantities is sufficient to establish usable data in preliminary form, and continuing A.S.H.V.E. research is expected to improve and extend these data.

Values of U. The values of U for use in Equation 9 are listed in Table 12 for a few constructions. Other values are given in Chapter 6. Note, however, that Table 12 is based upon $f_o = 4.0$ Btu per (hr) (sq ft) (F deg), whereas the values in Chapter 6 are based upon $f_o = 6.0$. The question of which value of f_o is the more satisfactory is the subject of some controversy at the moment. The difference in U is not a critical one, however, in view of the inevitable approximations which enter into cooling-load estimates, and hence the tables of Chapter 6 may be used without correction where necessary.

Values of t_p. The sol-air data for New York City, Table 10, are recommended as the basis for determinations of t_p. (These data may be adjusted for latitude, air temperature, and (b/f_o) as previously explained.) Magnitudes of the factor λ, and the time lag needed to obtain $t_e{}^*$ may be estimated as previously indicated. Calculations then follow directly from the defining equation,

$$t_p = t_m + \lambda\,(t_e{}^* - t_m) \qquad (10)$$

It is expected that *design tables* may be made available in due time which will give values of t_p directly and make detailed calculations unnecessary.

GLASS AREAS—DESIGN TABLES

In order to clearly set forth the principles involved in calculating heat transfer through glass areas the general instantaneous heat-balance relation will be presented. Fig. 5 shows this schematically. The net heat gain for the indoor space is the result of several contributing phenomena.

In discussing the heat gain through glass, there are three dimensionless quantities which require definition:

a = Absorptivity of glass, or fraction of incident radiation intensity which is absorbed within the glass itself.
τ = Transmissivity of glass, or fraction of incident radiation intensity which is transmitted through the glass.
r = Reflectivity of glass, or fraction of incident radiation intensity which is reflected at the surface.

It is necessary that

$$a + \tau + r = 1 \qquad (11)$$

These quantities vary with wave length and angle of incidence, primarily; and they are determined by the properties and thickness of the glass material concerned. Data are obtainable from glass manufacturers for their various products. The dependence of these quantities upon wave length has important practical consequences; for example, common

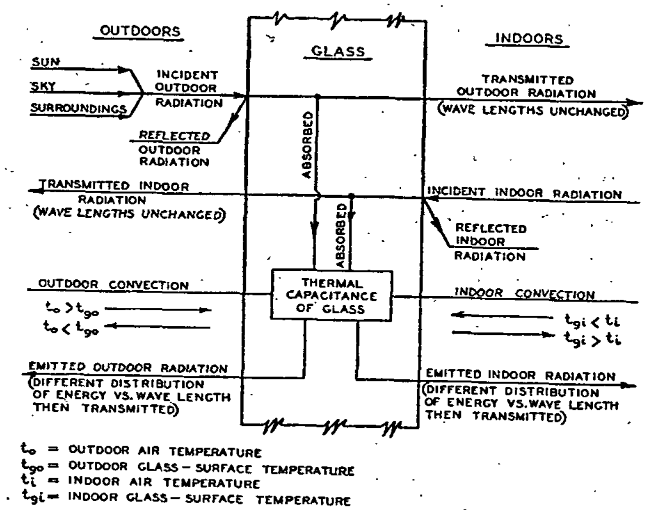

FIG. 5. INSTANTANEOUS HEAT-BALANCE CONDITIONS ON A GLASS SECTION

window glass transmits a large portion of incident *solar* radiation, whereas it transmits outward only a very small portion of the indoor radiation falling upon the inside surface because this latter is principally in the longer wave lengths.

A recent analysis has served to demonstrate the effects of the various controlling variables upon the heat gain from glass in relation to air-conditioning problems [11]. The practical results for a single sheet of common window glass will be cited here. For average conditions, the design equation for the instantaneous rate of heat transfer from the indoor glass surface to the conditioned space (for single sheets of common window glass only) in Btu per (hour) (square foot of sunlit surface) was found to be:

$$\left(\frac{q}{A}\right) = 1.04\,(t_o - t_i) + 0.022\,I_d + 0.0165\,I_s + \tau_d I_d + 0.778\,I_s. \qquad (12)$$

where t_o = Outdoor air temperature, Fahrenheit degrees.
t_i = Indoor air temperature, Fahrenheit degrees.
I_d = Intensity of solar or direct radiation on the outer glass surface, Btu per (hour) (square foot of sunlit surface).
I_s = Intensity of sky radiation on the outer glass surface.
τ_d = Transmissivity of the glass for solar radiation, dimensionless, given as a function of the angle of incidence in Table 14.

TABLE 14. TRANSMISSIVITY OF SINGLE-SHEET COMMON WINDOW GLASS FOR DIRECT SOLAR RADIATION

Angle of Incidence[a] Deg	Transmissivity τ_d	Angle of Incidence[a] Deg	Transmissivity τ_d	Angle of Incidence[a] Deg	Transmissivity τ_d
0	0.87	50	0.83	80	0.41
20	0.86	60	0.77	90	0
40	0.85	70	0.65		

[a]Of Direct Solar Radiation.