TABLE 19. VALUES OF THE AZIMUTH-DIFFERENCE ANGLE, γ, DEGREES, FOR WINDOW-REVEAL SHADING CALCULATIONS (SEE EQUATION 12)

Computed for solar declination of 18 deg—August 1

N. Latitude Degrees	Mean Sun Time	Window Orientation						
		NE	E	SE	S	SW	W	NW
30	6 a. m.	61	74	29	Shade	Shade	Shade	Shade
	7	54	81	36	....	....	....	....
	8	47	88	43	....	....	....	....
	9	39	84	51	6	....	....	....
	10	28	73	62	17	....	....	....
	11	7	52	83	38	....	....	....
	12 N	Shade	0	45	90	45	0	....
	1 p. m.	....	Shade	Shade	38	83	52	7
	2	....	....	....	17	62	73	28
	3	....	....	....	6	51	84	39
	4	....	....	....	Shade	43	88	47
	5	....	....	....	....	36	81	54
	6	....	....	....	....	29	74	61
40	6 a. m.	59	76	31	Shade	Shade	Shade	Shade
	7	50	85	40	....	....	....	....
	8	40	85	50	5	....	....	....
	9	27	74	61	16	....	....	....
	10	14	59	76	31	....	....	....
	11	Shade	35	80	55	....	....	....
	12 N	....	0	45	90	45	0	....
	1 p. m.	....	Shade	10	55	80	35	....
	2	....	....	Shade	31	76	59	14
	3	....	....	....	16	61	74	27
	4	....	....	....	5	50	85	40
	5	....	....	....	Shade	40	85	50
	6	....	....	....	....	31	76	59
50	6 a. m.	57	78	33	Shade	Shade	Shade	Shade
	7	45	90	45	0	....	....	....
	8	33	78	57	12	....	....	....
	9	20	65	70	25	....	....	....
	10	3	48	87	42	....	....	....
	11	Shade	26	71	65	19	....	....
	12 N	....	0	45	90	45	0	....
	1 p. m.	....	Shade	19	65	71	26	....
	2	....	....	Shade	42	87	48	3
	3	....	....	....	25	70	65	20
	4	....	....	....	12	57	78	33
	5	....	....	....	0	45	90	45
	6	....	....	....	Shade	33	78	57

Solar altitudes are given in Table 15 for various latitudes and an August 1 design day. Values of the angle γ are given in Table 19 for the August 1 design day. Special cases not covered by the tabulated data may be solved analytically [13]; however, the design conditions chosen will yield a satisfactory approximation if used without correction for estimates at any time during the summer period.

Example 6. Estimate the instantaneous rate of sky and solar radiation heat gain from a west window 3 ft wide by 5 ft high with a setback of 6 in. for August 1 and a north latitude of 40 deg at 3 p. m. (sun time).

From Table 15, the instantaneous rate of sky and solar radiation heat gain per square foot of sunlit glass is 172 Btu per hour. From the same table, the solar altitude is 45.5 deg. From Table 19, the angle γ is 16 deg, from Equation 13, the fraction of the total window area that is receiving direct solar radiation is:

$$G_f = 1 - 0.1 \tan 45.5 - 0.167 \tan 16 + 0.0167 \tan 45.5 \tan 16.$$
$$= 1 - 0.102 - 0.048 + 0.005 = 0.855.$$

Although the *sky* radiation is not reduced in proportion to the shaded portion, since the sky radiation is small this fact may be neglected, and hence instantaneous sky-and solar-radiation heat gain for this window is:

$$q = 3 \times 5 \times 0.855(172) = 2206 \text{ Btu per hour.}$$

TABLE 20. EFFECT OF SHADING UPON TOTAL (RADIATION, CONDUCTION AND CONVECTION) RATES OF INSTANTANEOUS HEAT GAIN THROUGH SINGLE THICKNESS OF COMMON WINDOW GLASS[a]

Type of Shading	Finish	Fraction of Gain Through Unshaded Window
Outside Shading Screen: metal slats 0.050 in. wide, spaced 0.063 in. apart and set at 17 deg angle with horizontal.	Dark	0.20-0.35
Canvas Awning	Dark	0.25-0.35
Outside Venetian Blind: slats at 45 deg, extended as an awning without sides to cover approximately two-thirds of window.	Light	0.35-0.50
Inside Roller Shade: fully drawn.	Aluminum	Approx. 0.45
Outside Venetian Blind: slats at 45 deg, fully covering window.	Aluminum	Approx. 0.3
Inside Venetian Blind: slats at 45 deg, fully covering window.	Aluminum	0.65-0.80
Inside Roller Shade: half drawn.	Buff	Approx. 0.7
Inside Roller Shade: half drawn.	Dark	0.90-0.95

[a]These factors are not accurate for heat absorbing glass or glass blocks.

A window such as the one in Example 6 above would customarily be provided with an additional shading means for use particularly when directly sunlit. Conventional shading devices include *awnings*, *shades*, and *screens* of various types.

In Table 20 are given the ratios of the instantaneous rates of heat gain from windows shaded by different indoor and outdoor shading fixtures to the rate of heat gain from unshaded glass according to tests [13] at the A.S.H.V.E. Research Laboratory. There are a number of variables affecting these ratios such as color, fit, solar altitude, and angle of incidence of the solar radiation. These values, therefore, must be considered as approximate, only, and will have to be used with considerable judgment. An inside shade is effective to the extent of its reflectivity, since the portion of the solar radiation directly transmitted by the glass that is absorbed by the shade is transferred by convection to the room air and by radiation to the solid surfaces of the room.

Instantaneous Heat Gains vs. Instantaneous Cooling Loads

The difference between instantaneous heat gain and instantaneous cooling load has been mentioned previously; its practical importance is sufficient to warrant further consideration.

Fig. 6 offers a simplified schematic illustration showing how the *radiative* part of the instantaneous heat gain is first absorbed by solid objects and is not encountered by the conditioning equipment as a cooling load

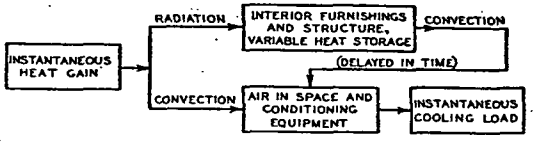

FIG. 6. ORIGIN OF THE DIFFERENCE BETWEEN THE MAGNITUDES OF THE INSTANTANEOUS HEAT GAIN AND INSTANTANEOUS COOLING LOAD

The radiation absorbed by the interior furnishings and structure reaches the conditioning equipment after a considerable delay in time.