Divide cubic contents by 800.
Add together the above and multiply by 6.
The result is the area of the basement pipe in sq. in.
(See Section 9, *b*)

$$\left.\begin{array}{l}\text{The sum of:}\\ \text{Glass (sq. ft.) (}\textit{Note 3}\text{)} \div 12\\ \text{Net Wall (sq. ft.) (}\textit{Note 4}\text{)} \div 60\\ \text{Cubic Contents} \div 800\end{array}\right\} \times 6 = \text{Area of Basement Pipe}$$

Section 3. Each Third Floor Room.

Divide square feet of glass by 12.
Divide square feet of net outside wall by 60.
(See Table A)
Divide cubic contents by 800.
Add together the above and multiply by 5.
The result is the area of the basement pipe in sq. in.

$$\left.\begin{array}{l}\text{The sum of:}\\ \text{Glass (sq. ft.) (}\textit{Note 3}\text{)} \div 12\\ \text{Net Wall (sq. ft.) (}\textit{Note 4}\text{)} \div 60\\ \text{Cubic Contents} \div 800\end{array}\right\} \times 5 = \text{Area of Basement Pipe}$$

Basis of Working Rules for Pipes

a. These formulae are for 70 deg. temperature difference (outside temperature zero, inside temperature 70 deg. fahr.). When temperature difference is more than 70 deg., add 1½ per cent per deg. to final figures. When temperature difference is less than 70 deg., deduct 1½ per cent per deg. room final figures.

b. The values as given in Table A for use in the working rules, Article 3, Sections 1, 2 and 3 are derived as follows:

Example.—The factor 60 in Table A, Item No. 1, is based upon a coefficient of heat transmission of 0.23 B.t.u. per square foot per degree difference per hour, thus:

$W \times 0.23 \times 70 \div 111 =$ sq. in. first floor leader to compensate for the heat loss through walls only. In this,

W = net area of exposed wall in sq. ft.
0.23 = coefficient of transmission in B.t.u. per sq. ft. per degree difference per hr.
70 = difference in temperature of air on inside and outside of wall.
111 = heat delivering capacity of 1 sq. in. of first floor leader pipe for a register temperature of 175 deg. fahr.

Reduced to its simplest approximate form this is

$$\frac{W \times 9}{60}$$

Likewise substitute 167 for second floor and 200 for third floor in place of 111.

The values in Table A for the different types of walls were obtained by substitution of proper coefficient of heat transmission instead of 0.23 in the above formula.

TABLE A

(The factor 60 used in Art. 3, Secs. 1, 2 and 3 is for buildings constructed as in item No. 1. When other types of walls are used substitute the appropriate factor as given below)

No. 1.—Frame wall constructed of siding, paper, sheathing, studding, lath and plaster	60
No. 2.—Frame wall constructed of siding or stucco direct to sheathing (no paper), lath and plaster	52
No. 3.—9 in. Brick Wall (no plaster)	40
No. 4.—9 in. Brick Wall, plastered one side	48
No. 5.—9 in. Brick Wall, air space, furred and plastered	65
No. 6.—13 in. Brick Wall, no plaster	53
No. 7.—13 in. Brick Wall, plastered one side	57
No. 8.—13 in. Brick Wall, air space, furred and plastered	75
No. 9.—4 in. Brick, 4 in. hollow tile, plastered	55
No. 10.—4 in. Brick, paper, sheathing, studding, lath and plaster (brick veneer)	68
No. 11.—8 in. Hollow tile stucco and plaster	67
No. 12.—8 in. Hollow tile, stucco furred and plastered	90
Roofs	
No. 13.—1 in. T & G. Sheeting, Tar and Gravel	48
No. 14.—1 in. T & G. Sheeting and Composition roof	40
No. 15.—1 in. T & G. Sheeting and Tin	24
No. 16.—Corrugated Iron on strips	9.3
Ceilings	
No. 17.—Lath and plaster without floor above	50
No. 18.—Lath and plaster with tight floor above	90
No. 19.—Metal without floor above	40
No. 20.—Metal with tight floor above	70

Method for Determining Size of Wall Stacks

Section 4. First Floor Rooms.
Same as Section 1.

Section 5. Second Floor Rooms.
Not less than 70 per cent of basement pipe area as determined in Section 2.

Section 6. Third Floor Rooms.
Not less than 70 per cent of basement pipe area as determined in Section 3.

Where two or more rooms are heated from the same basement pipe and stack, the area of such basement pipe and stack shall equal the combined areas as determined in Art. 3. Sections, 1 2 and 3.

Explanatory Notes

Note 3.—In obtaining glass surface use full casement opening. An outside door is figured as glass.

Note 4.—To obtain net outside wall multiply height by width and deduct the glass in all windows and outside doors. For all rooms with attic spaces immediately above, full ceiling areas shall be taken into account using Table A. Floors over unexcavated spaces shall be figured as 50 per cent exposed wall and fully exposed floors shall be figured as 100 per cent exposed wall.

Note 5.—For rooms having unusual exposure, ordinarily north, northeast and northwest, add 15 per cent to pipe area. For east and west exposure, add 10 per cent.

Note 6.—Use no warm-air pipe less than 8 in. in diameter. If a basement warm-air pipe figures greater area than any standard commercial size then the nearest commercial size shall be used, provided however, that the total pipe area shall in no case be less than the total requirements according to Sections 1, 2 and 3.

Note 7.—It is understood in using the above values for determining basement warm-air pipe areas, that these pipes should be run comparatively straight and that they should not be over 10 to 12 ft. in length. Sharp turns and long pipes should have extra capacity. When warm-air pipes exceed 12 ft. in length or have more than two 70 deg. turns, the next larger commercial size pipe must be used.

Note 8.—The value of 800 (used in cubic contents) is for an estimated air change of one room volume per hour. If it is desired to provide for 1½ room volume use the figure 600. If for two room volumes use the figure 400.

Transition Fittings and Stacks

Section 7. a. Transition from warm-air pipes to stacks or register heads shall be made with a well designed elbow or boot and no stack shall be less than 70 per cent of the area of the warm-air pipe leading to it.

b. All first floor fittings and connections, shall maintain a free area equal to the round basement pipes leading to them.

Method for Determining Size of Registers

Section 8. All registers shall have a free area at least equal to the area of the basement pipes leading to them.

Method for Determining Size of Furnace

Section 9. a. Add together the areas (expressed in square inches) necessary for heating the building, as determined by the foregoing calculated requirements, Art. 3, Secs. 1, 2 and 3, and install a furnace, rated by the following formula:

Furnace Rating Formula

$$L = 1.75\,G\,[\,1 + 0.02\,(R - 20)\,]$$

L = square inches of warm-air pipe connected to the furnace as calculated.
G = grate area in square inches; the area of the firepot at the grate level; its most restricted area.
R = ratio of heating surface area to grate area;
1.75 = a constant based upon the results obtained in the Association Research on a furnace having 20 sq. ft. of heating surface for each square foot of grate, and including factors for:

E = efficiency of heater;
C = combustion rate;
F = calorific value of fuel;
0.75 = percentage of heat available at registers;
136 = B.t.u. delivering value of 1 sq. in. of pipe, assuming half of the heat is sent to each floor. This value is based on an operating temperature of 175 deg. fahr. at the register.