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RADIANT HEATING

SIMPLIFIED DESIGN AND INSTALLATION

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Simplified Design and Installation

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Reg. U.S. Pat. Off.

Copper & Brass Research Association

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A Simple Method of Designing Low-Temperature Radiant Panel Heating Systems Using Copper Tube with Brief Suggestions for their Installation

DESIGN

This simplified design method is intended for use in connection with buildings of such size that the time and expense necessary for extremely refined design are normally not justified.

It is of course unavoidable that the reduction of a rather complex procedure of designing a radiant heating installation to a very simple form which requires familiarity only with ordinary arithmetic calls for some sacrifice in accuracy and general applicability. This is no serious handicap, however, as even in the more refined methods of design a number of assumptions are necessary. The regulation of the water temperature, of the velocity with which the water is circulated through the coils, and the setting of the valves and the thermostats in any event leave a wide margin of adjustment to meet specified design conditions provided, of course, that the boiler capacity is ample. For this reason the only restrictions on using the simplified design method are imposed by the following assumptions:

I. That the installation shall roughly conform to the kinds of panels and the forms of construction shown,

for ceiling panels, in Fig. 1
for wall panels, in Fig. 2
for floor panels, in Fig. 3

II. That the design room air temperature lie between 65° F. and 75° F. Although the method submitted is based on an approximate room air temperature of 70° F., deviation from this value within the range indicated produces no significantly different results.

III. That the difference in water temperatures at inlet and outlet of the panels (the "temperature drop") in no case exceeds 30° F. for ceiling and wall panels, or 20° F. for floor panels.

IV. That the distance from boiler outlet to entrance of farthest coil does not exceed 100 feet.

The position of a radiant heating panel greatly influences its output. The amount of convected heat is least from ceiling panels, and greatest from floor panels, with that of wall panels in between. Since the amount of radiant heat per unit area from panels with a given surface temperature is the same, regardless of their position, the total output (radiation plus convection) per unit area of floor panels for this surface temperature is greater than that of wall panels, and of wall panels greater than that of ceiling panels. For the same output per square foot of panel the surface temperatures of the three kinds of panel are in the reverse order. This means that for the same heat output per square foot of panel surface, wall panels must be warmer than floor panels, and ceiling panels still warmer than wall panels.

The advantage of the relatively greater unit output of floor panels is offset to some extent by the dictates of foot-comfort. These restrict the floor panel's surface temperature in living rooms, offices, and other spaces normally occupied continuously for any length of time, to about 85° F. In areas only intermittently occupied and for relatively short periods as for instance corridors and bath rooms, or where contact with the floor is infrequent and usually short, as along the strips of floor bordering on exposed outside walls or large glass areas, it may be safe to raise this temperature to as high as, say 95° or even 100° F., with a correspondingly greater output than given in **Table 2.**

The higher surface temperatures permissible in ceiling and wall radiant heating panels are limited by two factors, namely: (a) the surface temperature of the panel at the time of its maximum required output must be low enough to avoid causing any discomfort to the occupants of the room (this restriction is of particular significance for low-reaching wall panels and for ceiling panels used in rooms with especially low ceilings), and (b) the maximum temperature of the water in the coils which is needed to produce the required surface temperature shall be well under that which might cause damage to the material in which the coils are embedded.

Because of the above limitations no output ratings greater than those specified in **Table 2** should be used for panels designed to heat spaces which are intended for continuous occupation.

If the panel is large, the amount of water necessary to supply the heat required may be so great that the use of only a single coil in such a panel would require a pressure exceeding the maximum pressure which a standard pump, or circulator, can supply. In such cases it is usually much more economical to distribute the heating load of the panel over two or more coils, or circuits, arranged in parallel across supply and return lines, so that the total pressure drop through coils, mains and boiler circuit stays well within the commercial pump ratings. Under **step 4,** in **table 4** are given the maximum lengths, for various tube sizes, which can be used in a panel without causing the pressure drop through each circuit to exceed 3.5 feet (about 1.5 p.s.i.).

Having taken account of the fore- *(Continued on page 6)*

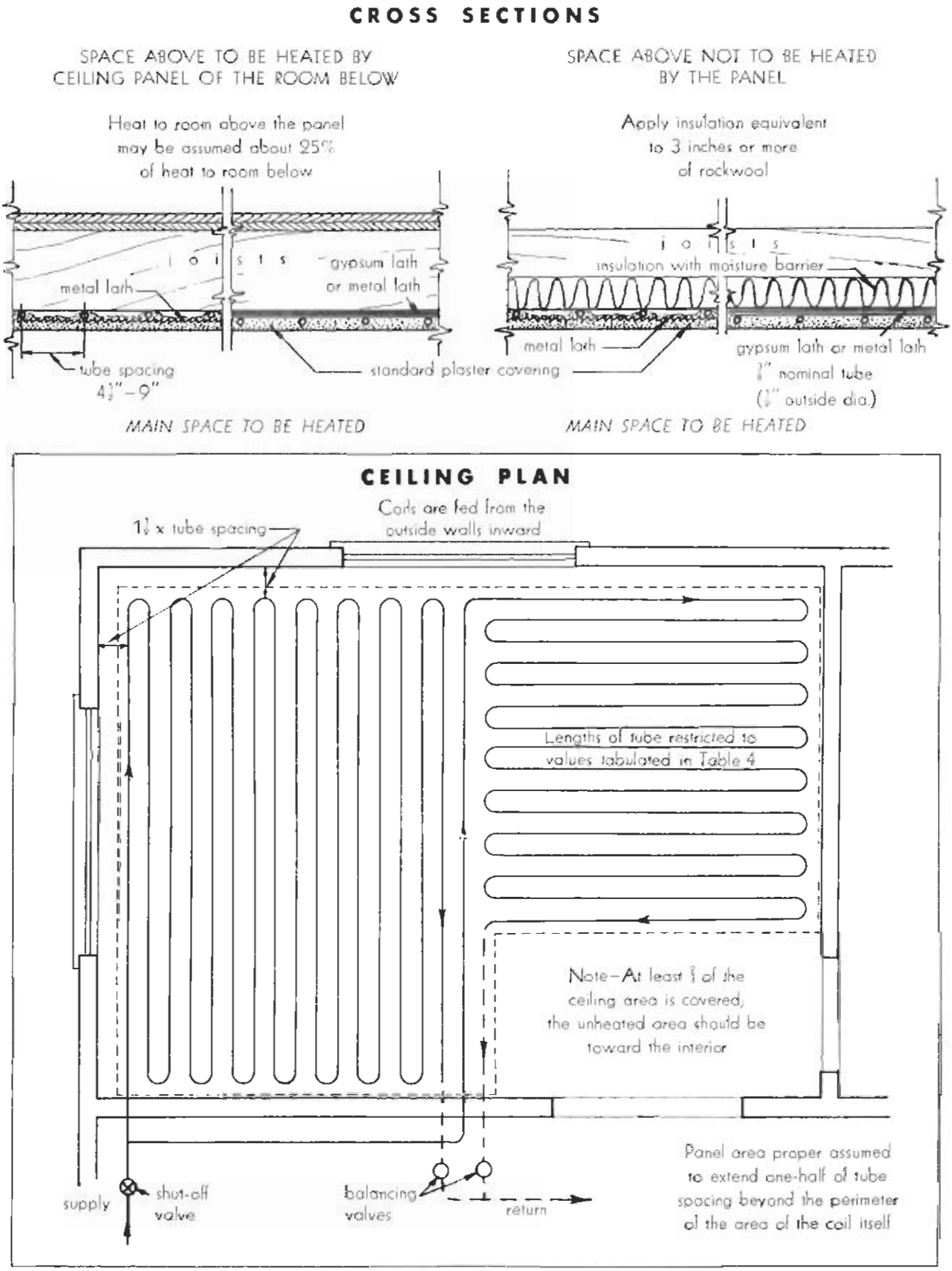


FIG. 1. TYPICAL CEILING PANEL CONSTRUCTION

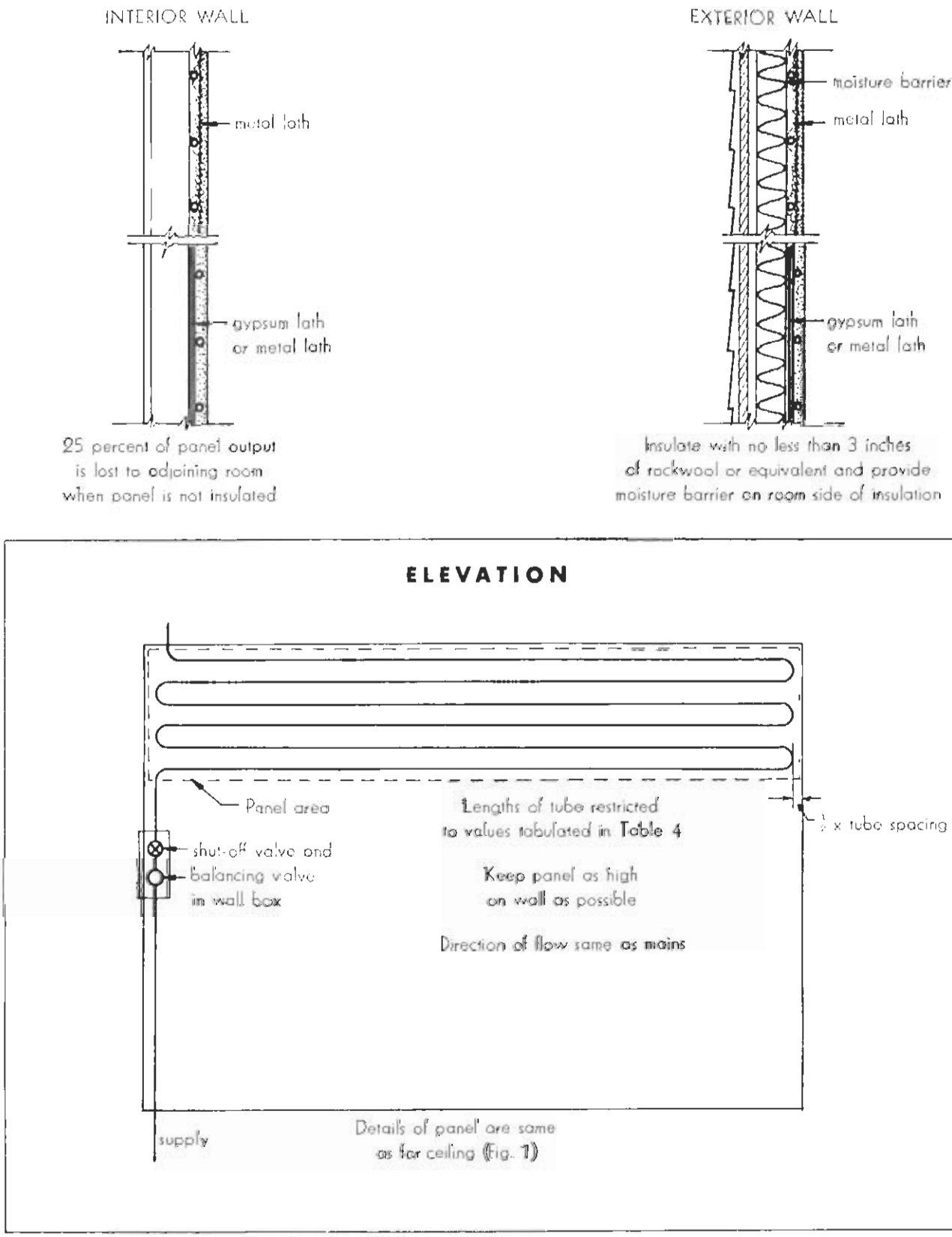


FIG. 2. TYPICAL WALL PANEL CONSTRUCTION

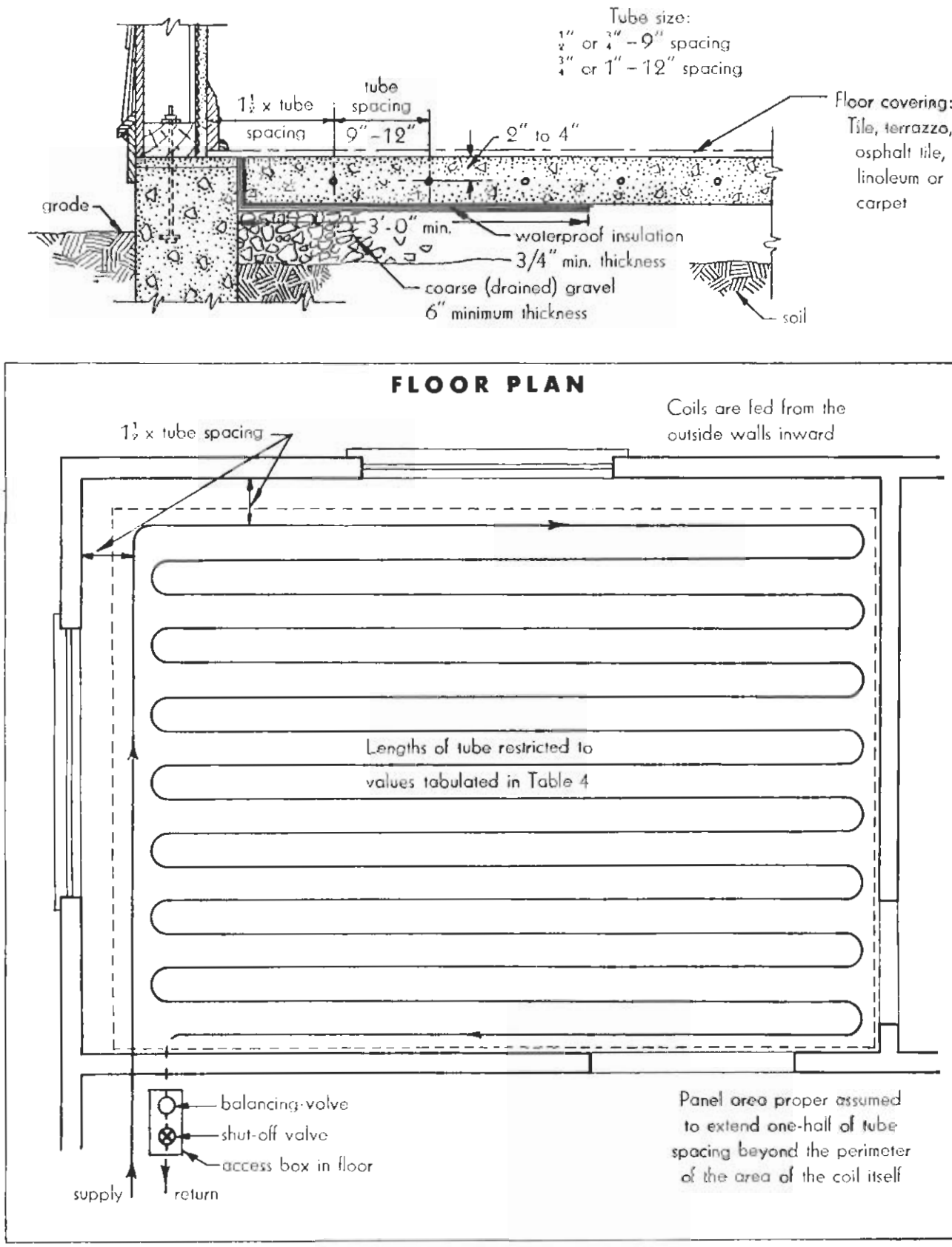


FIG. 3. TYPICAL FLOOR PLAN CONSTRUCTION

going considerations the designer proceeds step-by-step as follows:

STEP 1. ***Calculate the heat loss of each room in Btu. per hour.***
Use the method outlined in the "Guide" of the American Society of Heating and Ventilating Engineers or any other recognized method. The heat loss coefficients and tables of the Institute of Boiler and Radiator Manufacturers are reprinted with its permission as **Tables 1, 1a** and **1b,** beginning on page 15.

STEP 2. ***Determine the area of the panel required for each room.***
Divide the room's heat loss calculated under **Step 1** by the rated output of the selected type of panel shown in **Table 2.**

TABLE 2

Location of Panel	PANEL TUBES		RATED OUTPUT OF PANEL	
	Nominal Size Inches	Spacing, C. to C. Inches	Recommended Btu./hr., sq. ft.	Maximum Btu./hr., sq. ft.
Ceiling	3/8	4½	65	75
	3/8	6	50	60
	3/8	9	35	40
Wall	3/8	4½	65	75
	3/8	6	50	60
	3/8	9	35	40
Floor*	½ or ¾	9	40	50
	¾ or 1	12	40	50

* The output ratings of floor panels are limited by the average floor surface temperature which can be tolerated and for this reason are practically independent of tube size. The selection of tube size and spacing for any panel is based on economical circuit lengths **(see Step 4).** In general, wider tube spacings than those shown above produce greater variation in surface temperatures and are not desirable.

If the area in the selected location of the panel is insufficient to supply the total heat requirements, the deficiency can generally be made up by an auxiliary panel in another location.

Because of the heat transmitted through a floor from an uninsulated panel immediately under it, the calculated heat loss of the upper room may be reduced by 25% of the output of the portion of the ceiling panel immediately below in determining the panel area required for the upper room.

STEP 3. ***Determine the tube length for each panel.***
Find the length of the tube required for each panel by multiplying the panel area by the proper factor (feet of tube per square foot of panel), given in **Table 3.**

TABLE 3

Tube Spacing — Inches	Factor
4½	2.7
6	2.0
9	1.3
12	1.0

STEP 4. ***Determine the number of circuits for each panel.***

Divide the length of the tube required for each panel into circuits of lengths not exceeding those listed in **Table 4.**

TABLE 4

Type of Panel	NOMINAL TUBE SIZES			
	⅜ in.	½ in.	¾ in.	1 in.
Ceiling or Wall with Recommended Rated Output	200	—	—	—
Ceiling or Wall with Maximum Rated Output	175	—	—	—
Floor	—	180	230	450

STEP 5. ***Determine the size of the mains.***

Size the mains leading to and from the panels according to **Table 5.**

TABLE 5

Size of Main	NUMBER OF PANEL CIRCUITS			
	In Ceiling and Wall Panels Nominal Tube Sizes		In Floor Panels Nominal Tube Sizes	
	⅜ in.	½ in.	¾ in.	1 in.
2 in. carries	33	20	10	6
1½ in. carries	18	9	4	3
1¼ in. carries	11	6	3	2
1 in. carries	6	3	1	1
¾ in. carries	3	1	..	
½ in. carries	1	—	—	—

The distance from the boiler to the farthest coil should not be over 100 feet. If the panel circuits are designed in accordance with **Table 4**, the total pressure drop in panels and mains will not exceed 6 feet (2.6 p.s.i.).

STEP 6. ***Select the circulating pump.***

Determine the pump size from the data in **Table 6.**

TABLE 6

Size of Main, Inches	MINIMUM PUMP CAPACITY		Suggested Pump Size
	G.P.M.	Head in Feet	
2	20	6	2" Standard, or 1½" High Head
1½	10	6	1½" " " 1¼" " "
1¼	6	6	1¼" " " 1" " "
1	3.5	6	1¼" " " 1" " "

STEP 7. ***Balancing, Venting, and Draining.***

Each panel circuit should be provided with a balancing valve, preferably installed on the return end, to adjust the hot water flow. To discourage unauthorized changing of their original adjustment, which should be done upon completion of the installation, balancing valves without handles are recommended.

A shut-off valve for each circuit may be desirable to meet changes in weather conditions, in occupancy or use of a room, etc., as in any conventionally heated room.

NOTE: Wherever there is danger of freezing, no circuits should be shut off completely for prolonged periods during cold weather unless an anti-freeze solution is used in the system.

At the lowest point the system should be provided with a drain cock or plug protected from unauthorized operation to permit its complete draining either by gravity or compressed air.

All valves should be clearly labeled or identified with the coils to which they belong. Shut-off and balancing valves can be housed together in wall or floor boxes conveniently located in closets or similar out-of-the-way places. In another arrangement the balancing cocks are mounted side by side at a central point, usually in or close to the boiler room where the returns from the various rooms enter the common return header leading directly back to the boiler.

Provision for venting and drainage of the coil system is essential but the means used are not different in principle from those necessary for conventional circulating hot water systems. **Figures 4 and 5** illustrate two simple and adequate methods of venting.

The system's main air vent is normally installed in the main feed line from boiler to panels in such a manner that the water coming from the boiler is sufficiently slowed down to release the entrained air.

The kind of vent shown in **Fig. 4** consists simply of an enlarged section of pipe or tube inserted at the highest point of the tube system. A small tube, ordinarily not exceeding ¼" in diameter, and provided at a convenient location with a small petcock, is run from the enlarged tube's cap-like top to a place where possible overflowing would do no harm. The same results may be obtained by running the feed line to a small tank at the highest point of the system **(see Fig. 5)**. The air in this case accumulates at the top of the tank, from which it can be bled off by means of a hand-operated petcock or an automatic air vent.

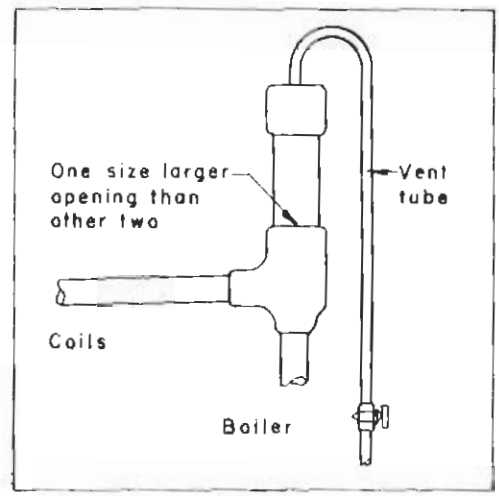


Fig. 4

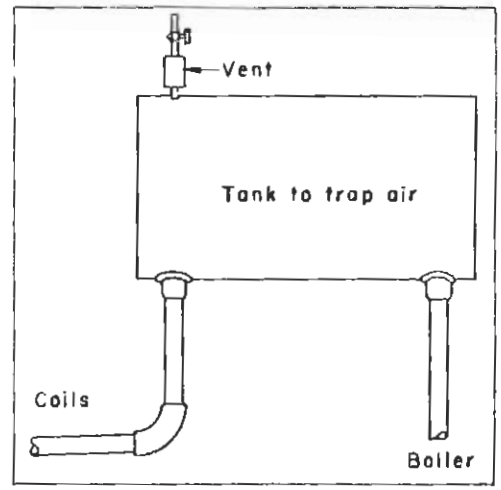


Fig. 5

CONTROL

The controls used in connection with radiant heating systems, just as in the case of any conventional method of heating, depend not only on the size and use of the building in which they are installed but also on the closeness of control desired. In many small residence installations, for instance, room temperature conditions can be controlled satisfactorily by means of a single room thermostat located in a carefully chosen spot representative of the entire area to be heated. More often, however, the demands on the control system are so many and vary so widely with location, construction, exposure, and use of the building, and whether zoning is involved, that no recommendations as to details of control can be given here. Such recommendations can be readily obtained, however, from various control manufacturers who have developed complete control systems to meet almost any conceivable combination of requirements.

INSTALLATION AND TEST

TESTING THE COILS

In copper tube radiant heating panels joints are made by means of solder-joint fittings. *Before being connected to the boiler*, mixing valve(s), circulator(s) or other accessories, and *before the coils are covered in any way*, whether by metal lath, plaster, concrete or other materials, the entire piping system, including the panel coils, the supply and the return lines, should be pressure-tested for leaks. In such hydraulic tests the water pressure should be from 200 p.s.i. to 300 p.s.i. This pressure should be maintained steady for a period of from 4 to 8 hours and all joints should be carefully inspected while under pressure.

Where compressed air is available (usually at 100 p.s.i. pressure), a preliminary test of the piping system with compressed air is suggested (**CAUTION,** see Note). This test makes it possible to break any joints that may leak and remake them while still dry, without having to drain the piping system of water. The test is readily carried out by connecting the piping system to the compressed air source with a cut-off cock at the inlet side of the pressure gauge. The presence and size of leaks show up by the speed with which the pressure indicated on the gauge drops. Major leaks are easily located by their hiss or whistle, while slow leaks betray themselves by the bubbles when soap suds are systematically applied to all joints.

NOTE: Because of the inherent risk which accompanies the use of any compressed gas compared with that of water or other liquids under pressure, the compressed air test should be carried out with caution and preferably only by personnel familiar with such tests.

STARTING OPERATION OF THE INSTALLATION

WARNING: Do not start operation of the radiant heating installation until the plaster or the concrete of the panels has had a chance to cure and dry out thoroughly. For ceiling and wall panels a period of two weeks minimum after completion of the plastering is recommended (See Note at bottom).

After having filled the entire coil and pipe system with water—which should be done slowly to prevent surging and undue entrainment of air—and with all air vents kept open until water runs out of them, the operating instructions given below should be carried out in the order indicated:

(1) Make sure that the entire system, including the boiler, is filled with water, except for an adequate amount of air being retained in the expansion tank.

(2) Start the circulator. This may require the temporary cutting out of its control.

(3) Check at this stage that water circulates through the by-pass, if there is one.

(4) Set the burner control to maintain the lowest possible temperature of the boiler water.

(5) Start the burner.

(6) After the boiler water has reached the temperature for which the burner control was set (see Instruction **(4)**), regulate the temperature of the water supplied to the panels so that it will not exceed the room air temperature by more than 20° F. or be more than 90° F. altogether.*

(7) For a period of not less than 48 hours the water temperature should not be allowed to rise above that given in the preceding Instruction **(6)**. Ample ventilation should be provided to carry off excess moisture and to promote drying out of the panels.

(8) The water temperature can now be raised slowly up to that specified in the design, but on no account more than about 15° F. per day.*

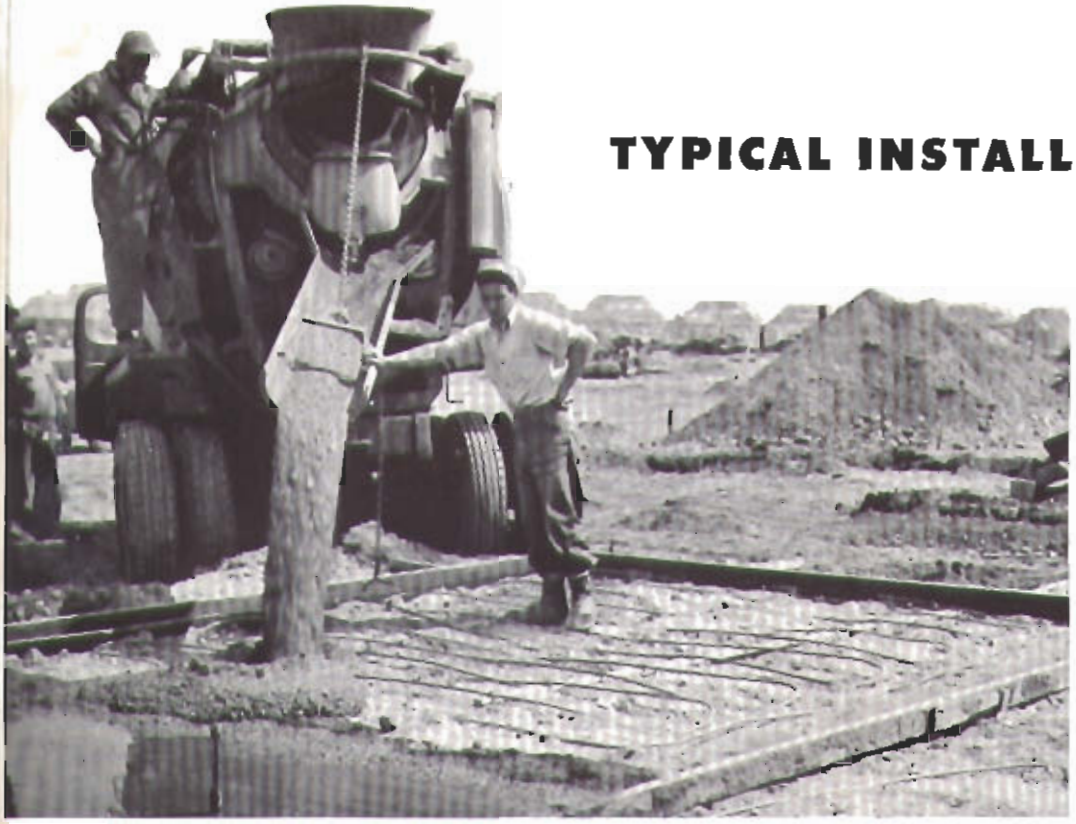
(9) Adjust the controls in accordance with the control manufacturer's instructions. What the water temperature should be to provide thermal comfort conditions at the time can be determined only by actual operation. The following tabulation, however, gives estimated water temperatures *at the entrance to the supply mains* for operation under the extreme conditions upon which the design is based, and thus may serve as a guide.

Location	Recommended Output	Maximum Output
Ceiling Panels	155° F. max.	165° F. max.
Wall Panels	150° F. max.	160° F. max.
Floor Panels	120° F. max.	130° F. max.

(10) During the starting-up period occasionally make sure that the air vents function properly, and see to it that the expansion tank retains adequate air.

*NOTE: It is imperative that these particular instructions be followed to the letter, especially with ceiling and wall panels, in order to prevent damage to the embedding material. More detailed instructions regarding the embedding materials and their method of installation may be obtained from the Gypsum Association, 20 North Wacker Drive, Chicago, Illinois, and the Portland Cement Association, 33 West Grand Avenue, Chicago 10, Illinois.

TYPICAL INSTALLATIONS OF COPPER

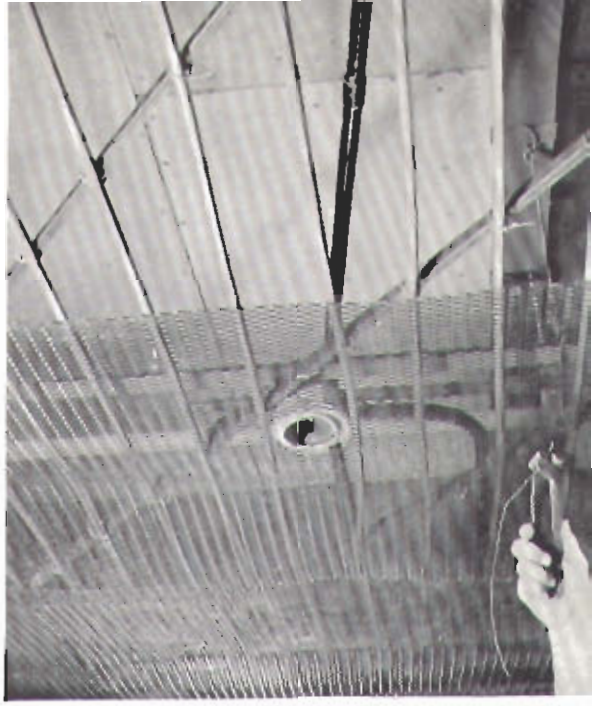


Pouring concrete over the copper tube floor coils at a large housing development on Long Island.

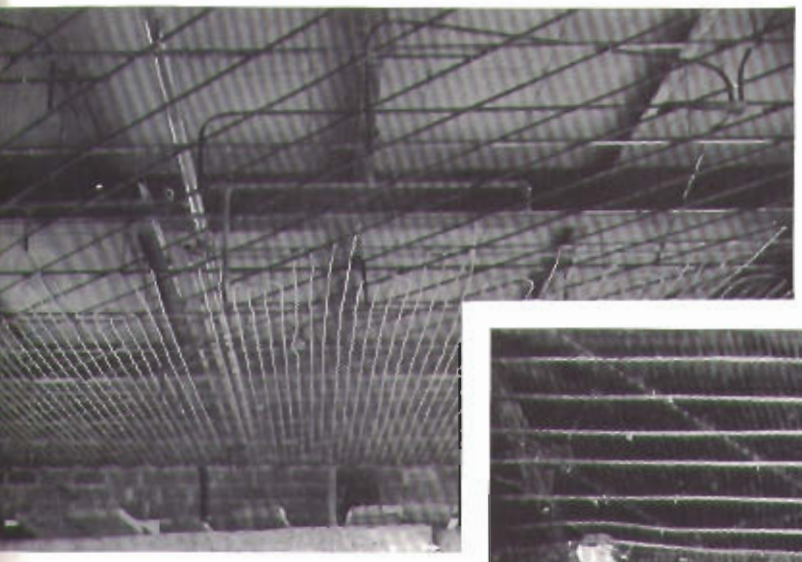
Ceiling panel of the 18' x 32' living room in a midwest residence. The wide spacing of the ⅜" copper tube coils in this case points to the use of an auxiliary panel, actually used. It consists of a floor panel with ½" copper tube embedded in 3" of concrete with a ¼" terrazzo surface finish.

The rumpus room floor panel shown with ¾" soft copper tube on 14-inch centers, is typical of the other eleven panels used to heat the ground floor in a large, modern, midwestern residence. Laid on a 4" concrete slab, the coils are embedded in 3" of concrete with a terrazzo surface finish.

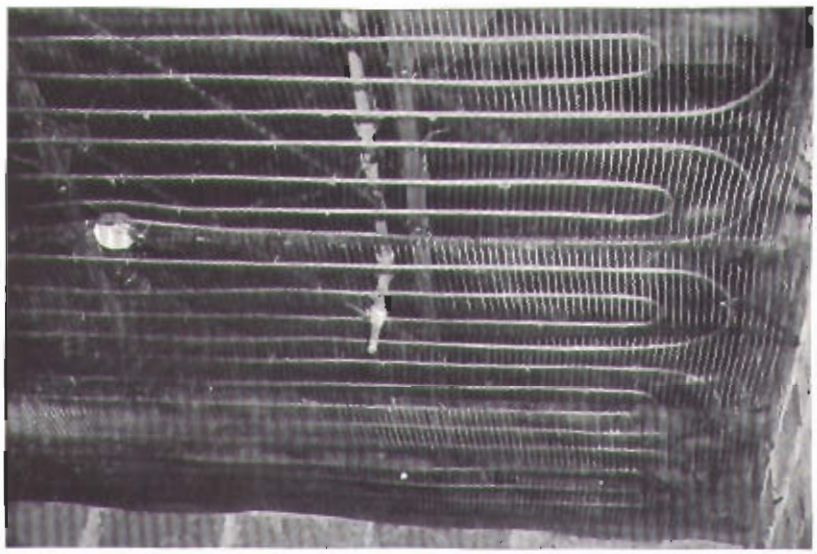
TUBE FOR RADIANT HEATING



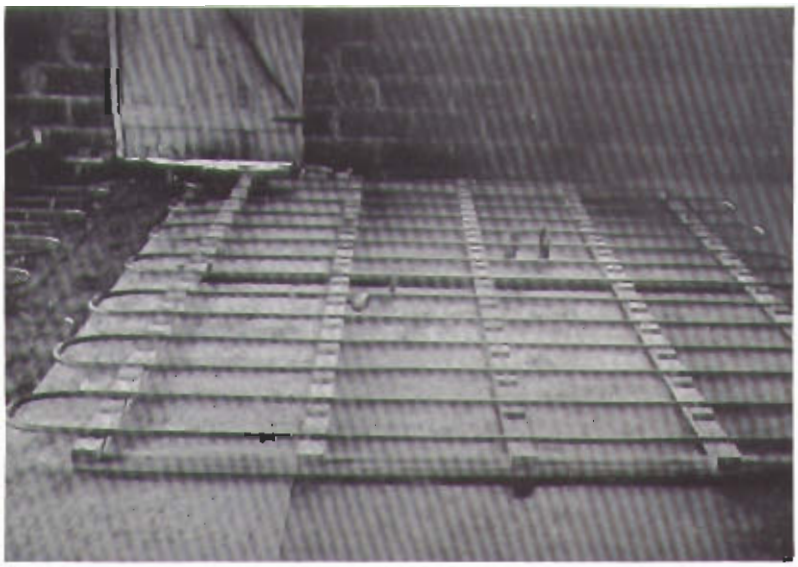
The metal lath being fastened (independent of but in close contact with the coil tubes) to the structure supporting the ceiling panel.



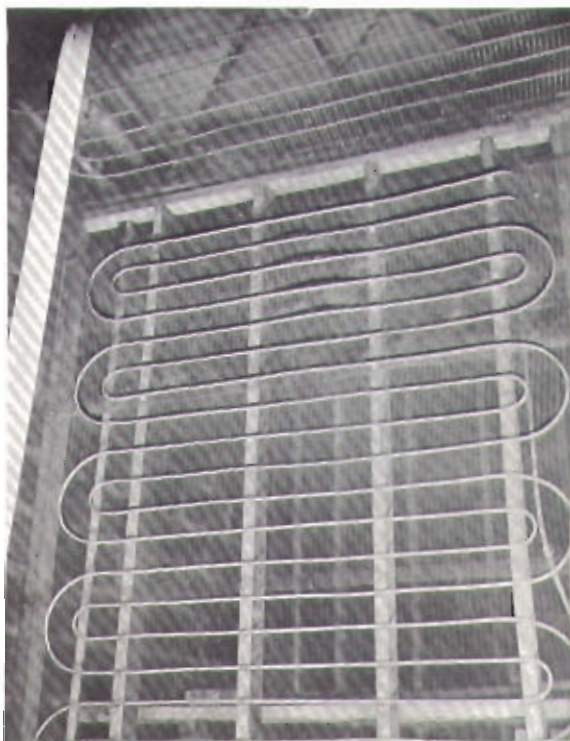
Bench-formed copper ceiling coils in position, ready for mounting of the metal lath.



The copper ceiling coils shown in the two preceding illustrations, covered with the independently mounted metal lath, ready for plastering.



Frames like this (Fig. 8 shows typical design) greatly facilitate transportation and mounting of all sizes of sinuous copper radiant heating coils.



Bench-formed copper coils for typical wall panel ready for plastering.

SOME PRACTICAL SUGGESTIONS ON FABRICATING AND INSTALLING THE PANELS

Most of the sinuous copper coils used in the type of radiant panel heating dealt with in this booklet are of soft-temper Type L Copper Water Tube. The stock generally carried by suppliers is in circular coils of 60 ft. or 100 ft. lengths, thus eliminating a large percentage of the joints needed when other kinds of pipe or tube, normally available only in 12- or 20-ft. standard lengths, are used.

Sinuous coils can be formed directly in position as shown in **Fig. 6,** but often time and effort can be saved in their forming and installation by the use of simple rigs such as are shown in **Figs. 7 and 8,** which frequently can be made right on the job. The wood frame is temporarily wired to the ceiling joists until a sufficient number of copper tube straps have been attached to support the coil. The frame is then removed and the balance of the tube straps are nailed in place.

If the frame is used for floor coils it should be on top of the coil.

Since in all radiant heating panels it is the surface of the embedding material rather than the tube coils themselves which supplies the heat for the space to be heated, the construction of the panel should be such as to readily conduct the heat from the tubes to the panel surface and to make the panel surface temperature as uniform as possible. To accomplish these ends best, the following principles should be observed:

IN CEILING AND WALL PANELS

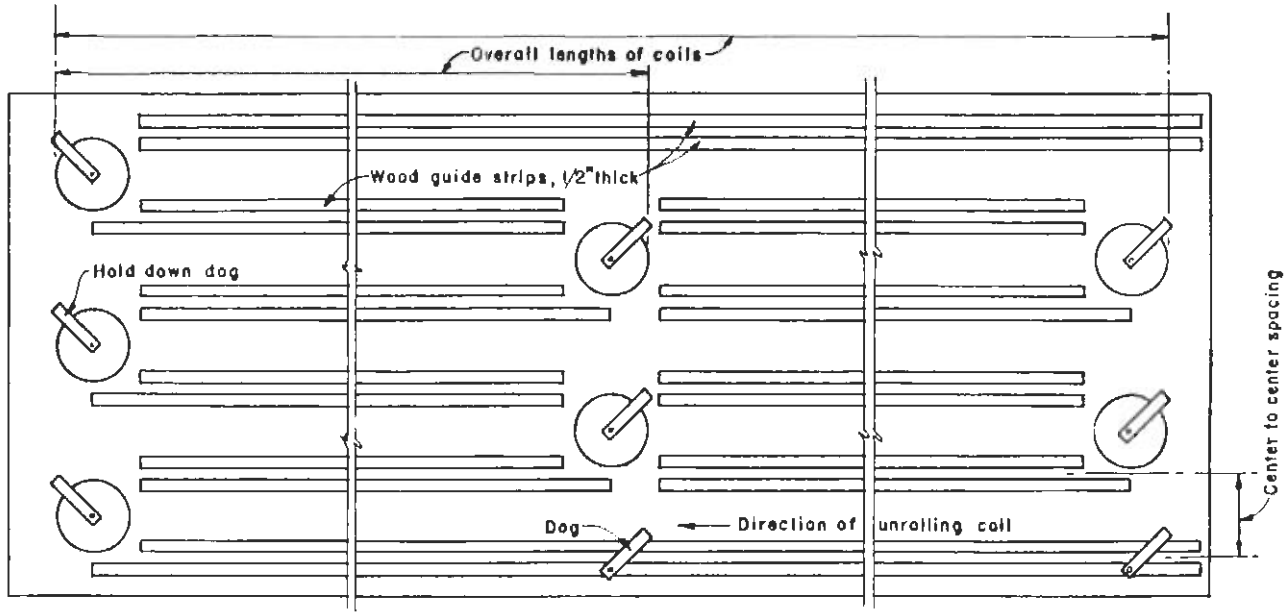
1. The lath and coils should be fastened independently to joists or studs.
2. There should be the closest possible contact between the metal lath, where used, and the coil tubes.
3. With the tubes above or behind the metal lath adequate, but not necessarily complete embedment of the tubes in the plaster should be procured.
4. With tubes on the room side of the metal lath, a minimum cover of ¼" of plaster on the tubes should be maintained.

IN FLOOR PANELS

1. Tubes should be completely embedded in concrete of normal density. No insulating concrete should be used to embed the coils.
2. No insulating concrete or other insulating material should be used between the coils and the radiating surface of the panel as part of the panel structure. If wood is used at all, it should not exceed ⅜" in thickness.
3. Contact between tube and cinders or cinder base concrete should be carefully avoided, as cinders are generally corrosive to all metals commonly used for tube and pipe.

FIG. 6. "SINUOUS COILS CAN BE FORMED IN POSITION . . ." NOTE USE OF HELICAL BENDING SPRING.

TOP PLAN OF BENCH



DETAIL OF TEMPLATE

Cut from ¾" wood

TUBE SPACING DIMENSIONS

Nominal Size (Inches)	SPACING — C. TO C. OF TUBES (Inches)			
	4½	6	9	12
	DIMENSION R (Inches)			
⅜	2*	2¾	4¼	—
½	—	—	4 3/16	5 11/16
¾	—	—	4 1/16*	5 9/16

*Suitable bending tool required for Type L tube.

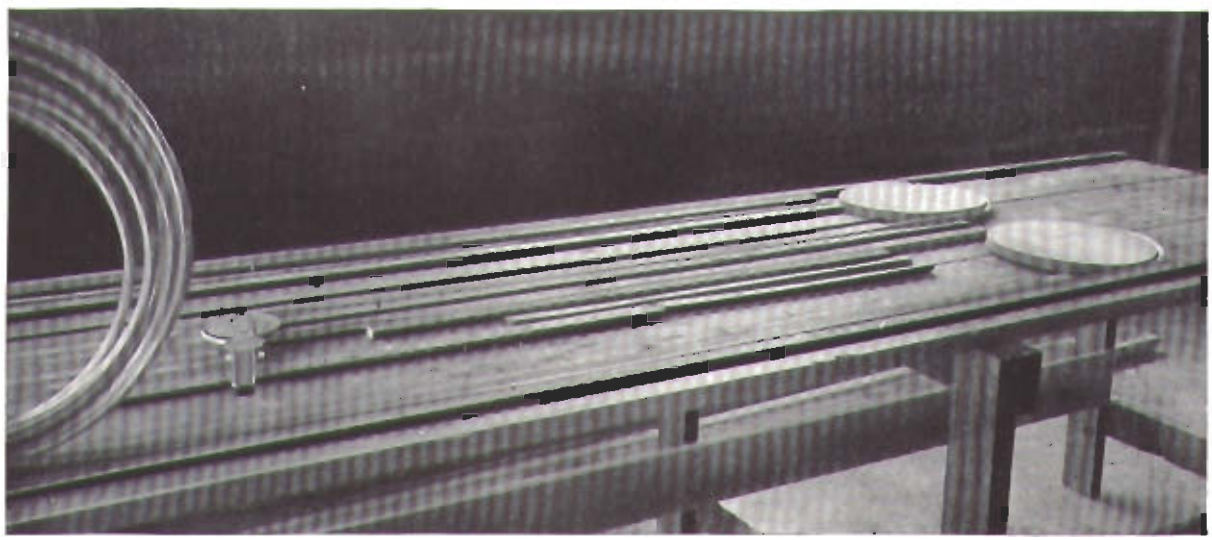
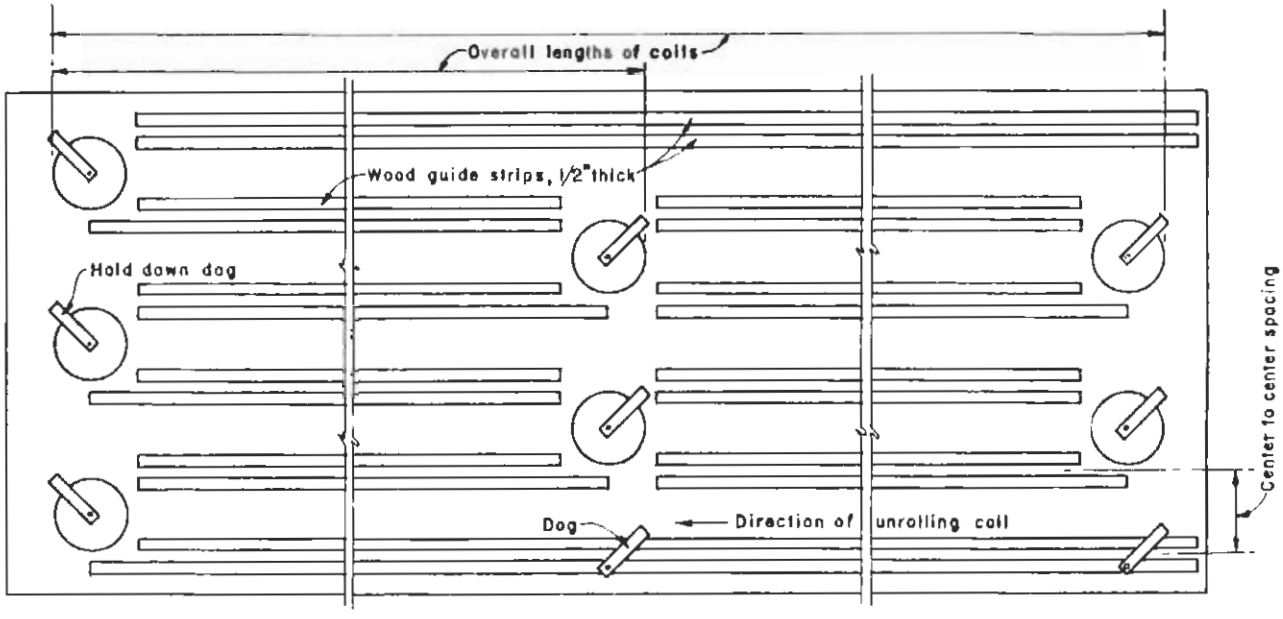


FIG. 7. FORMING BENCH FOR SINUOUS RADIANT HEATING COILS USING COPPER WATER TUBE

TOP PLAN OF BENCH



DETAIL OF TEMPLATE

Cut from ¾" wood

TUBE SPACING DIMENSIONS

Nominal Size (Inches)	SPACING — C. TO C. OF TUBES (Inches)			
	4½	6	9	12
	DIMENSION R (Inches)			
⅜	2*	2¾	4¼	—
½	—	—	4⅜16	5 11/16
¾	—	—	4 11/16*	5 9/16

*Suitable bending tool required for Type L tube.

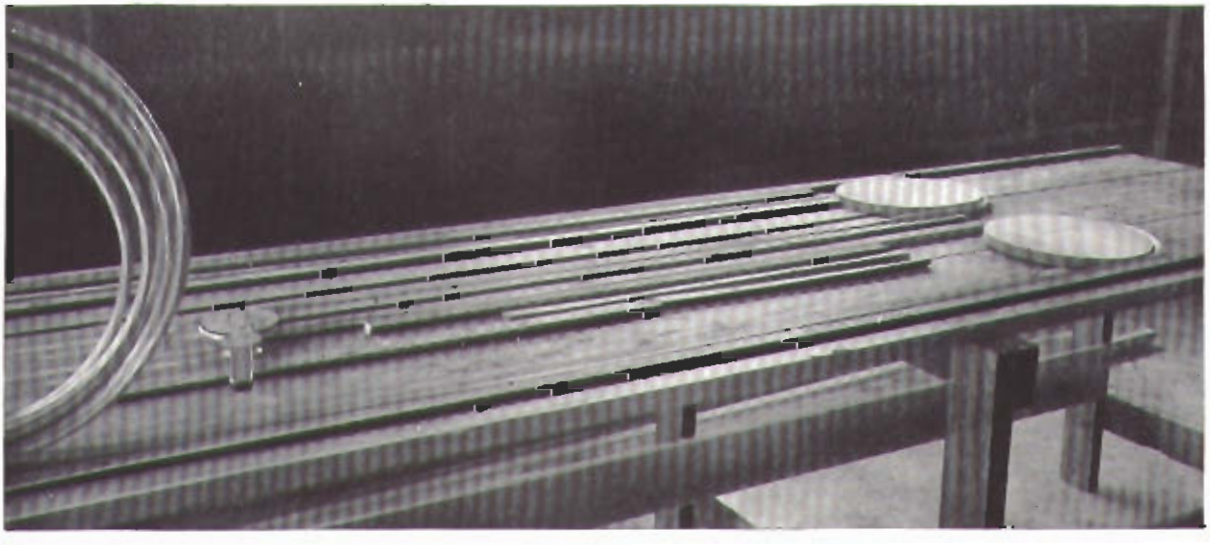
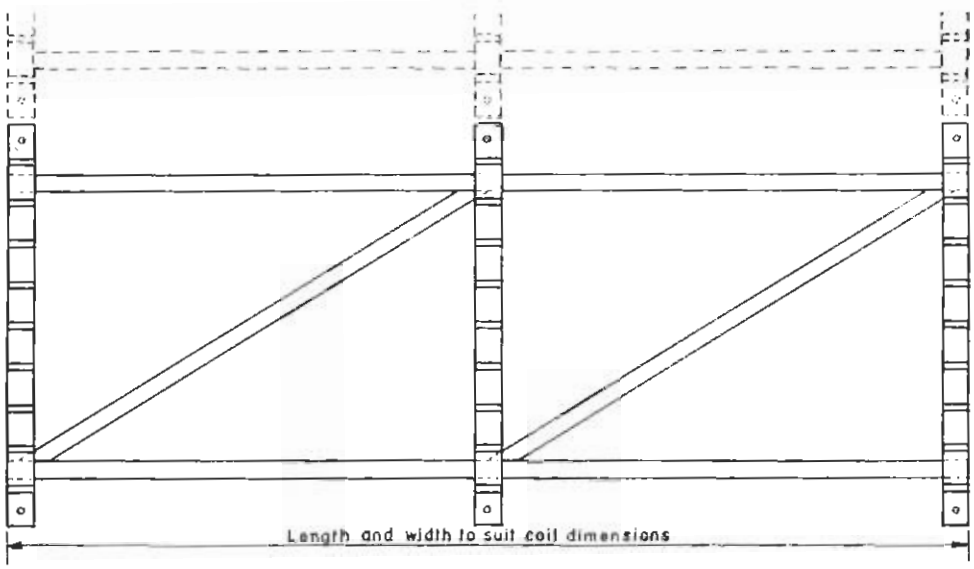


FIG. 7. FORMING BENCH FOR SINUOUS RADIANT HEATING COILS USING COPPER WATER TUBE

PLAN OF FRAME



END ELEVATION OF FRAME

TUBE SPACING DIMENSIONS

Nominal Size (Inches)	Dimension D	SPACING—C. TO C. OF TUBES (Inches)			
		4½	6	9	12
		DIMENSION C (Inches)			
⅜	½	4	5½	8½	—
½	⅝	3⅞	5⅜	8⅜	11⅜
¾	⅜	FLOOR COILS		8⅛	11⅛

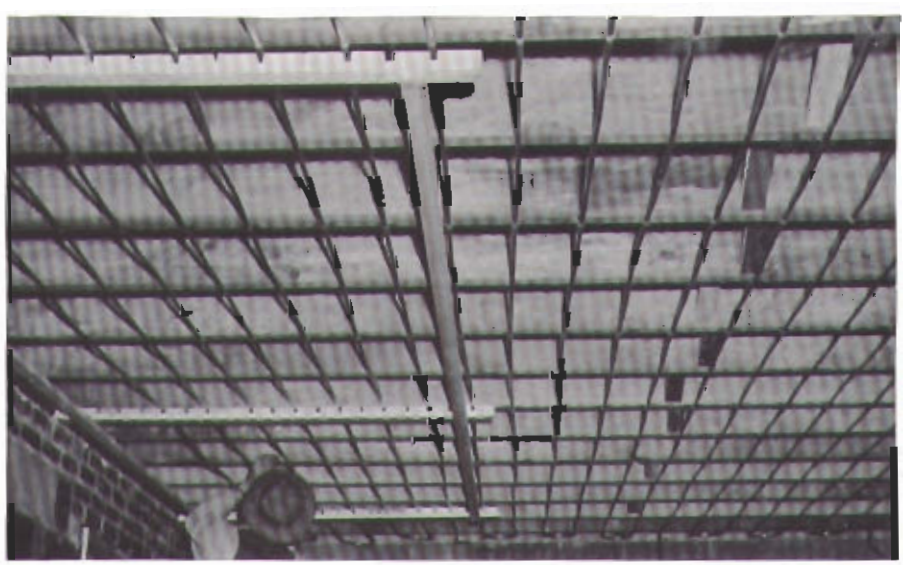


Fig. 8. Wood Frame for Handling Sinuous Radiant Heating Coils Using Copper Water Tubes

HEAT LOSS FACTORS Table 1

Tables 1, 1a and 1b are reprinted by permission of The Institute of Boiler and Radiator Manufacturers as they appear in the I.B.R. Installation Guide No. 100.

Item	Description	Factor

EXPOSED WALLS

No. 1. Frame, Not Insulated

a	Clapboards or wood siding, studs, lath and plaster or plaster board (no sheathing)	0.35
b	Same as **1a** with composition siding over wood siding	0.28
c	Wood siding, paper, sheathing, studs, lath and plaster or plaster board	0.25
d	Same as **1c** with composition siding over wood siding	0.21
e	Same as **1c** substituting asphalt or asbestos shingles for wood siding	0.30

No. 2. Frame, Insulated

a	Wood siding, paper, sheathing, studs, ½" rigid insulation, plaster or plaster board	0.19
b	Wood siding, 25/32" rigid insulation, studs, lath and plaster or plaster board	0.19
c	Wood siding, paper, sheathing, ½" flexible insulation in contact with sheathing, studs, lath and plaster or plaster board	0.17
d	Same as **2c** with air space on both sides of insulation	0.15
e	Same as **2c** substituting 3⅜" rock wool or equivalent for ½" flexible insulation	0.08
f	Same as **2c** substituting 2" rock wool or equivalent for ½" flexible insulation	0.10

No. 3. Brick, Not Insulated

a	8" Brick, plaster or plaster board one side	0.46
b	8" Brick, furred, lath and plaster or plaster board one side	0.30
c	12" Brick, plaster or plaster board one side	0.35
d	12" Brick, furred, lath and plaster or plaster board one side	0.24
e	4" Brick, 8" hollow tile, plaster or plaster board one side	0.33
f	4" Brick, 8" hollow tile or cinder block, furred lath and plaster or plaster board	0.24
g	4" Brick, paper, sheathing, studs, lath and plaster or plaster board	0.27
h	4" Brick, 4" light weight aggregate block, furred, lath and plaster or plaster board	0.21

No. 4. Brick, Insulated

a	8" Brick, furred, ½" rigid insulation, plaster or plaster board one side	0.22
b	12" Brick, furred, ½" rigid insulation, plaster or plaster board one side	0.19
c	4" Brick, 8" hollow tile, ½" rigid insulation, plaster or plaster board one side	0.18
d	4" Brick, 4" light weight aggregate block, ½" rigid insulation, plaster or plaster board one side	0.16
e	4" Brick, paper, sheathing, studs, rigid insulation, plaster or plaster board	0.20
f	4" Brick, 25/32" rigid insulation, studs, lath and plaster or plaster board	0.21

EXPOSED WALLS (Cont.)

g	4" Brick, paper, sheathing, 3⅜" rock wool or equivalent, studs, lath and plaster or plaster board	0.08
h	Same as **4g** substituting 2" blanket for 3⅜" blanket insulation	0.10

No. 5. Hollow Tile

a	8" Tile, stucco exterior, furred, lath and plaster or plaster board	0.26
b	Same as **5a** substituting ½" rigid insulation for lath	0.20

No. 6. Hollow Concrete Block, Gravel Aggregate

a	8" Block, plain, above grade	0.56
b	Same as **6a** plaster or plaster board one side	0.51
c	Same as **6a** furred, lath and plaster or plaster board	0.32
d	Same as **6c** substituting ½" rigid insulation for lath	0.23
e	Same as **6a** basement wall below grade	0.06
f	12" Block, plain, above grade	0.49
g	Same as **6f** basement wall below grade	0.06

No. 7. Hollow Concrete Block, Cinder Aggregate

a	8" Block, plain	0.42
b	Same as **7a** plaster or plaster board one side	0.39
c	Same as **7a** furred, lath and plaster or plaster board	0.27
d	Same as **7c** substituting ½" rigid insulation for lath	0.20

No. 8. Hollow Concrete Block, Light Weight Aggregate

a	8" Block, no interior finish	0.37
b	Same as **8a** plaster or plaster board one side	0.35
c	Same as **8a** furred, lath and plaster or plaster board	0.26
d	Same as **8c** substituting ½" insulating board for lath	0.19
e	Same as **8c** plus 1" insulating blanket	0.13

No. 9. Poured Concrete

a	8" Wall, above grade	0.69
b	8" Wall, below grade	0.06
c	12" Wall, above grade	0.56
d	12" Wall, below grade	0.06

No. 10. Limestone or Sandstone

a	8" Stone, furred, lath and plaster or plaster board	0.37
b	Same as **10a** substituting ½" rigid insulation for lath	0.25
c	12" Stone, furred, lath and plaster or plaster board	0.33
d	Same as **10c** substituting ½" rigid insulation for lath	0.23
e	12" Stone below grade	0.06
f	16" Stone below grade	0.06

No. 11. Gloss Block

a	3⅝" Block, corrugated surface	0.49

HEAT LOSS FACTORS Table 1 — continued

Item	Description	Factor

PARTITIONS

No. 12. Frame

a	With lath and plaster or plaster board one side only	0.31
b	Same as **12a** substituting ½" rigid insulation for lath	0.18
c	Same as **12a** with ½" rigid insulation on exposed side	0.13
d	With lath and plaster or plaster board both sides	0.17
e	Same as **12d** substituting ½" rigid insulation for lath	0.10
f	Same as **12d** with 3⅝" rock wool or equivalent	0.01
g	Same as **12d** with 2" rock wool or equivalent	0.06

CEILINGS

No. 13. Attic Space Above

a	Lath and plaster or plaster board, no floor above	0.32
b	Lath and plaster or plaster board, tight floor above	0.20
c	Same as **13a** substituting ½" rigid insulation for lath	0.23
d	Same as **13b** substituting ½" rigid insulation for lath	0.16
e	Same as **13a** with ½" rigid insulation on top of joists	0.18
f	Same as **13a** or **13b** with 3⅝" rock wool or equivalent	0.08
g	Same as **13f** except with 2" rock wool or equivalent	0.13

No. 14. Part of Single Roof — No Attic Space

a	Lath and plaster or plaster board, rafter, sheathing, shingles	0.29
b	Same as **14a** substituting ½" rigid insulation for lath	0.21
c	Same as **14a** with 3⅝" rock wool or equivalent	0.08
d	Same as **14a** with 2" rock wool or equivalent	0.10

No. 15. Part of Built-up Roof — No Attic Space

a	Lath and plaster or plaster board, rafter, sheathing, built-up roofing	0.49
b	Same as **15a** substituting ½" rigid insulation for lath	0.23
c	Same as **15a** with 3⅝" rock wool or equivalent	0.08
d	Same as **15a** with 2" rock wool or equivalent	0.13

No. 16. Part of Metal Roof — No Attic Space

a	Lath and plaster or plaster board, joists, sheathing, metal roof	0.26
b	Same as **16a** substituting ½" rigid insulation for lath	0.18
c	Same as **16a** with 3⅝" rock wool or equivalent	0.08
d	Same as **16a** with 2" rock wool or equivalent	0.10

FLOORS

No. 17. Wood, Over Exposed or Unheated Space

a	Double floor on joists over enclosed, unheated space	0.17
b	Same as **17a** over exposed space	0.35
c	Same as **17a** with ½" rigid insulation on bottom of joists	0.10
d	Same as **17b** with ½" rigid insulation on bottom of joists	0.13
e	Same as **17a** with 2" rock wool or equivalent between joists	0.06
f	Same as **17b** with 2" rock wool or equivalent between joists	0.13
g	Same as **17a** with 3⅝" rock wool or equivalent between joists	0.01
h	Same as **17b** with 3⅝" rock wool or equivalent between joists	0.08

No. 18. Concrete

a	1" thick floor on ground	0.06
b	4" thick floor on 3" cinder fill	0.06
c	Same as **18b** with hardwood floor on pine sub-floor	0.06
d	Floor on ground, below grade	0.01

WINDOWS

No. 19. Windows

a	Single (no storm sash)	1.13
b	With storm sash or double glazed	0.45
c	Double glazed with ¼" air space	0.60

EXTERIOR DOORS

No. 20. With or Without Glass

Same as Windows

INFILTRATION

(Based on volume of room in cubic feet)

No. 21. Windows and Doors Without Weather-stripping or Storm Sash

a	Rooms with windows or exterior doors on one side only	0.017
b	Rooms with windows or exterior doors on two sides	0.027
c	Rooms with windows or exterior doors on three sides	0.036
d	Entrance Halls	0.036
e	Sun Rooms with many windows on three sides	0.054

No. 22. Windows and Doors Weatherstripped or with Storm Sash

a	Rooms with windows or exterior doors on one side only	0.011
b	Rooms with windows or exterior doors on two sides	0.017
c	Rooms with windows or exterior doors on three sides	0.027
d	Entrance Halls	0.027
e	Sun Rooms with many windows on three sides	0.036

Btu/Hr. REQUIREMENTS FOR AREAS AND VOLUME Table 1a

70° F Indoor Minus Outdoor Temperature Difference

Btu. Hr. Required	Window and Door Areas, Sq. Ft.			Infiltration Room Volume, Cu. Ft.					Wall, Ceiling and Floor Areas, Sq. Ft.										
	Factors			Factors					Factors										
	0.45	0.60	1.13	0.011	0.017	0.027	0.036	0.054	0.04	0.06	0.08	0.10	0.13	0.15	0.16	0.17	0.18	0.19	0.20
100	3.2	2.4	1.3	130	84	52.9	39.7	26.5	35.7	23.8	17.9	14.3	10.9	9.5	8.9	8.4	7.9	7.5	7.1
200	6.4	4.8	2.5	260	168	106	79.4	52.9	71.4	47.6	35.7	28.6	21.9	19.0	17.8	16.8	15.9	15.0	14.3
300	9.5	7.1	3.8	390	252	159	119	79.4	107	71.4	53.6	42.9	32.9	28.5	26.7	25.2	23.8	22.6	21.4
400	12.7	9.5	5.1	519	336	212	159	106	143	95.2	71.4	57.1	43.9	38.1	35.7	33.6	31.7	30.1	28.6
500	15.9	11.9	6.3	649	420	265	198	132	179	119	89.3	71.4	54.9	47.6	44.6	42.0	39.7	37.6	35.7
600	19.0	14.3	7.6	779	504	317	238	159	214	143	107	85.7	65.9	57.1	53.6	50.4	47.6	45.1	42.9
700	22.2	16.7	8.8	909	588	370	278	185	250	167	125	100	76.9	66.7	62.5	58.8	55.6	52.6	50.0
800	25.4	19.0	10.1	1039	672	423	317	212	286	190	143	114	87.9	76.1	71.4	67.2	63.5	60.1	57.1
900	28.6	21.4	11.4	1169	756	476	352	238	321	214	161	129	98.9	85.7	80.3	75.6	71.4	67.7	64.3
1000	31.7	23.8	12.6	1299	840	529	397	265	357	238	179	143	110	95.2	89.3	84.0	79.4	75.2	71.4
1100	34.9	26.2	13.9	1429	924	582	437	291	393	262	196	157	121	105	98.2	92.4	87.3	82.7	78.6
1200	38.1	28.6	15.1	1558	1008	635	476	317	429	286	214	171	132	114	107	101	95.2	90.2	85.7
1300	41.3	31.0	16.4	1688	1092	688	516	344	464	310	232	186	143	124	116	109	103	97.7	92.8
1400	44.4	33.3	17.7	1818	1176	741	556	370	500	333	250	200	154	133	125	118	111	105	100
1500	47.6	35.7	18.9	1948	1260	794	595	397	536	357	268	214	165	143	134	126	119	113	107
1600	50.8	38.1	20.2	2078	1345	846	635	423	571	381	286	229	176	152	143	134	127	120	114
1700	53.9	40.5	21.5	2208	1429	899	675	450	607	405	304	243	187	162	152	143	135	128	121
1800	57.1	42.9	22.7	2338	1513	952	714	476	643	429	321	257	198	171	161	151	143	135	129
1900	60.3	45.2	24.0	2468	1597	1005	754	503	679	452	339	271	209	181	170	160	151	143	136
2000	63.5	47.6	25.2	2597	1681	1058	794	529	714	476	357	286	220	190	179	168	159	150	143
2100	66.7	50.0	26.5	2727	1765	1111	833	556	750	500	375	300	231	200	187	176	167	158	150
2200	69.8	52.4	27.8	2857	1849	1164	873	582	786	524	393	314	242	210	196	185	175	165	157
2300	73.0	54.8	29.0	2987	1933	1217	913	608	821	548	411	329	253	219	205	193	183	173	164
2400	76.2	57.1	30.3	3117	2017	1270	952	635	857	571	429	343	264	229	214	202	190	180	171
2500	79.4	59.5	31.6	3247	2101	1323	992	661	893	595	446	357	275	238	223	210	198	188	179
2600	82.5	61.9	32.8	3377	2185	1376	1032	688	929	619	464	371	286	248	232	218	206	195	186
2700	85.7	64.3	34.1	3506	2269	1429	1071	714	964	643	482	386	297	257	241	227	214	203	193
2800	88.9	66.7	35.3	3636	2353	1481	1111	741	1000	667	500	400	308	267	250	235	222	211	200
2900	92.0	69.0	36.6	3766	2437	1534	1151	767	1036	690	518	414	319	276	259	244	230	218	207
3000	95.2	71.4	37.9	3896	2521	1587	1190	794	1071	714	536	429	330	286	268	252	238	226	214
3100	98.4	73.8	39.1	4026	2605	1640	1230	820	1107	738	554	443	341	295	277	260	246	233	221
3200	101	76.2	40.4	4156	2689	1693	1270	847	1143	762	571	457	352	305	286	269	254	241	229
3300	105	78.6	41.6	4286	2773	1746	1310	873	1179	786	589	471	363	314	295	277	262	248	236
3400	108	81.0	42.9	4416	2857	1799	1349	899	1214	810	607	486	374	324	304	286	270	256	243
3500	111	83.3	44.2	4545	2941	1852	1389	926	1250	833	625	500	385	333	312	294	278	263	250
3600	114	85.7	45.4	4675	3025	1905	1429	952	1286	857	643	514	396	343	321	303	286	271	257
3700	117	88.1	46.7	4805	3109	1958	1468	979	1321	881	661	529	407	352	330	311	294	278	264
3800	121	90.5	48.0	4935	3193	2011	1509	1005	1357	905	679	543	418	362	339	319	302	286	271
3900	124	92.9	49.2	5065	3277	2063	1548	1032	1393	929	696	557	429	371	348	328	310	293	279
4000	127	95.2	50.5	5195	3361	2116	1587	1058	1429	952	714	571	440	381	357	336	317	301	286
4100	130	97.6	51.7	5325	3445	2169	1627	1085	1464	976	732	586	451	390	366	345	325	308	293
4200	133	100	53.0	5455	3529	2222	1667	1111	1500	1000	750	600	461	400	375	353	333	316	300
4300	136	102	54.2	5584	3613	2275	1706	1138	1536	1024	768	614	472	409	384	361	341	323	307
4400	140	105	55.5	5714	3697	2328	1746	1164	1571	1048	786	629	483	419	393	370	349	331	314
4500	143	107	56.7	5844	3781	2381	1786	1190	1607	1071	804	643	494	429	402	378	357	338	321
4600	146	110	58.1	5974	3866	2434	1825	1217	1643	1095	821	657	505	438	411	387	365	346	329
4700	149	112	59.3	6104	3950	2487	1865	1243	1679	1119	839	671	516	448	420	395	373	353	336
4800	152	114	60.6	6234	4034	2540	1905	1270	1714	1143	857	686	527	457	429	403	381	361	343
4900	156	117	61.8	6364	4118	2593	1944	1296	1750	1167	875	700	538	467	437	412	389	368	350
5000	159	119	63.1	6494	4202	2645	1984	1323	1786	1190	893	714	549	476	446	420	397	376	357

TO USE THIS TABLE: Enter at top under factor determined from Table 1. Read down to nearest value in sq. ft. or cu. ft. Read to left to determine the Btu/Hr. required.

Btu/Hr. REQUIREMENTS FOR AREAS AND VOLUME Table 1a (continued)

70° F Indoor Minus Outdoor Temperature Difference

Btu. Hr. Required	Wall, Ceiling and Floor Areas, Sq. Ft.																					
	Factors																					
	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.35	0.37	0.39	0.42	0.46	0.49	0.51	0.56	0.69
100	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	4.9	4.8	4.6	4.5	4.3	4.1	3.9	3.7	3.4	3.1	2.9	2.8	2.6	2.1
200	13.6	12.9	12.4	11.9	11.4	10.9	10.5	10.2	9.9	9.5	9.2	8.9	8.7	8.2	7.7	7.3	6.8	6.2	5.8	5.6	5.1	4.1
300	20.4	19.5	18.6	17.9	17.1	16.5	15.8	15.3	14.8	14.3	13.8	13.4	13.0	12.2	11.6	10.9	10.2	9.3	8.7	8.4	7.7	6.2
400	27.2	25.9	24.8	23.8	22.8	21.9	21.1	20.4	19.7	19.0	18.4	17.9	17.3	16.3	15.4	14.7	13.6	12.4	11.7	11.2	10.2	8.3
500	34.0	32.4	31.0	29.7	28.5	27.5	26.4	25.5	24.6	23.8	23.0	22.3	21.6	20.4	19.3	18.3	17.0	15.5	14.6	14.0	12.8	10.4
600	40.8	38.9	37.2	35.7	34.2	32.9	31.7	30.6	29.6	28.6	27.6	26.8	26.0	24.5	23.1	22.0	20.4	18.6	17.5	16.8	15.3	12.4
700	47.6	45.4	43.4	41.6	39.9	38.5	37.0	35.7	34.5	33.3	32.3	31.2	30.3	28.6	27.0	25.6	23.8	21.7	20.4	19.6	17.9	14.5
800	54.4	51.9	49.6	47.6	45.7	43.9	42.3	40.8	39.4	38.1	36.9	35.7	34.6	32.6	30.9	29.3	27.2	24.8	23.3	22.4	20.4	16.6
900	61.2	58.4	55.8	53.5	51.4	49.4	47.6	45.9	44.3	42.8	41.5	40.2	39.0	36.7	34.7	33.0	30.6	27.9	26.2	25.2	23.0	18.6
1000	68.0	64.9	62.1	59.5	57.1	54.9	52.9	51.0	49.3	47.6	46.1	44.6	43.3	40.8	38.6	36.6	34.0	31.1	29.1	28.0	26.0	20.7
1100	74.8	71.4	68.3	65.4	62.8	60.4	58.2	56.1	54.2	52.4	50.7	49.1	47.6	44.9	42.5	40.3	37.4	34.2	32.1	30.8	28.1	22.8
1200	81.6	77.9	74.5	71.4	68.5	65.9	63.5	61.2	59.1	57.1	55.3	53.6	52.0	49.0	46.3	44.0	40.8	37.3	35.0	33.6	30.6	24.8
1300	88.4	84.4	80.7	77.3	74.2	71.4	68.9	66.3	64.0	61.9	59.9	58.0	56.3	53.1	50.2	47.6	44.2	40.4	37.9	36.4	33.2	26.9
1400	95.2	90.9	86.9	83.3	79.9	76.9	74.1	71.4	69.0	66.7	64.5	62.5	60.6	57.1	54.0	51.3	47.6	43.5	40.8	39.2	35.7	29.0
1500	102	97.3	93.1	89.2	85.7	82.4	79.4	76.5	73.9	71.4	69.1	67.0	65.0	61.2	57.9	54.9	51.0	46.6	43.7	42.0	38.3	31.0
1600	109	104	99.3	95.2	91.4	87.9	84.7	81.6	78.8	76.2	73.7	71.4	69.3	65.3	61.8	58.6	54.4	49.7	46.6	44.8	40.8	33.1
1700	116	110	106	101	97.1	93.3	89.9	86.7	83.7	80.9	78.3	75.9	73.6	69.4	65.6	62.3	57.8	52.8	49.5	47.6	43.4	35.2
1800	122	117	112	107	103	98.8	95.2	91.8	88.7	85.7	82.9	80.4	77.9	73.5	69.5	65.9	61.2	55.9	52.5	50.4	45.9	37.3
1900	129	123	118	113	109	104	100	96.9	93.6	90.5	87.6	84.8	82.3	77.5	73.3	69.6	64.6	59.0	55.4	53.2	48.5	39.3
2000	136	130	124	119	114	110	106	102	98.5	95.2	92.1	89.3	86.6	81.6	77.2	73.3	68.0	62.1	58.3	56.0	51.0	41.4
2100	143	136	130	125	120	115	111	107	103	100	96.8	93.7	90.9	85.7	81.1	76.9	71.4	65.2	61.2	58.8	53.6	43.5
2200	150	143	137	131	126	121	116	112	108	105	101	98.2	95.2	89.8	84.9	80.6	74.8	68.3	64.1	61.6	58.7	45.5
2300	156	149	143	137	131	126	122	117	113	110	106	103	99.6	93.8	88.8	84.2	78.2	71.4	67.0	64.4	61.2	47.6
2400	163	156	149	143	137	132	127	122	118	114	111	107	104	97.9	92.6	87.9	81.6	74.5	69.9	67.2	63.8	49.7
2500	170	162	155	149	143	137	132	127	123	119	115	112	108	102	96.5	91.6	85.0	77.6	72.9	70.0	66.3	51.8
2600	177	169	161	155	149	143	138	133	128	124	120	116	113	106	100	95.2	88.4	80.7	75.8	72.8	68.9	53.8
2700	184	175	168	161	154	148	143	138	133	129	124	121	117	110	104	98.9	91.8	83.8	78.7	75.6	71.4	55.9
2800	190	182	174	167	160	154	148	143	138	133	129	125	121	114	108	103	95.2	86.9	81.6	78.4	74.0	58.0
2900	197	188	180	173	166	159	153	148	143	138	134	129	126	118	112	106	98.6	90.0	84.5	81.2	76.5	60.0
3000	204	195	186	179	171	165	159	153	148	143	138	134	130	122	116	110	102	93.2	87.4	84.0	79.1	62.1
3100	211	201	193	185	177	170	164	158	153	148	143	138	134	127	120	114	105	96.3	90.3	86.8	81.6	64.2
3200	218	208	199	190	183	176	169	163	158	152	147	143	139	131	124	117	109	99.4	93.2	89.6	84.2	66.2
3300	224	214	205	196	189	181	175	168	163	157	152	147	143	135	127	121	112	102	96.2	92.4	86.7	68.3
3400	231	221	211	202	194	187	180	173	167	162	157	152	147	139	131	125	116	106	99.1	95.2	89.3	70.4
3500	238	227	217	208	200	192	185	179	172	167	161	156	152	143	135	128	119	109	102	98.0	91.8	72.5
3600	245	234	223	214	206	198	190	184	177	171	166	161	156	147	139	132	122	112	105	101	94.4	74.5
3700	252	240	230	220	211	203	196	189	182	176	170	165	160	151	143	136	126	115	108	104	96.9	76.6
3800	258	247	236	226	217	209	201	194	187	181	175	170	165	155	147	139	129	118	111	106	99.5	78.7
3900	265	253	242	232	223	214	206	199	192	186	180	174	169	159	151	143	133	121	114	109	102	80.7
4000	272	260	248	238	229	220	212	204	197	190	184	179	173	163	154	147	136	124	117	112	105	82.8
4100	279	266	255	244	234	225	217	209	202	195	189	183	177	167	158	150	139	127	119	115	107	84.9
4200	286	273	261	250	240	231	222	214	207	200	194	187	182	171	162	154	143	130	122	118	110	86.9
4300	292	279	267	256	246	236	228	219	212	205	198	192	186	175	166	158	146	134	125	120	112	89.0
4400	299	286	273	262	251	242	233	224	217	209	203	196	190	180	170	161	150	137	128	123	115	91.1
4500	306	292	279	268	257	247	238	230	222	214	207	201	195	184	174	165	153	140	131	126	117	93.2
4600	313	299	286	274	263	253	243	235	227	219	212	205	199	188	178	168	156	143	134	129	120	95.2
4700	320	305	292	280	269	258	249	240	232	224	217	210	203	192	181	172	160	146	137	132	122	97.3
4800	326	312	298	286	274	264	254	245	236	229	221	214	208	196	185	176	163	149	140	134	125	99.4
4900	333	318	304	292	280	269	259	250	241	233	226	219	212	200	189	179	167	152	143	137	128	101
5000	340	325	311	298	286	275	265	255	246	238	230	223	216	204	193	183	170	155	146	140	130	104

TO USE THIS TABLE: Enter at top under factor determined from Table 1. Read down to nearest value in sq. ft. or cu. ft. Read to left to determine the Btu/Hr. required.

EQUIVALENT Btu/Hr. HEAT LOSS Table 1b

For Various Indoor Minus Outdoor Temperature Differences

70° F	50° F	55° F	60° F	65° F	75° F	80° F	85° F	90° F	70° F	50° F	55° F	60° F	65° F	75° F	80° F	85° F	90° F
1000	710	790	860	930	1070	1140	1210	1290	7000	5000	5500	6000	6500	7500	8000	8500	9000
1100	790	860	940	1020	1180	1260	1340	1410	7100	5070	5580	6090	6600	7610	8120	8620	9130
1200	860	940	1030	1110	1290	1370	1460	1540	7200	5140	5660	6170	6690	7710	8230	8740	9260
1300	930	1020	1110	1210	1390	1490	1580	1670	7300	5210	5740	6260	6780	7820	8340	8860	9390
1400	1000	1100	1200	1300	1500	1600	1700	1800	7400	5290	5810	6340	6870	7930	8460	8990	9510
1500	1070	1180	1290	1390	1610	1710	1820	1930	7500	5360	5890	6430	6960	8040	8570	9100	9640
1600	1140	1260	1370	1490	1710	1830	1940	2060	7600	5430	5970	6510	7060	8140	8690	9230	9770
1700	1210	1340	1460	1580	1820	1940	2060	2190	7700	5500	6050	6600	7150	8250	8800	9350	9900
1800	1290	1410	1540	1670	1930	2060	2190	2310	7800	5570	6130	6690	7240	8360	8920	9470	10030
1900	1360	1490	1630	1760	2040	2170	2310	2440	7900	5640	6210	6770	7340	8460	9030	9590	10160
2000	1430	1570	1720	1860	2140	2290	2430	2570	8000	5710	6290	6860	7430	8570	9140	9710	10290
2100	1500	1650	1800	1950	2250	2400	2550	2700	8100	5790	6360	6940	7520	8680	9260	9840	10410
2200	1570	1730	1890	2040	2360	2510	2670	2830	8200	5860	6440	7030	7610	8790	9370	9960	10540
2300	1640	1810	1970	2140	2460	2630	2790	2960	8300	5930	6520	7110	7710	8890	9490	10080	10670
2400	1710	1890	2060	2230	2570	2740	2910	3090	8400	6000	6600	7200	7800	9000	9600	10200	10800
2500	1790	1960	2140	2320	2680	2860	3040	3210	8500	6070	6680	7290	7890	9110	9720	10320	10930
2600	1860	2040	2230	2410	2790	2970	3160	3340	8600	6140	6760	7370	7990	9210	9830	10440	11060
2700	1930	2120	2310	2510	2890	3090	3280	3470	8700	6210	6840	7460	8080	9320	9940	10560	11190
2800	2000	2200	2400	2600	3000	3200	3400	3600	8800	6290	6910	7540	8170	9430	10060	10690	11310
2900	2070	2280	2490	2690	3110	3310	3520	3730	8900	6360	6990	7630	8260	9540	10170	10810	11440
3000	2140	2360	2570	2790	3210	3430	3640	3860	9000	6430	7070	7710	8360	9640	10290	10930	11570
3100	2210	2440	2660	2800	3320	3540	3760	3990	9100	6500	7150	7800	8450	9750	10400	11050	11700
3200	2290	2510	2740	2970	3430	3660	3890	4110	9200	6570	7230	7890	8540	9850	10520	11170	11830
3300	2350	2590	2830	3060	3540	3770	4010	4240	9300	6640	7310	7970	8640	9960	10630	11290	11960
3400	2430	2670	2910	3160	3640	3890	4130	4370	9400	6710	7390	8060	8730	10070	10740	11420	12090
3500	2500	2750	3000	3250	3750	4000	4250	4500	9500	6790	7460	8140	8820	10180	10860	11540	12210
3600	2570	2830	3090	3340	3860	4110	4370	4630	9600	6860	7540	8230	8910	10290	10970	11660	12340
3700	2640	2910	3170	3440	3960	4230	4490	4760	9700	6930	7620	8310	9010	10390	11090	11780	12470
3800	2710	2990	3260	3530	4070	4340	4610	4890	9800	7000	7700	8400	9100	10500	11200	11900	12600
3900	2790	3060	3340	3620	4180	4460	4740	5010	9900	7070	7780	8490	9190	10610	11320	12020	12730
4000	2860	3140	3430	3710	4290	4570	4860	5140	10000	7140	7860	8570	9290	10710	11430	12140	12860
4100	2930	3220	3510	3810	4390	4690	4980	5270	10100	7210	7940	8660	9380	10820	11540	12260	12990
4200	3000	3300	3600	3900	4500	4800	5100	5400	10200	7290	8010	8740	9470	10930	11660	12390	13110
4300	3070	3380	3690	3990	4610	4910	5220	5530	10300	7360	8090	8830	9560	11040	11770	12510	13240
4400	3140	3460	3770	4090	4710	5030	5340	5660	10400	7430	8170	8910	9660	11140	11890	12630	13370
4500	3210	3540	3860	4180	4820	5140	5460	5790	10500	7500	8250	9000	9750	11250	12000	12750	13500
4600	3290	3610	3940	4270	4930	5260	5590	5910	10600	7570	8330	9090	9840	11360	12120	12870	13630
4700	3360	3690	4030	4360	5040	5370	5710	6040	10700	7640	8410	9170	9940	11460	12230	12990	13760
4800	3430	3770	4110	4460	5140	5490	5830	6170	10800	7710	8490	9260	10030	11570	12340	13110	13890
4900	3500	3850	4200	4550	5250	5600	5950	6300	10900	7790	8560	9340	10120	11680	12460	13240	14010
5000	3570	3930	4290	4640	5360	5720	6070	6430	11000	7860	8640	9430	10210	11790	12570	13360	14140
5100	3640	4010	4370	4740	5460	5830	6190	6560	11100	7930	8720	9510	10310	11890	12690	13480	14270
5200	3710	4090	4460	4830	5570	5940	6310	6690	11200	8000	8800	9600	10400	12000	12800	13600	14400
5300	3790	4160	4540	4920	5680	6060	6440	6810	11300	8070	8880	9690	10490	12110	12920	13720	14530
5400	3860	4240	4630	5010	5790	6170	6560	6940	11400	8140	8960	9770	10590	12210	13030	13840	14660
5500	3930	4320	4710	5110	5890	6290	6680	7070	11500	8210	9040	9860	10680	12320	13140	13960	14790
5600	4000	4400	4800	5200	6000	6400	6800	7200	11600	8290	9110	9940	10770	12430	13260	14090	14910
5700	4070	4480	4890	5290	6110	6520	6920	7340	11700	8360	9190	10030	10860	12540	13370	14210	15040
5800	4140	4560	4970	5390	6210	6630	7040	7460	11800	8430	9270	10110	10960	12640	13490	14330	15170
5900	4210	4640	5060	5480	6320	6740	7160	7590	11900	8500	9350	10200	11000	12750	13600	14450	15300
6000	4290	4710	5140	5570	6430	6860	7290	7710	12000	8570	9430	10290	11140	12860	13720	14570	15430
6100	4360	4790	5230	5670	6540	6970	7410	7840	12100	8640	9510	10370	11240	12960	13840	14690	15560
6200	4430	4870	5310	5760	6640	7090	7530	7970	12200	8710	9590	10460	11330	13070	13940	14810	15690
6300	4500	4950	5400	5850	6750	7200	7650	8100	12300	8790	9670	10540	11420	13180	14060	14940	15810
6400	4570	5030	5490	5940	6860	7320	7770	8230	12400	8860	9740	10630	11510	13290	14170	15060	15940
6500	4640	5110	5570	6040	6960	7430	7890	8360	12500	8930	9820	10710	11610	13390	14290	15180	16070
6600	4710	5190	5660	6130	7070	7540	8010	8490	12600	9000	9900	10800	11700	13500	14400	15300	16200
6700	4790	5260	5740	6220	7180	7660	8140	8610	12700	9070	9980	10890	11790	13620	14520	15420	16320
6800	4860	5340	5830	6310	7290	7770	8260	8740	12800	9140	10060	10970	11890	13710	14630	15540	16460
6900	4930	5420	5910	6410	7390	7890	8380	8870	12900	9210	10140	11060	11980	13820	14740	15660	16590

TO USE THIS TABLE: Enter under column headed 70° F. Read down to Btu/Hr. determined from Table 1a. Read across to the column which represents the indoor minus outdoor temperature difference for which the system is designed.

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Upon request the Association will be very glad to send you any or all of the following three books:

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This is a well illustrated non-technical publication showing both ceiling and floor installations of copper tube for radiant heating. The book gives the history of the use of copper tube for this form of heating and points out its many advantages.

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This is a 72-page technical handbook containing information, drawings, photographs and data on the use of copper tube for plumbing and heating.

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A 48-page book showing practical methods for the bending of pipe and tube of copper, brass and related alloys.

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