the radiator, the air will be crowded at first to the further end of the radiator, and should the system be a gravity circulation, without an outlet to the atmosphere, it will remain in the radiator, impairing its efficiency and often deceiving the novice, as it in time heats by contact with the steam; but when there is a thumb cock or air valve on the radiator, usually on the furthermost pipe from the inlet, the result is quite different. In the common return-bend radiator and others of good construction the action is direct, and the pipes heat consecutively, excepting, perhaps, the pipe the air valve is on and a few near it which sometimes heat ahead of their order, on account of the draught of the air valve.

Thus when the steam enters a well-constructed radiator the air falls to the base and is driven out at the air valve, the pipe of which may be run down inside the base (as seen at D, Fig. 1), which will bring it into the lower stratum, drawing it off to the last.

This is the most simple test for a good heater, and any make of radiator that nearly always has a few cold pipes, sometimes in one part of the heater and sometimes in another, should be avoided.

Fig. 2 shows a device (patented) for making a return bend radiator positive. The pockets, A A, filling with condensed water, makes a seal which at times prevents the flow of steam along the base and forces it in a continuous stream through the pipes (see arrows in cut).

Figs. 3 and 4 show cross section of modifications of positive return bend radiators. Fig. 3 can be used as a vertical radiator only, but Fig. 4 can be used in any position from perpendicular to hoizontal, as seen at Figs. 5 and 6, and is peculiarly adapted to indirect heating.

Single tube radiators welded, or closed at the top with a cap, with an inside circulating device, are also much used; some of them compare favorably with the return-bend radiator, but are slower in heating.

Fig. 7 shows the first of this class put on the market. A is the cast iron base, B the welded tube, and C the septum of wrought iron slipped inside the tube and projecting an inch into the base. This heater depends on the gravity of the air for a circulation.

Fig. 8 shows another heater of this class which is positive in its action. A, cast iron base; B, diaphragm cast in base; C, welded tube; D, inside tube, open top and bottom and screwed into the diaphragm. The action of the steam can be seen by the arrows.

Fig. 9 shows a fire bent tube radiator very positive in its action.

Cast iron radiators are of two kinds, *plane* and *extended* surfaces.

Plane surfaces, as the trade understands them, may be either flat, round, or corrugated, provided the coring or inside surface of the iron corresponds and follows the indentations of the outside, as in Fig. 10, and all wrought iron heaters. Extended surface is understood when the outside surface of the heater is finned, corrugated, or serrated, with the inside straight, as in Fig. 11.

For direct radiation where the heater is placed in the room there is little or nothing gained by having the surface of the heater extended, and a steamfitter in calculating the extent of his heating surfaces should not take into consideration the whole outside surface of such a heater; he should simply treat it as if the projections were cut off, leaving a flat or plane surface.

For indirect heating (the coil to be under the floor or in a flue) the result is a little different when in comparison with shallow plane surface coils, where the air cannot stay long enough in contact with them to get thoroughly warmed, but presses into the room without hinderance. In this case the extended surface gives a better result, not because a square foot of the surface can transmit as much heat in the same time, but because it hinders the direct passage of the air, holding it longer in contact and preventing stratification.

The cast iron vertical tube radiator is a quick heater, the large size of the tubes causing large and few chambers, which expedites the expulsion of the air.

Fig. 12 shows stack of cast iron extended surface radiators for indirect heating.

Sheet iron radiators are used in very low-pressure heating, the commonest form of which is the flat Russia iron heater, seamed at the edges and studded or stayed in the middle, with a space of about ⅜ of an inch between the sides. They are used in a one pipe job.

COILS.

Coils are always made of wrought iron steam pipe and fittings, and though not considered an ornament are first-class and cheap heaters.

Fig. 13 shows a *flat coil*, which is a continuous pipe connected with return bends at the ends and strapped with flat iron, which is a very positive heater.

Fig. 14 shows a miter or wall coil. It is composed of headers or manifolds, A A; steam pipes, B; elbows, C; and hook plates, D.

There are many modifications of this coil, but one indispensable point in the making of it is, it must *turn a corner* of the room or miter up on the wall. The pieces from the elbows to the upper header are called *spring pieces*, they are screwed in right and left, and are the last of the coil to be put together.

If a coil is put together straight between two headers, as seen at Fig. 15, it will be like Fig. 16 when heated, and cannot be kept tight for a single day, the expansion of the first pipe to heat being a powerful purchase to force the headers asunder, and when it cannot do so it will spring them sidewise.

TO ESTIMATE THE AMOUNT OF HEATING SURFACE NECESSARY TO MAINTAIN THE HEAT OF THE AIR OF ENCLOSED SPACE IN BUILDINGS TO THE DESIRED TEMPERATURE.

The ordinary rule-of-thumb way of the average pipe-fitter is to multiply the length by the breadth of a room and the result by the height, then cut off two figures from the right hand side, and call the remainder square feet of heating surface, with an addition of from 15 to 30 per cent, for exposed or corner rooms.

In the computing of heating surfaces there is much more to be considered, and it is evident the amount of surface necessary for a good and well constructed building will not be enough for a cheap and poorly put up one.

The cubical contents of a room occupies only an inferior place when estimating for large rooms and halls, and no place at all in figuring for small or ordinary office rooms or residences, which are heated from day to day throughout the winter.

Suppose a small room on the second floor of a three-story building with only one outside wall, with no windows, but the whole furred, lathed, and plastered, with all the other rooms of the building heated and maintained to 70° Fah.; now place a portable heater in this room and keep it there until the room is heated to 70° also, then remove it. How long will it take to cool 10°? Answer, perhaps three hours. Now make a window without blinds, and you find it cools 10° in less than half the time. Why? Because the glass of the window being a good transmitter of heat, it is able to cool more air than the whole outside wall. You may now say: What about the inside walls and floor? Why, they actually help to maintain the heat in the room by conduction, etc., from the other rooms.

Thus the windows are the first and most considerable item. Secondly, the outside walls, how they are plastered—whether on the hard walls or on lath and furring. Thirdly, the prospect—whether exposed or sheltered. Fourthly, is the whole house to be heated, or only part of it? and, lastly, what the building is to be used for.

TABLE OF POWER OF TRANSMITTING HEAT OF VARIOUS BUILDING SUBSTANCES, COMPARED WITH EACH OTHER.

Window glass	1,000
Oak and walnut	66
White pine	80
Pitch pine	100
Lath and plaster	75 to 100
Common brick (rough)	120 to 130
Common brick (whitewashed)	125
Granite or slate	150
Sheet iron	1,030 to 1,110

In figuring wall surface, etc., multiply the superficial area of the wall in square feet by the number opposite the substance in the table, and divide by 1,000 (the value of glass), the product is the equivalent of so many square feet of glass in cooling power, and may be added to the window surface and treated the same.

The following method has given good results and is not wholly empirical. The writer has used it for many years in preference to any other:

Divide the difference in temperature between that at which the room is to be kept and the coldest outside atmosphere, by the difference between the temperature of the steam pipes and that at which you wish to keep the room, and the product will be the square feet or fraction thereof, of plate or pipe surface to each square foot of glass or its equivalent in wall surface.