say, fifty feet surface, on as many floors. On the left is shown what is required in the new method, with an estimate of the stock and labor to properly supply both arrangements.

This is an example where the main horizontal supplies are *required* to be located under the first floor; this is not always desirable, *but must be followed in the old method*, and so we begin our comparisons at this point.

To produce circulation in the double piping (on the right), steam is supplied to the main from the boiler, then upward through the vertical supply to the radiators on the different floors, the air being first expelled before the steam will enter the tubes. The first radiator "vented," discharges in the room this access of spent and vitiated air, to the discomfort of all persons, who are thus led to ascribe this avoidable nuisance to the "bad quality of steam heat." But first the "supply" valve must be opened, then the "return;" so in closing, *both* must be shut firmly, or the radiator will become filled with water; so a "rule" has been made:—"Open wide, and close both valves together."

To the two lines of piping, located near together for ease of connection, the radiator must be joined; but, as the connections are of iron, can only be done by careful measurements and considerable labor, being mostly below the floor; and, when connected, the radiator becomes a *fixture*, until a workman is again called to release it—no easy operation where furniture and carpets must be removed.

These double lines of pipe of different diameters are unsightly, yet cannot be concealed in the walls without fear of leakage and a loss of heating power. Now, as the *joints* are the main item of first cost, and after maintenance, and the valves are constant sources of trouble, a method of piping which reduces these nearly one-half, while doing an equal or a *better* work, should challenge the attention of all interested parties.

In cities, where the basements are finished and used for business, the location of piping, for which in the "old order" there is no other place, are both unsightly, and at times so overheat these rooms as to greatly impair their value.

So, also, to provide for the two connections, the floor must be bored and "bushed" for the passage of the pipes from and to the "risers;"

that the return connection *must* go below the floor is apparent; also, that, whatever plan is adopted for heating, (as in building the structure,) the owner *pays the bills*, not only of the first cost, but those which follow yearly in the shape of repairs. Even if the first cost between the two estimates should appear the same, one would be in reality much dearer than the other. That so much steam work is yearly put up, so generally deficient in plan, and without the best results, is proof, first, of how little is really known of what the proper standard is; that almost any arrangement of pipe and fittings may be made to operate *somehow* is the key to the question of: How can people, with little experience and less knowledge, make a living by selling heating material, *and often their customers*, who, however, do not understand this until by bitter experience they have paid for their knowledge?

Let us now turn to the other exhibit, (left side of same Plate 1,) and see what can be done with much less materials, time and labor.

It will be observed that we start from the main supply, (below the first floor, as in the other case,) but we now run the vertical supply pipe, all of one size, without cutting or distribution, to any convenient point *near the highest radiator*, from which point the "supply" becomes also the return, to which the radiators are connected with a single valve, the outlet and tee being above or below the floor, as desired.

The steam entering the supply-pipe expells the contained air, not into the rooms, but into the basement, through the air-vent provided, establishing at once a circulation, regardless of the radiators, which, if open, go immediately to work, as most of their air is drawn out by the *descending circulation* of the steam and water.

Here, then, is the key to a circulation at even a minimum pressure, the air being allowed to *fall* out of the pipes, instead of being lifted and forced out, as in the old method; the pipes under this arrangement do more efficient work as soon as steam is raised and as long as it remains.

The radiator now being wanted, we have to open but one valve, which admits the steam and also discharges the water, the air only of the *radiator* being discharged into the rooms.

The desirability of using but one valve to open and close the radiator is readily conceded, as persons not familiar with steam work are li-

able to work only one, in which case trouble always follows in one shape or another. This condition is just as true of "indirect stacks" put in boxes below the floor; they can be and are operated, under this system, with only one connection and valve. It may be remarked here that while our plans show only one connection and valve to the radiators, as specified in Patent No. 154,561, of Sept. 1, 1874, yet the original Patent No. 145,962, of Dec. 30, 1873, and the Reissue No. 6591, both show two connections to the radiator, but they are still on the return pipe and supplied from above. This arrangement is useful where circulating pipes are used in place of radiators, and also where hot water is the medium for conveying the heat, instead of steam.

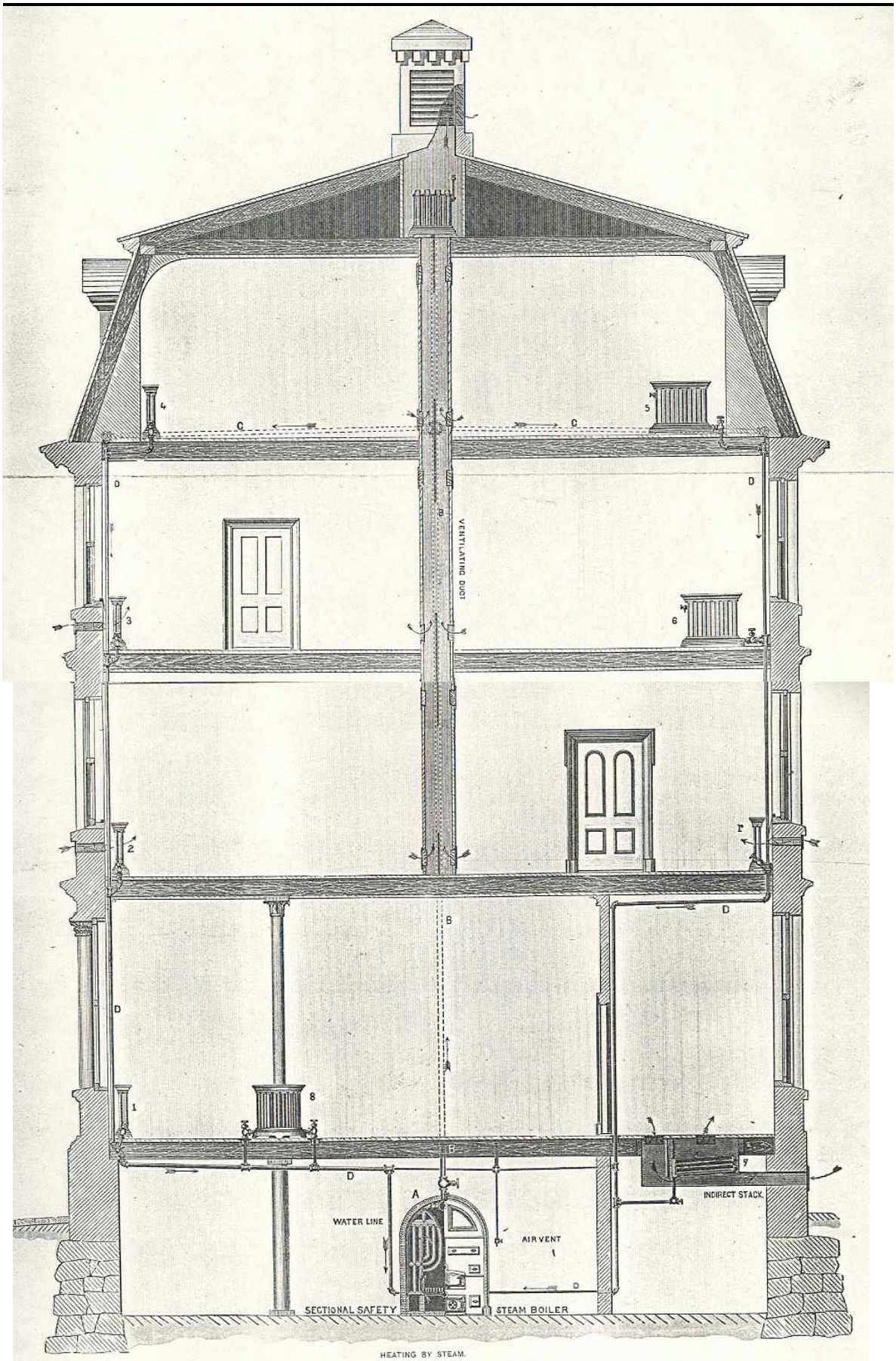
In our Plate No. 2, right side, is shown a "stack" complete, arranged for both outside and inside air. All the piping being outside the casing, the circulation goes on independent, and is not subject to danger of being frozen, even if the cold air-box (as is often the case) be left open after the steam goes down.

Another great advantage of running the "supply" pipes *free* (without cutting) is that they may be located away from the "return," in closets or other rooms, as they have only to connect to the "return" at the point where it begins its work. A foot of these service pipes is found much more efficient than a foot of any radiator made, a single line of 1½ in. pipe, (1 to 125,) warming medium-sized sleeping-rooms to 60°.

In the earlier stages of steam heating, and sometimes now, a single pipe and valve are tried, supplying the steam upward against the air and the *descending* water of condensation, which thus must re-enter the boiler at the *top*, instead of below the water-line — an arrangement so defective in principles and results that it finds no favor with Engineers or practical people, its use being restricted to a single radiator, on a line that could not otherwise be reached.

In Plate No. 2 is shown a different and the *preferred* arrangement, whenever the building admits of a general distribution on or under the upper floor to be heated.

Here the steam is taken in one or more main supplies, of liberal size, directly to the upper floor, where the heating begins, or where the horizontal distribution is arranged, and from which point all the



HEATING BY STEAM.

PLATE No. 2. NEW METHOD.

OVERHEAD SUPPLY AND DISTRIBUTION.

lines become both supply and return in one and the same pipe; but *all the elements, steam, air and water, travel together in the same direction towards the boiler*, a general *vent* for the air being provided on the "returns" in the basement, but above the water-line of the boiler; this vent is open when the pipe is cold, and closed when steam appears.

It is thus seen that the pressure at the boiler, be it much or little, is always transmitted through the "supplies" and back to the water, which may thus re-enter the boiler under the natural law of gravity.

This sending of the steam unweakened to the farthest points, to begin the work, is the secret of a uniform pressure in the whole "plant," as is sure to be the reverse in the old system, where the steam is supplied to the radiator nearest the boiler, and thus is successively reduced the farther it has to travel.

As we before remarked, the different construction and arrangement of buildings require different treatment, location of pipe and radiators. The main supplies for some buildings cannot be placed in the basement; in others, not in the upper stories; but with the two plans every structure and condition can be properly and successfully met, reducing the first cost by reducing the amount of material and labor required to perform an equal work.

The different kinds of fittings that may be used to advantage are shown by the different connections to the radiators in Plate No. 2. The 45° angle tee may be used either above or below the floor, but it is a far better and safer rule to put no fittings below the floor.

The question of what relation one connection to a radiator bears to two, as regards the amount of work done, was raised, and at once put to a test by extended experiment, the record of which is submitted, as the results show a gain even in favor of *one* orifice over two. It should be explained that two radiators were selected, exactly alike, of 60 feet surface each; they were supplied from the same steam pipe, and delivered the resulting water into separate iron vessels, from which it was weighed at the end of each experiment; all due care was observed to avoid any side currents of air on either radiator. See table of Experiments, page 32.

Thus it is seen that, under the average and ordinary conditions, a surface foot of radiator will condense about 5 cubic feet of steam per

hour, yielding about 5 cubic inches of water; or for a radiator of 60 feet surface, 300 cubic inches of water per hour, equal to $1\frac{3}{4}$ cubic feet in 10 hours.

But, by referring to table of Experiments, page 34, it is seen that a foot of radiator may be made to do double this work, by supplying double the quantity of air; so that by using a forced circulation much less feet of radiator would be required, while the air so warmed may be delivered at any point desired at about the same first cost. The steam used to drive an engine and fan may be exhausted into the heating pipes, and would have as much value for *heating* purposes as before it passed the engine; that is, it contains all the sensible and latent heat due to its pressure.

A third application of our "system" is shown in Plate No. 3, as applied to Church and Hall heating. These buildings, owing to their great height and large dimensions generally, are not easily reached by ordinary methods.

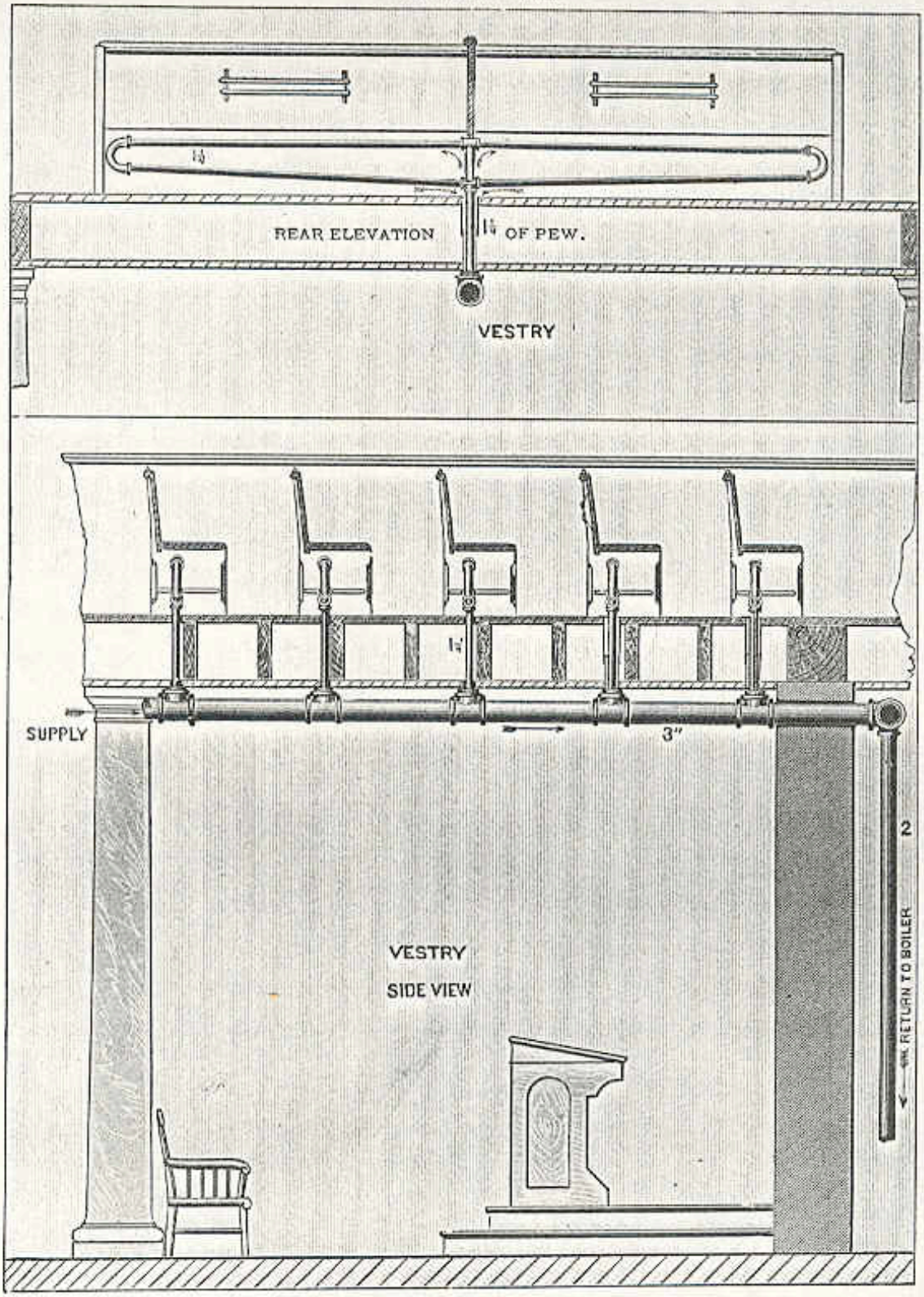
In churches it is difficult to place the radiation at the wall, and yet reach the centre, except after long application. The arrangement of "indirect" surface (under the floor) is not always possible, owing to the vestry below; that the best place to reach the cold air is near the floor, and at many points, is plain; also, that to supply heat in the pew near the feet of the occupants would produce an immediate result that could be reached in no other way, the necessary supply of pure air for ventilation without cold currents being provided for.

That church heating differs as widely from all other heating as the edifice differs from all other buildings in its architecture and uses has been conceded by all who have attempted anything in this line; and that so little practical success has attended the various methods and means employed is evidence that the problem is not one of easy solution.

But two methods need claim our attention, namely, by Furnaces and Steam; other methods, such as Stoves and Hot Water, holding no practical position. That furnaces of cast or wrought iron should have been so long the main reliance is due to a few simple but weighty reasons: the transition from the open fires of our ancestors to stoves was not made rapidly nor without much opposition, for while their

PLATE NO. 3.

HEATING BY STEAM.



CHURCH OR HALL HEATING, HORIZONTAL DISTRIBUTION.

greater efficiency was admitted, their unhealthiness did not escape the notice of practical men; the furnace of to-day is but a large outgrowth of the stove, so generally distrusted, and would not be tolerated at this period, except for apparent improvements and that most seductive quality—*cheapness*.

The main point we wish to bring to your attention is that, while there is little choice in the manner of applying furnace heat, or any new or valuable results to be looked for, steam is yet in its infancy, especially in the matter of proper apparel in which to appear at church. What we believe to be the great error in both methods as generally applied is the attempt to treat the *whole body* of the air contained within the walls as if it were only a few thousand cubic feet, and that, too, from a very few centres of contact with the heating surfaces.

The best furnaces are never at such disadvantage as when attempting the control of large bodies of air, which are at liberty to rise indefinitely as soon as heated; this is also the case even with steam heat, when the radiating surfaces are placed in similar positions — that is, under the floor, the air being drawn down over them and then returned to the space above. The advocates of this *indirect* application lay great stress on this method as the healthy and more convenient arrangement, which is doubtless true when applied to a private dwelling, but erroneous when applied in buildings of magnitude. By the plan proposed and submitted, it will be seen that the heating pipes are located, not in boxes below the floor, or in coils on the walls away from the floor where most needed, but directly at the foot of each and every individual, warming the air contained in the pews *first and last;* even after the steam should be entirely removed, the large amount of warm pipes remain, diffusing a mild and gentle heat to be secured in no other way. The space under each seat affords the most convenient and out-of-the-way situation for this heating surface, at the same time effecting in a most sanitary way the thorough ventilation of the inclosed slips, because the heat applied to the air in them causes it to rise, at the same time the purer air falling by the walls and windows takes its place, supplying the needed oxygen just where and when required, while the warmed air rises and finds an exit at the ventilating registers in the walls.