radiating surfaces were issued prior to those on which the Nason Manufacturing Company built its radiator business during the years from 1862 forward. No rec-

ords of the actual commercial use of the radiators manufactured on the principle of these prior patents are available to the author. Their appearance as visualized by the patentees and the claims as set forth by them are in-

Fig. 32.—Early type of direct-indirect radiator

valve, globe valve, stop cock as well as for much of the machinery needed for their manufacture.

A few patents, however, relating to radiators and

Fig. 33.—Duplex stairway direct radiator. A type of radiation for placement under stairways in hotels, halls, lobbies, etc., where this floor space not otherwise usable might be utilized. The radiator was usually built on a high leg base so as to allow ample space underneath for air to pass up through and between the loops

teresting as they present early ideas which, while crude in application, undoubtedly stimulated the developments which followed.

On November 4, 1851, a patent was granted to K. K. Ingalls for "a new and useful arrangement, for heating

(Continued on Page 111)
A History of the Development of the Radiator

(Continued from Page 56)

A ventilating public and private buildings—by the use
of "steam or hot water" and which was "denom-
itied" by the patentee as "The temperate heat-distrib-
utor."

The principle of this apparatus is illustrated as Fig.
9. It consisted essentially of a series of chambers, an
inlet pipe for steam or hot water and a pipe for carry-
ing away the condensed steam or cooled water. It is
apparent that it represents a crude form of the steam
radiator of a little later period.

These "heat distributors" were claimed to be con-
structible of "tin, copper, cast or wrought iron, or of any
material known to furnish a good radiating surface."
They were constructed of rectangular box form, Fig.
10, and it was claimed that the principle might be applied
to a cylindrical form, Fig. 11. They were placed directly
in the room to be warmed and thus presented an early
type of direct hot water or steam radiator. Small legs
are shown in the illustrations of Figs. 10 and 11. These
legs raised the apparatus from the floor so that air might
pass under and into the spaces between the heating sec-
tions and as it was warmed pass upward and out the top.
Ventilation was assured by connecting an outside air duct
directly to the underside of the radiator. In this partic-
ular patent, much stress was laid on the advantages of
the tapering form of the radiating surfaces, but these
claims were not borne out in practice.

About ten years later, June 12, 1860, a patent for
a steam radiator was granted to A. F. Plinkin and herein
the radiator, as we know it, begins to take on more
definite form. Considerable trouble had been experienced
through the bursting of connections due to unequal ex-
pansion or from permitting pressures within that were
excessive for the material or manner in which it was
used.

In describing his invention, this inventor recognized
many requirements of radiator design which were passed
on as the art progressed. In Fig. 12 the drawings accom-
palnng this request for patent illustrate a cluster of
five radiators. The patentee claimed improvement in
steam radiators by "making a perpendicular radiator of
one piece of metal with the two sides cast or made to-
gether, having intermediate connections to support the
plates." He recognized the need of providing against
unequal expansion or excessive pressure, of prevent-
ing collapsing when bolting the sections together, of
assuring free entrance for the air between sections, for
providing a ready means for collection of the condensed
steam, and provision for relieving air from the radiator.
This radiator certainly possessed advantages over its
predecessors in that it offered more economical construc-
tion through its manufacture without seam or joint; its
compactness and hence relatively large amount of radiat-
ing surface for space occupied; its simplicity; its ready
means of extension and the improved entrance for the air
at bottom, between sections.

On March 11, 1862, a patent for improvement in steam
radiators was granted to Joseph Nason and Robert Briggs.
The general appearance of this radiator is illustrated as
The radiating tube of this improved Nason radiators shown in Fig. 14, and consisted of the tube 1, a diaphragm 2, a steam-pedestal 3, an inlet-pipe 4, and an outlet-pipe 4. In Fig. 14, the diaphragm 2 extends from the bottom of the tube 1 nearly to its top. This diaphragm was made of sheet-iron or other suitable material and of such width that when curved slightly and pushed into the tube, it would remain securely in place by friction contact.

Mr. Nason recognized the necessity of air removal and a function of effective warming with steam, and he based his claim on the fact that the interior diaphragm provided means for establishing and maintaining an inward current of steam and an outward current of air opposite sides of the diaphragm.

A modification of the application of the principle illustrated at B, Fig. 14, where the interior tube 1 b extends from the lower part of the pedestal 3 nearly to the top of the radiating tube 1 a. It was claimed in one case that steam was admitted to the pedesatal 3, that it was allowed to flow upward and enter the tube 1 a, while the air, being heavier, would flow down the interior tube 1 b and then into the pedestal and into the outlet pipe.

In 1861, this type of radiator with the cast base, tubes and flange plate began to be installed in each room to be warmed just as present direct radiator practice. It was provided with a grill top and each tube was guaranteed to have one square foot of radiating surface which simplified calculation.

In the illustration of Fig. 13, separate control valves are shown for each row of tubes. The assembled radiators as placed on the market is illustrated in Fig. 15 as a row valve with one inlet. This type was known as Nason standard pattern wrought iron welded tube radiators. Nason also made the "Improved" vertical wrought iron welded tube radiator. This type was made in 1-2-3 and 4-row patterns. Somewhat later, in the early 80's, there was added Nason's duplex pattern radiator which consisted of 8 rows of 24 tubes each. In overall dimensions were 4 feet, 5½ inches by 24½ inches and a tube contained 1 square foot of surface, it presented 8 square feet of radiating surface.

The rows of tubes were arranged in groups of 4 so as to permit air to pass up through openings in the base and thus allow the interior tubes to function as efficiently as those on the exterior. These radiators were carried in stock, either plain or bronzed, and immediate delivery could be obtained.

Improvements in steam radiator design were constantly being made through filing of various patent claims, but perhaps the most noteworthy advance in design was covered in the claim of Nelson H. Bundy under date of July 30, 1872, when he was granted a patent on improvement in tubes for steam radiators. This patent among the first, if not the first, to be granted on a radiator. It was indeed a forward step for it not only improved circulation for the radiator but materially increased the radiating surface.

Fig. 16 illustrates the construction of this Bundy, and Fig. 17 and 18 illustrate the commercial development of the idea. It provided for the circulation of steam through upright radiator pipes without the
duction of any independent device or pipe. The radiator tube or pipe was cast with separate passages a for its entire length, with the passages connected at the ends. A cast web, b, separated the passages. Thus, the passages were given an ellipsoidal shape and the area of radiating surface for a given diameter of radiator tube or pipe increased considerably. The upper ends of the pipes could be covered with a top as shown in Fig. 16.

The idea as presented through the Bundy patent seemed to provoke a desire to make more positive the circulation through the tube and we find a number of ideas advanced for the accomplishment of this end. Fig. 19 illustrates a construction for the base such that a projection on certain of the tubes would assure steam entering those pipes having these projections before it entered those without projections and thereby serve to drive the air quickly from the pipes with the result that a more rapid and quicker steam circulation was established and a more responsive heating of the radiator was obtained.

Another proposed plan for improving and assuring circulation is shown as Fig. 20. To say that it was cumbersome would be putting it mildly. Here the steam was admitted at b, to the base steam pipe A, to which the radiator tubes E and F were connected. The other base steam pipe B was similarly constructed and connected to A by means of the connecting pipe D through which water of condensation was carried. The steam entered at b, passed along the horizontal pipe A, up the vertical tubes E and along the hollow upper connection manifold C, down the vertical tubes F and along the horizontal pipe B to the outlet C.

The water of condensation, collecting in pipe A from the tubes E passed through connecting pipe D and the hollow sections CC to pipe B and there combining with condensation from tubes F passed to outlet C.

This radiator, as proposed, presented one of the many types of direct-indirect radiator for it was built with an air base K on or in which the radiator rested. The tubes H and I, Fig. 25, were air pipes into which air from the outside was admitted through an inlet L, Fig. 20, with valve control. Or, by means of ports in the base, circulation of inside air was provided for.

While the principle illustrated in Figs. 20 and 21 shows the trend in radiator design and consideration, the author is not informed as to any practical use of the patent.

Fig. 21 shows another idea where the base was divided into an upper and lower chamber and there was proposed, the use of a two-way cock, for admitting steam and drawing water of condensation. Nor did this ever receive commercial consideration so far as the writer is informed.

Other ideas of radiators from the inventive mind are shown as Figs. 22 and 23.

The prototype of the column radiator made its appearance between 1875 and 1880. Figs. 24 and 25 illustrate, respectively, a two- and a three-column type. The underlying principle of that shown as Fig. 24 was a spiral twist given the channels of the tubes to provide...
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ONE PIECE WATER CLOSET

A radiator illustrated in Fig. 25 claimed distinct improvement in circulation through providing two or more descending arms having a large amount of radiating surface to insure rapid condensation of the steam. A central arm or channel directly in the path of the entering steam so as to assure positive entrance thereinto and rapid flow to the top of the radiator. Special construction at the inlet of the central tube was used to insure the steam entering.

While the vertical tube, wrought-iron radiator and the loop type radiator were designed and built for steam, it was not long before it was applied to hot water radiators as well. Early in the history of this type such a radiator was produced by Bartlett, Hayward & Co. The top of their radiator consisted of a hollow, cast-iron casing into which tubes were screwed, exactly as they were screwed into the base of the Nason steam radiator. The free ends of the pipes were left open and passed through corresponding holes in the upper side of the radiator base and there expanded, similar to the expanding of boiler tubes. The bottom of the base was then attached with screws and a copper or other suitable gasket used to make a tight joint.

Tests with these radiators showed that, when the radiator was relieved of air, bottom connections could be used on both ends with practically equally good water circulation and heat emission, which contradicted the idea that the supply should always be made at the top.

To the L. A. Griffin Iron Co. (Samuel D. Tompkins, an officer of the company) has been credited the joining of cast-iron loops with a hollow top casing and of making the first cast-iron loop hot-water radiator.

In the construction of Bundy-Tompkins hot water radiator the loops were screwed into the base exactly as for a steam radiator. The cap or top was cast hollow, with a series of tapped openings through it. The upper opening was made large enough to permit passing short brass nipples used for joining the head of the loops with the lower holes. These lower holes and those in the heads of the loops were tapped in one operation so they coincided in taper and thread register. The short threaded taper tube or nipple, which was made of brass and had a square hole in it for a wrench, was then forced into the hole and into the head of the loop after which the hole was closed by means of a hollow plug. Then an entablature was placed over the whole to cover the plugs and present a pleasing radiator appearance.

The radiator as first constructed is shown in section as Fig. 26. Note the partition at which was introduced at first as necessary to turn the water into the head of the radiator and prevent its passing through the radiator from inlet to outlet.

This was no other than evidence of the prevalence of the old idea that a continuous current was necessary for circulation. The added resistance caused by the abrupt turn to force the water upward through the end tubes of the radiators and their nipples as noted by arrows in Fig. 26, before it reached the other tubes was high, so men often punched out the division at with the result that circulation was improved, better heating resulted and the division a was eventually omitted entirely.

Through the 80's and 90's and early in the 20th cen...
A Bronze-Welded Water Supply Line

(Continued from Page 6)

Welded cast iron pipe installations. Some time ago, it was found in investigations carried out on experimental installations of bronze welded pipe that the machining of a beveled edge for welding had the effect of exposing the small flakes of graphite which are typical of cast iron structure. It has been found that the bond between the deposited bronze and such cast iron machined surfaces is of uncertain adhesion due to the presence of these graphite flakes.

Acting on the results of these investigations, it has since then been the practice on all installations of bronze-welded cast iron pipe to subject the ends of the pipe, after beveling, to an oxy-acetylene flame until they become a dull red, after which they are allowed to cool. This burns up the graphite flakes and makes the surface adaptable to the bronze-welded joint. Usually this searing is done at the pipe foundry, but it can be performed at the job if necessary. It helps also in making the actual welding easier. The bronze tins quickly and easily on the seared edges. Naturally there is a distinct saving of time, and, it is believed, a good effect on the final efficiency of the lines.

The pipe was delivered on the job in 12-foot lengths, which the shear-vee joint machined, and lined up on the wharf for welding. It was not laid on skids as is usual in welding pipe lines in the field, but was laid flat on the surface of the wharf with triangular blocks nailed on each side to hold it in line and to keep it from rolling away while being turned. These blocks can be seen in Fig. 4.

All welds were of the shear-vee type except the welds that were made to fasten the flanges in place. These flanges were to be used in making the connections for the pumps (Fig. 2), and also were used on the bay end of the job for connecting strainers to the end of the line. Eight flanges were welded to the pipe, as shown in Fig. 3. The pipe is shown in Fig. 4, in process of welding. The operators can be seen making welds in the 6-inch line, and in one of the 8-inch lines. Portable welding units were used, aiding materially in speeding up this work. The welds were all made with a 1/4-inch bronze welding rod. On a number of these welds a time record was kept, and the average time taken for a 6-inch weld was about 20 minutes, and for an 8-inch weld about 25 minutes, with a No. 8 welding tip. The amount of bronze used for the joints was 1 1/2 pounds for the 6-inch and 2 pounds for the 8-inch welds.

After the welding was completed, as shown in Fig. 4, the three lines were subjected to a hydrostatic pressure of 125 pounds. This pressure was held for about 1 hour and everything was found to be satisfactory.

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