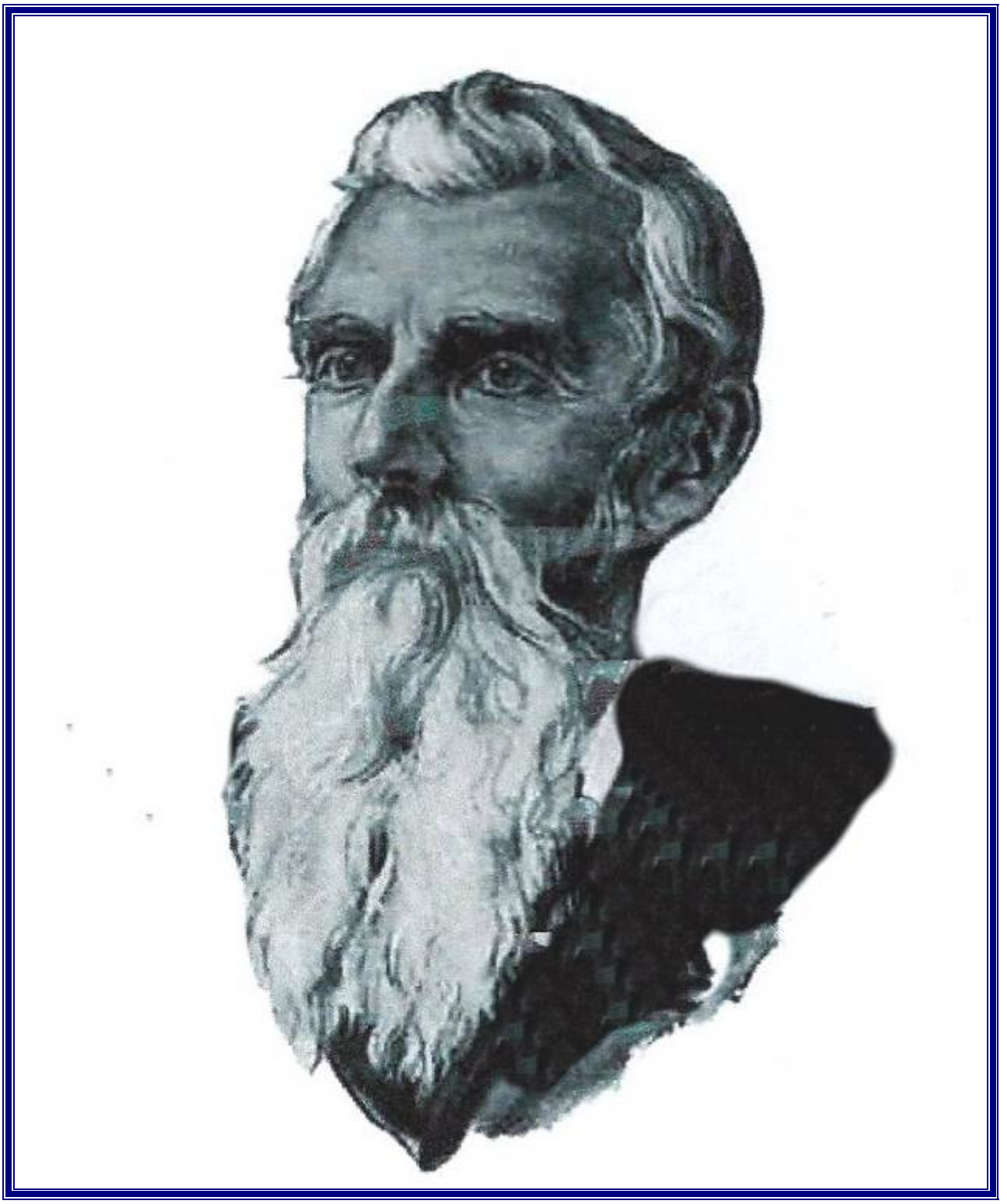
JOHN HENRY MILLS

By EurIng Brian Roberts, CIBSE Heritage Group



John Henry Mills, 1834-1908

John Henry Mills was born in 1834 and his work greatly advanced the adoption of steam heating systems in the USA while he also developed the design of boilers and radiators. He has been described as a “mechanical genius, who was in turn craftsman, inventor, heating contractor, scientific investigator and engineering consultant.”

In 1867, Mills patented his first cast-metal sectional steam boiler intended to drive an engine. He followed this with boilers for heating in 1869 and 1874. The manufacture of the heating boiler was carried out by George W Walker & Co at Watertown, Massachusetts, in the foundry of Miles Pratt & Co. However, a Walworth catalogue states that the first Mills sectional boiler was made, in 1870, at their factory in Cambridgeport, Massachusetts. At a later date, the Walworth Company manufactured both Mills direct and indirect radiators.

Mills boiler grates are also referred to in an H B Smith Co catalogue of 1871 and by 1873 Smith “was in complete control of Mills boiler manufacture.” Mills patented a steam radiator in 1877, but in the same year he decided that hot water was a superior heating agent. He admitted that it was more silent and steady than steam and more economical in use of fuel.

In 1877, John Mills wrote his treatise *Heating by Steam*, and between 1888 and 1890 he wrote his two-volume book *Heat, Science and Philosophy of its Production and Application to the Warming and Ventilation of Buildings*, described as “an important resource for boiler and steam heating engineers for years to come.”

In 1891, Mills patented his sectional boiler for steam or hot water. He achieved enormous success in the industry but indulged in ultra-extravagant experiments which left him, by 1905, penniless and destitute. He died in 1908.

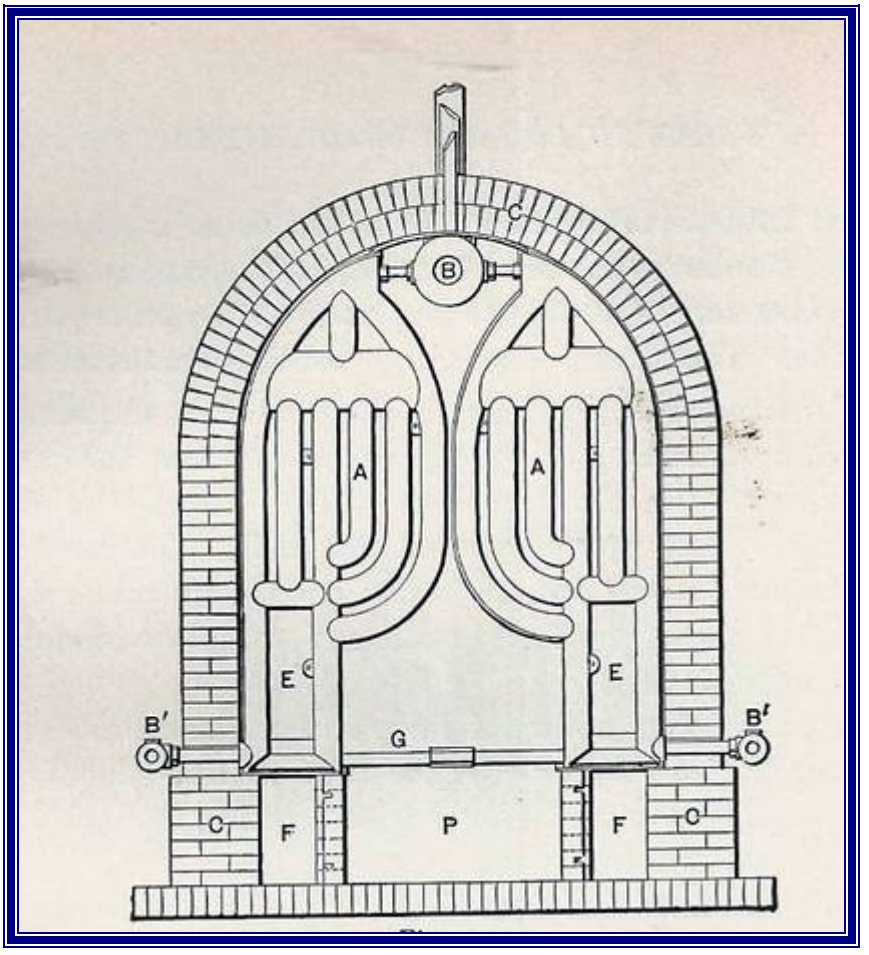
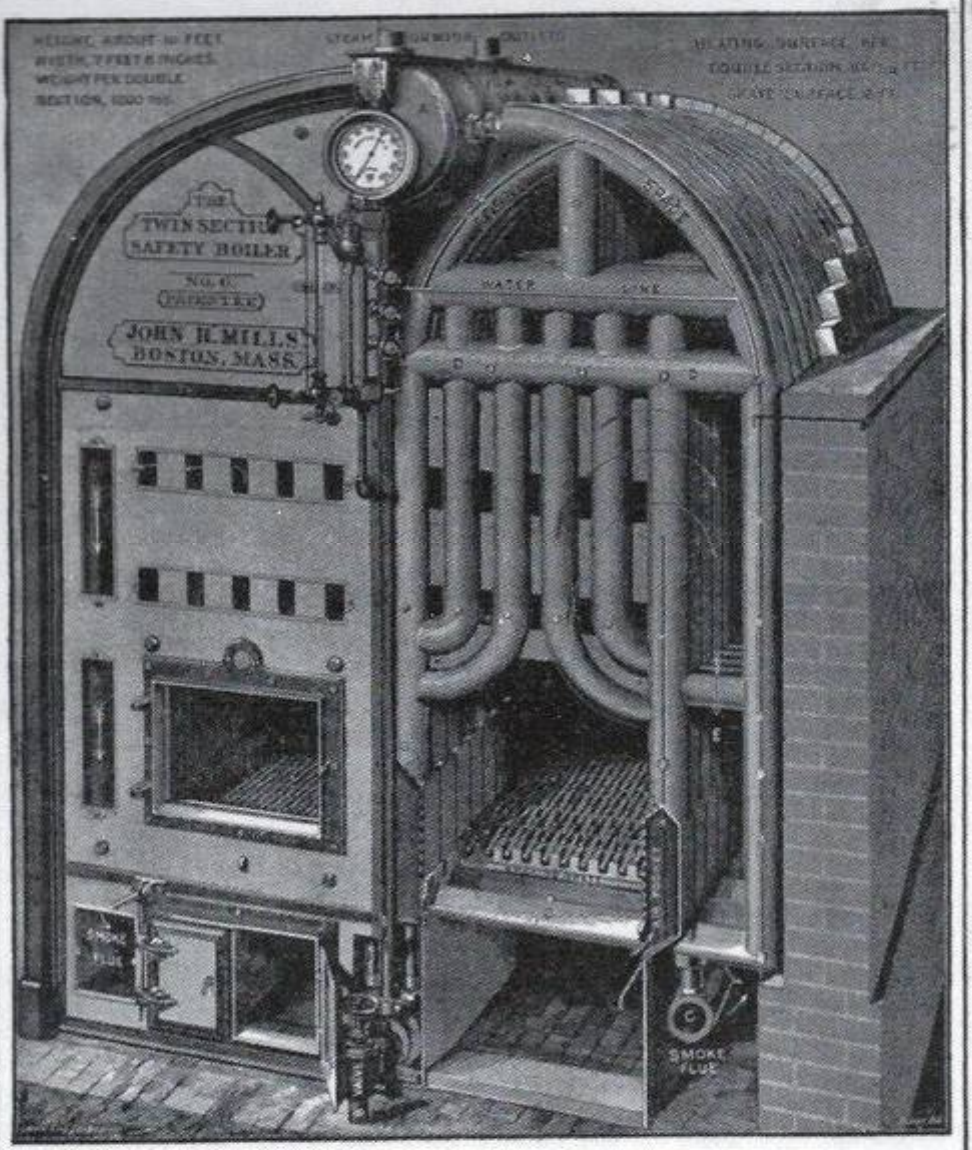


Illustration of a Mills steam boiler from a 1905 textbook

PLATE No. 14.

MILLS STEAM AND WATER SAFETY BOILER, No. 6.



Regular steam and water circulating boiler of 50 to 100 horse-power. Three of these are in use at the Pierce Building, Boston, Mass., three at the county buildings, Springfield, Mass., and three at State Prison, Cranston, R. I. (See evaporative experiment, page 265.)

Mills steam and hot water safety boiler, 1890

J. H. MILLS.

System of Steam and Water Piping for Buildings.

No. 145,962. Patented Dec. 30, 1873.

Fig. 2.

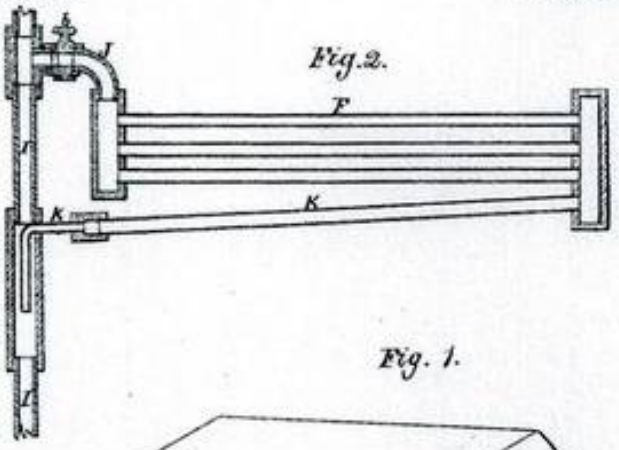
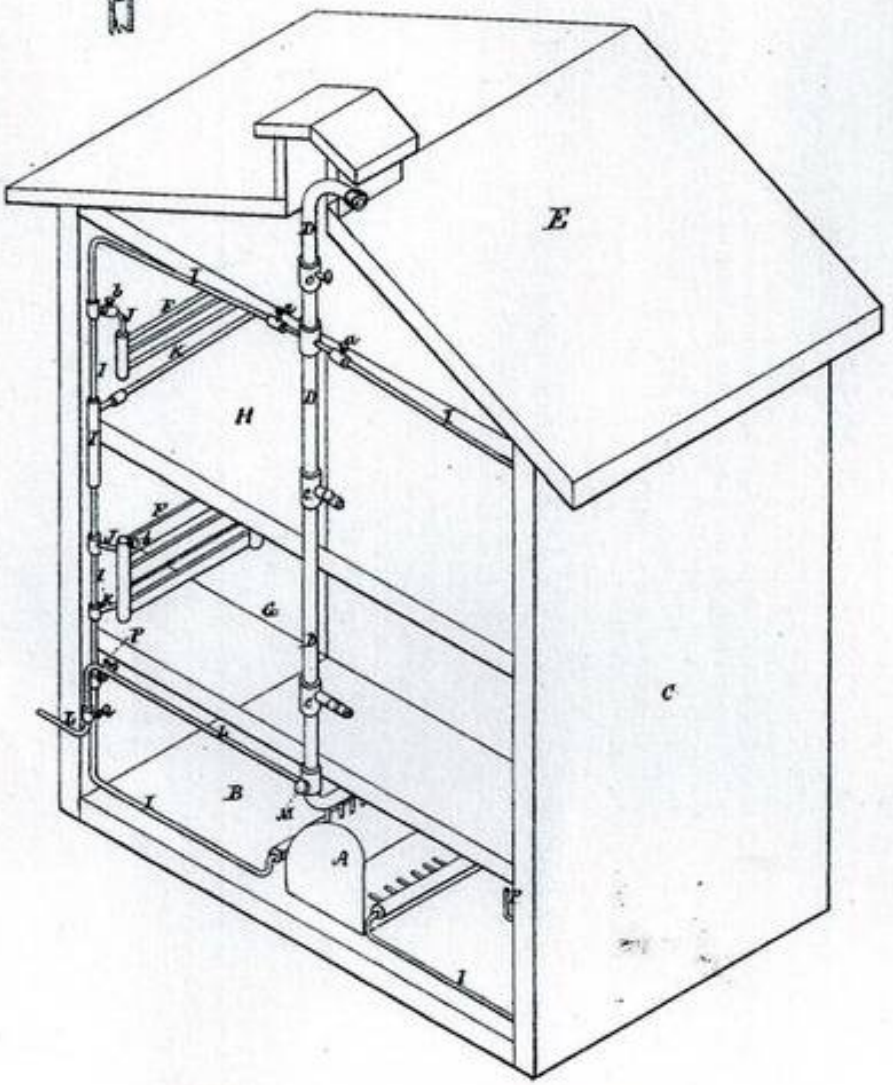


Fig. 1.



Witnesses,
L. Howell
W. E. Boardman.

John H. Mills.
by Curtis. Atty.

UNITED STATES PATENT OFFICE.

JOHN H. MILLS, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN SYSTEM OF STEAM AND WATER PIPING FOR BUILDINGS.

Specification forming part of Letters Patent No. **145,962**, dated December 30, 1873; application filed April 19, 1873.

To all whom it may concern:

Be it known that I, JOHN H. MILLS, of Boston, Suffolk county, Massachusetts, have invented an Improved System of Steam and Water Piping for Public Buildings and Private Residences, of which the following is a specification:

Of the different methods employed in piping, they all seem resolved, in present practice, to running the main supply-pipes from the boiler or generator around near the wall, suspended to the lower floor-timbers, from whence the risers or supplies are taken upward to feed the radiators or coils, a separate line of pipe being also returned to the generator, into which such radiators discharge their condense-water, the air being first allowed to escape into the room before such radiators will receive the steam. There are many difficulties attending heating by steam under these conditions, since the whole operation is attempted against natural laws. The three elements brought into juxtaposition — water, steam, and air—will not work harmoniously together until their relative specific gravities are duly considered and provided for. Under my system no conflict is possible, since the steam, being allowed to ascend through one or more vertical mains to the top of the structure, and from thence distributed downward, is always on the top of more dense and heavier elements, which are then not impeded in their passage from the radiators or in their return to the generator, the air being allowed to escape at a proper valve placed above the water-line, as shown. It will also be plain to those at all conversant with the operation of steam-heating, that once having conducted the steam to the highest point, and arranged for the escape of the air at the lowest, but above the water-line, the question of circulation through the pipes and radiators would be no longer, as now, a doubtful one.

Another advantage incident to my arrangement is the use on the coils and radiators of but one valve instead of two, both of which must, under the present system, be opened or closed together or the radiators will fill with water, causing much trouble and annoyance. There being but one valve (the supply) under my system, the radiator can never fill, as it is always open at the bottom for the full discharge of condense-water. When closed, no steam, under my system, will enter upward through the small inverted inside drip-pipe, because the radiator, under the operation of condensation, soon fills with such air as remains or works into the supply-pipes, and such radiators remain neutral, while the circulation goes on through the supply and returns the same as ever. Under the present system even the pipes themselves, in the upper and remote stories, will not fill or circulate until the radiators attached to such are vented of their contained air.

Elaborate experiments have demonstrated the fact that steam is a very powerful agent to extinguish fires, and that a given amount of water converted into steam possesses many hundred times the power for this purpose that it has in its original condition; while it is safe to say that much more property is ordinarily injured by the effects of water than by the fire itself. Therefore, as steam does not injure the building or its contents, I prefer to use this subtile and efficient agent by arranging outlets on the main supply, with proper valves tapped for hose-connections on each floor, so that, should the fire occur in any out-of-the-way places, the application of steam would be easy, certain, and effective. In case of fire outside or around the building, water would be preferable, and, for its instant application, I provide, as before stated, by making communications in the basement with the street-main to my vertical stand-pipe, first shutting off the steam from the generator, and closing the distributing-valves at the top of the building, when all is ready for a full and free supply, either inside or at the roof, as may be desired.

The drawings accompanying this specification represent, in Figure 1, a sectional view of a building, of several stories or floors, embodying my system of steam and water service, while Fig. 2 is a section, on an enlarged scale, of a portion of the down pipe and the drip-pipe of the radiator, to be hereinafter explained.

In the drawings, A denotes a steam-generator, of any suitable character, placed in the cellar or basement B of the structure C, while departing from such generator is a main sup-

2 Sheets--Sheet 1.

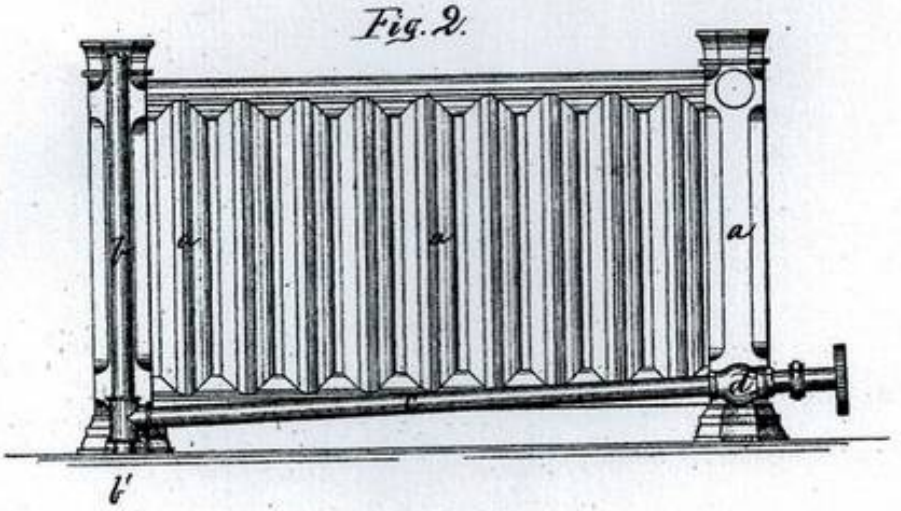
J. H. MILLS.

Connections for Steam-Radiators.

No. 154,561. Patented Sept. 1, 1874.

Fig. 1.

Fig. 2.



Witnesses:
George E. Phelps.
Maurice Andrén

Inventor:
John H. Mills
Alban Andrén
atty

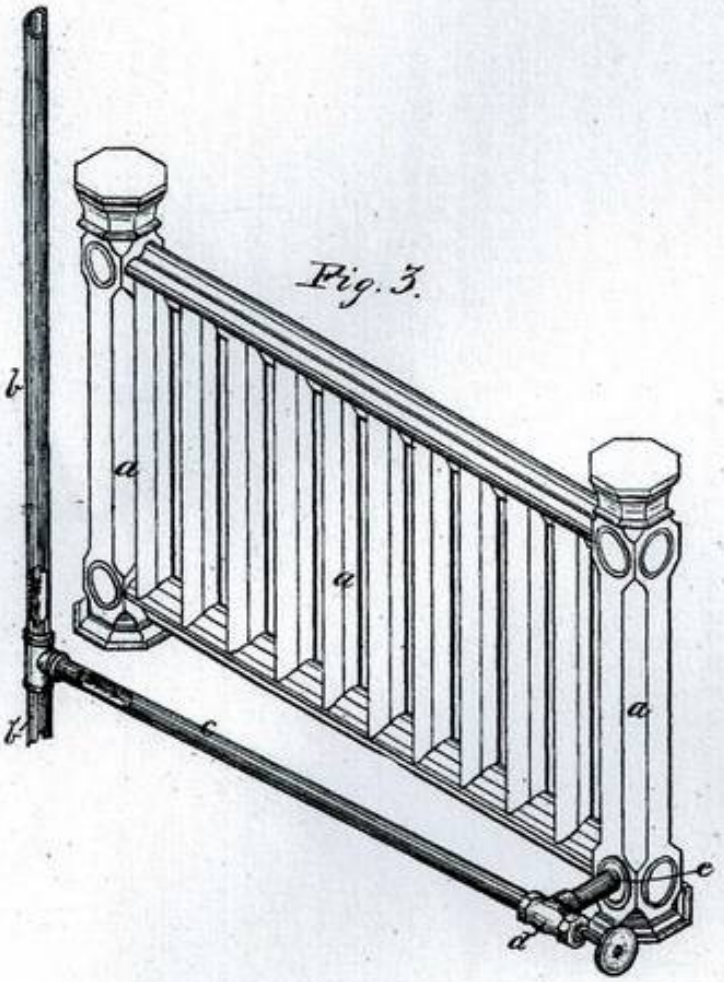
2 Sheets--Sheet 2.

J. H. MILLS.

Connections for Steam-Radiators.

No. 154,561. Patented Sept. 1, 1874.

Fig. 3.



Witnesses:
George E. Phelps.
Maurice Andrén

Inventor:
John H. Mills
by Aban Andrén
atty

UNITED STATES PATENT OFFICE

JOHN H. MILLS, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN CONNECTIONS FOR STEAM-RADIATORS.

Specification forming part of Letters Patent No. **154,561**, dated September 1, 1874; application filed March 17, 1874.

To all whom it may concern:

Be it known that I, JOHN H. MILLS, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Connections to Steam-Radiators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to improvements in the connections to steam-radiators; and consists in the combination, with an overhead steam-supply pipe, of a single connection and its valve entering the bottom of the radiator, as will herein be more fully shown and described.

On the drawings, Figure 1 represents a ground plan, Fig. 2 represents a side elevation, and Fig. 3 represents a perspective view, of my invention.

Similar letters refer to similar parts wherever they occur on the different parts of the drawings.

Heretofore it has been common to employ two or more connecting-pipes for radiators heated by steam, one of which pipes was used for the admittance of the steam, and another one for the discharge of the condensed water. It has also been common to use two valves for each radiator for the same purposes. This is objectionable on account of expensive pipings, fittings, and valves.

To avoid this difficulty and extra expense, I arrange and combine, with an overhead steam-supply pipe, a single connection and a single valve that enters the radiator at its lowest point, as shown in the accompanying drawing, on which *a* represents a steam-radiator, and *b* an overhead steam-supply pipe. A single connecting-pipe, *c*, provided with a single valve or cut-off, *d*, establishes a communication from the supply-pipe *b* to the bottom or lowest part *e* of the radiator *a*, as shown in the drawings. The single connecting-pipe *c* is placed in an inclined position, as shown in Fig. 2, in such a manner that the valve or cut-off *d* is a little higher than the end of the pipe *c* where it enters the supply-pipe *b*, so that the condensed steam may flow unobstructed from the radiator *a* through the lower part of the pipe *c*, and at the same time allow the steam from the overhead pipe *b* to enter the radiator through the upper part of the single pipe *c*. The extension *b'* of the supply-pipe *b* serves for the purpose of conducting the steam to another radiator on a story below, and also for the conveyance of the condensed steam from the radiator *a*.

Thus it will be seen that I am able to use a single connecting-pipe and its valve from the overhead supply-pipe, for the purpose of conveying the steam to the radiator, and to allow the condensed steam to exit therefrom without obstruction, and thereby dispense with additional pipes and valves.

I do not claim the use of a single pipe and valve, when arranged in combination with an underhead supply-pipe, as shown in C. A. Wilson's patent of September 4, 1860, as I use my single pipe and valve in combination with an overhead supply-pipe, by which the advantage is obtained of letting the steam and condensed water travel unobstructed in one and the same direction.

Having thus fully described the nature, construction, and operation of my invention, I wish to secure by Letters Patent, and claim—

In combination with an overhead steam-supply, *b*, of a single pipe, *c*, and its valve *d* entering the bottom of radiators, as and for the purpose herein set forth and described.

In testimony that I claim the foregoing I have hereunto set my hand this 10th day of March, 1874.

JOHN H. MILLS.

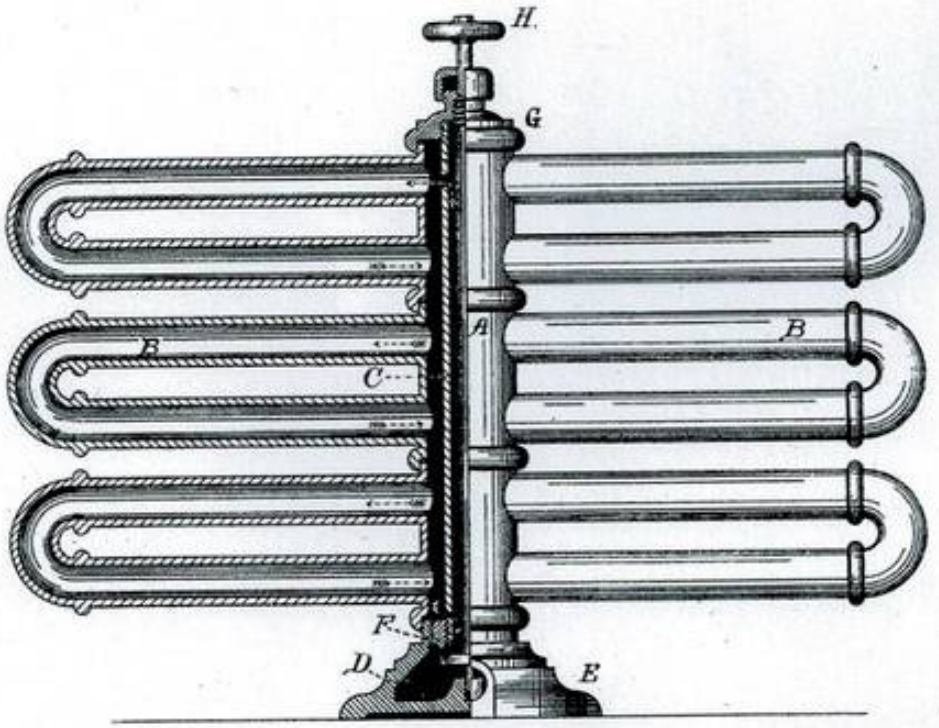
Witnesses:

ALBAN ANDRÉN,

GEORGE E. PHELPS.

J. H. MILLS.
Steam-Radiator.

No. 198,036. Patented Dec. 11, 1877.



Attest
Albert H. Bennett.
William N. Poddard

Inventor
John H. Mills.
Pr.....

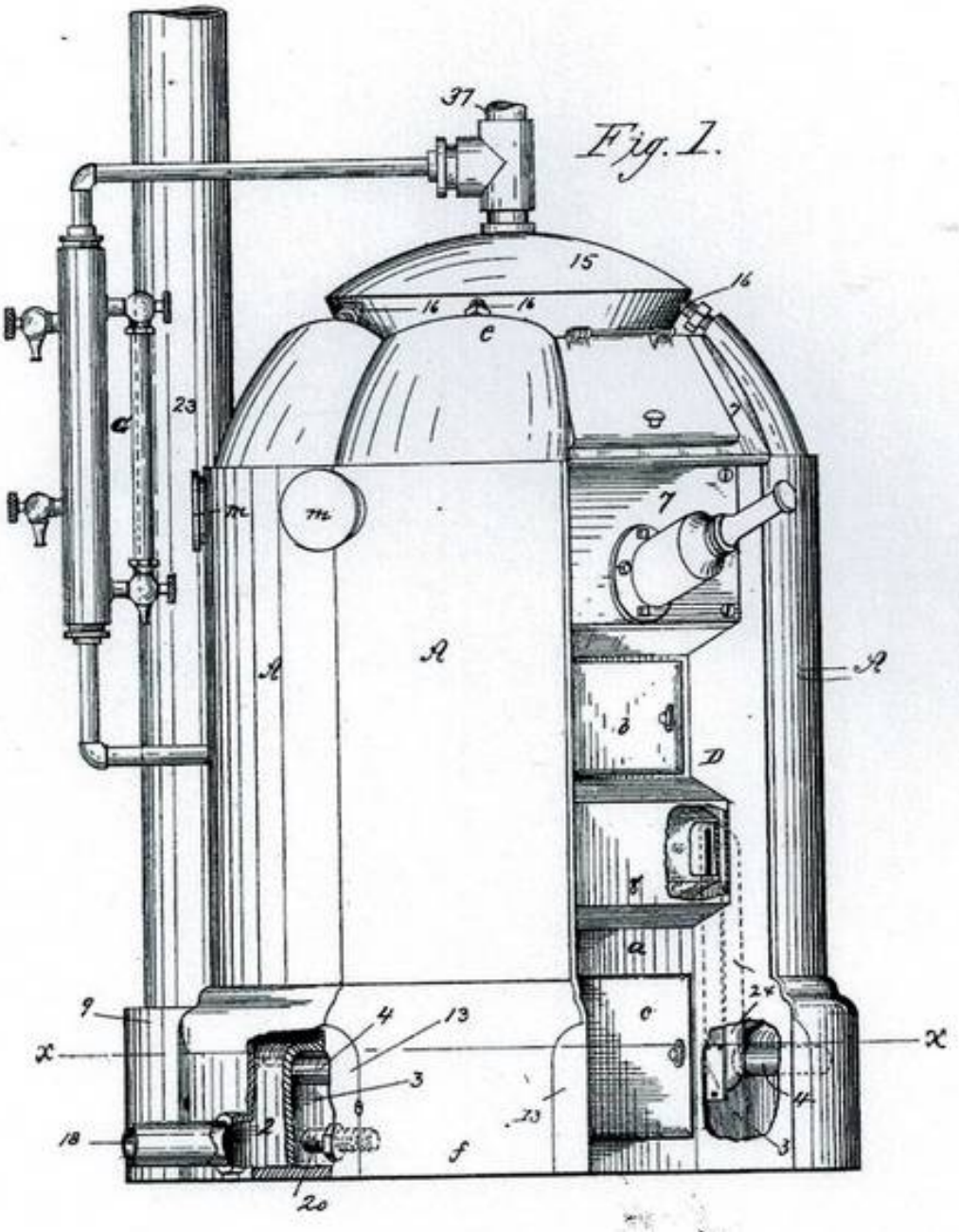
(No Model.) 4 Sheets—Sheet 1.

J. H. MILLS.

SECTIONAL BOILER.

No. 400,243. Patented Mar. 26, 1889.

Fig. 1.



Witnesses
Wm. H. Chapin
Wm. F. Bellows

Inventor
John H. Mills
By his Attorneys Chapin & Co.

(No Model.) 4 Sheets—Sheet 2.

J. H. MILLS.

SECTIONAL BOILER.

No. 400,243. Patented Mar. 26, 1889.

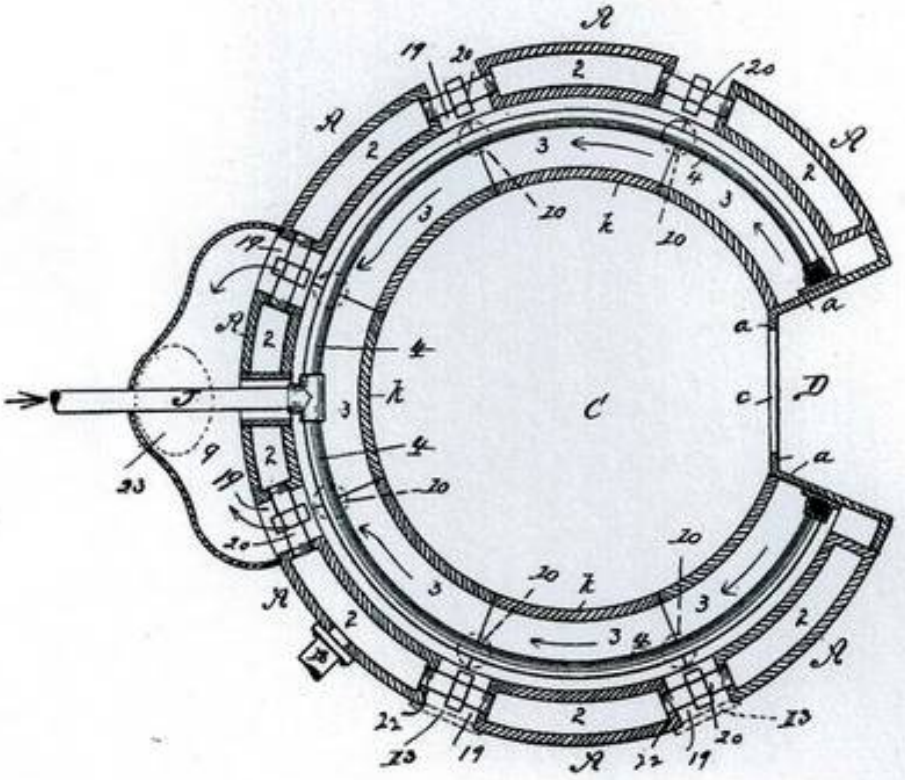


Fig. 2.

Witnesses
Wm. H. Chapin
W. F. Bellamy

Inventor
John H. Mills
By his Attorneys Chapin & Co.

(No Model.) 4 Sheets—Sheet 3.

J. H. MILLS.

SECTIONAL BOILER.

No. 400,243. Patented Mar. 26, 1889.

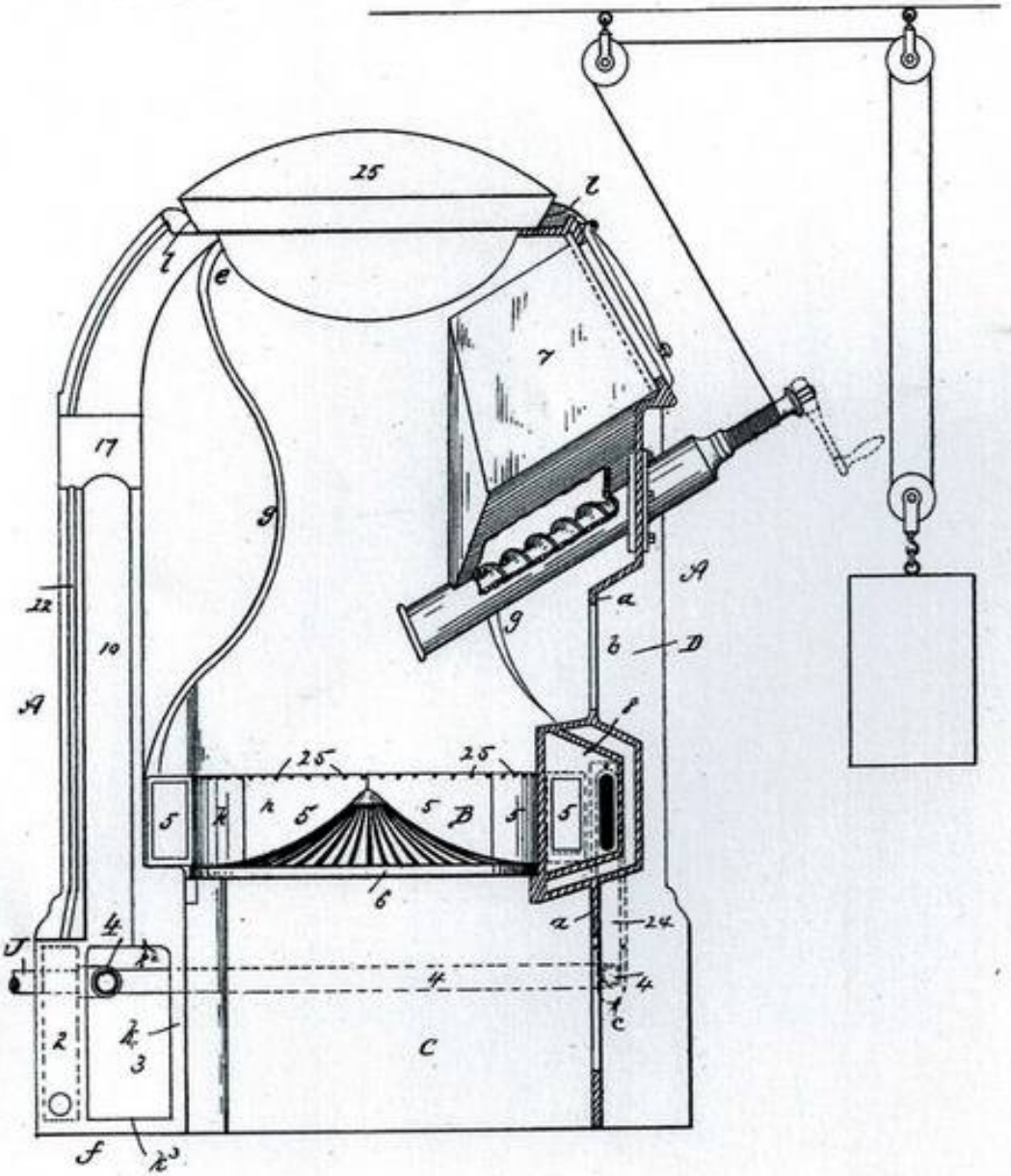


Fig. 3.

Witnesses
Wm. H. Chapin
W. S. Bellows

Inventor,
John H. Mills.
By his Attorneys, Chapin & Co.

(No Model.) 4 Sheets—Sheet 4.

J. H. MILLS.

SECTIONAL BOILER.

No. 400,243. Patented Mar. 26, 1889.

Fig. 4.

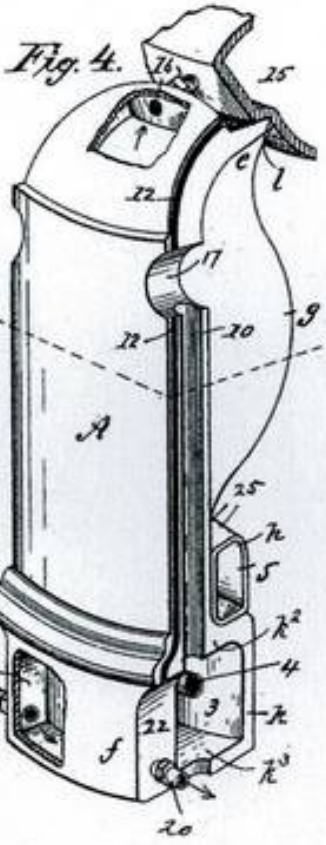


Fig. 7.

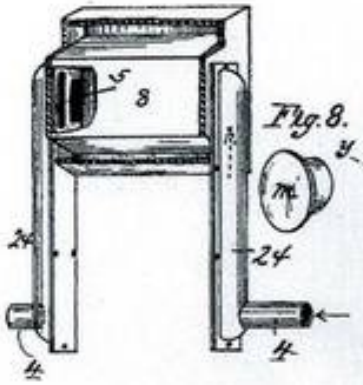


Fig. 8.

Fig. 6.

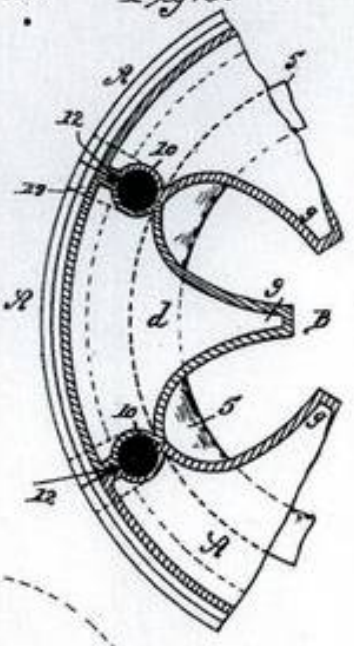


Fig. 9.

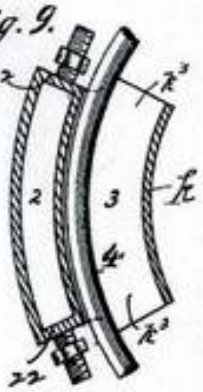
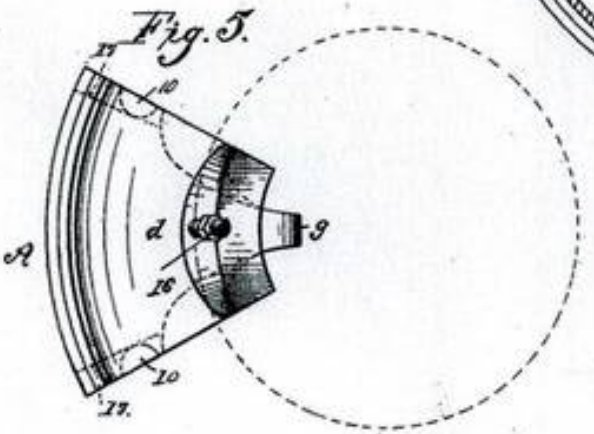


Fig. 5.



Witnesses
Wm. H. Chapin
Wm. F. Bellows

Inventor
John H. Mills
By his Attorneys
Chapin & Co.

UNITED STATES PATENT OFFICE.

JOHN H. MILLS, OF BOSTON, MASSACHUSETTS.

SECTIONAL BOILER.

SPECIFICATION forming part of Letters Patent No. 400,243, dated March 26, 1889.

Application filed June 16, 1888. Serial No. 277,357. (No model.)

To all whom it may concern:

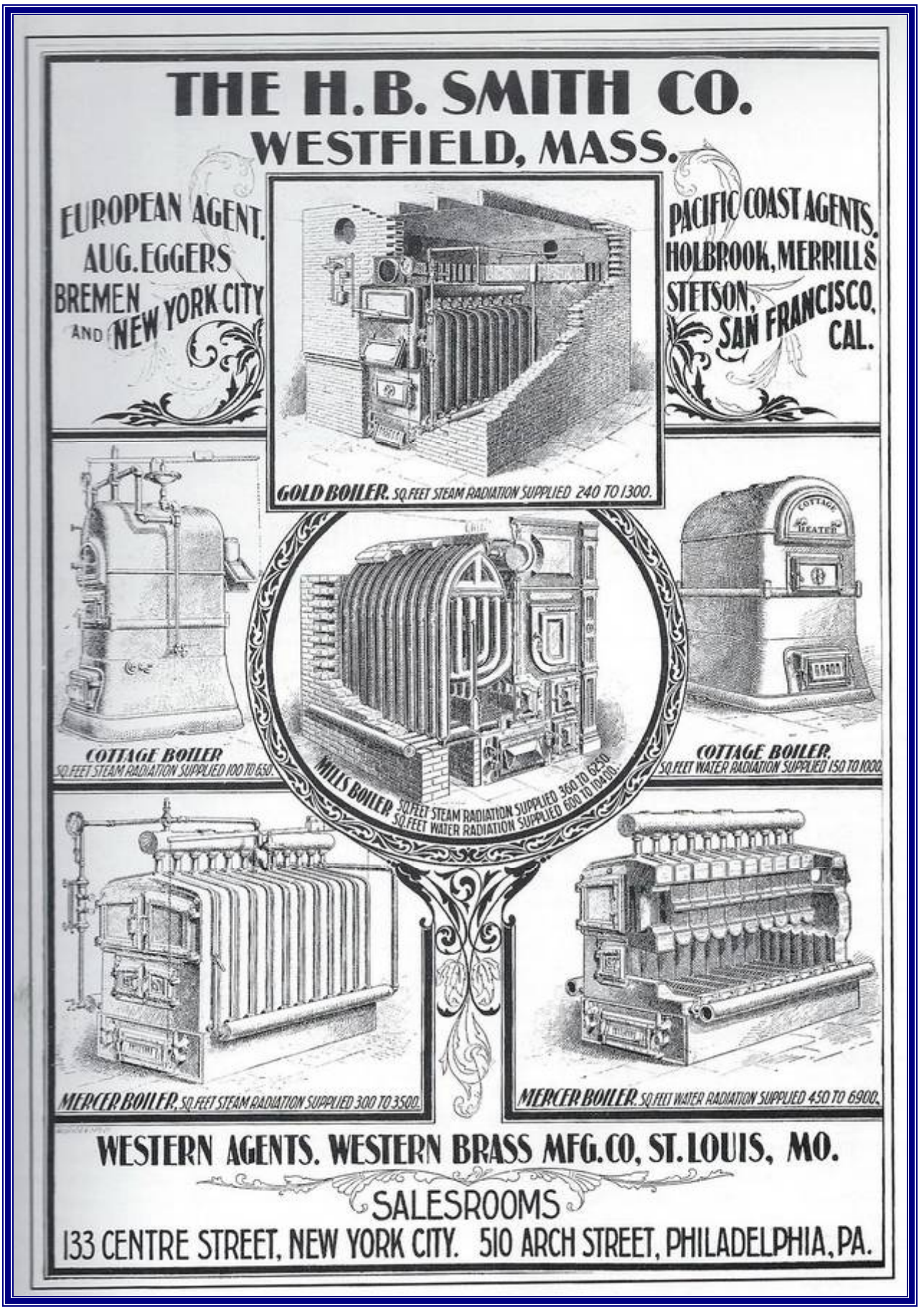
Be it known that I, JOHN H. MILLS, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Sectional Boilers, of which the following is a specification.

This invention relates to boilers for warming buildings, either by steam or water circulation, the object being to provide an improved boiler of the sectional class for the above-named purpose; and the invention consists in the peculiar construction and arrangement of the sectional portions of the boiler, together with the steam-drum thereof, and means for producing a perfect combustion of the fuel and for distributing the products of combustion throughout the boiler, all as hereinafter fully described, and pointed out in the claims.

In the drawings forming part of this specification, Figure 1 is an elevation of a sectional boiler embodying my improvements, portions of the base of two sections being shown broken away. Fig. 2 is a transverse section through the base of the boiler on line *x x*, Fig. 1. Fig. 3 is a side elevation of two of the boiler-sections and steam-drum, together with the grate, the fuel-magazine and its operating devices, said figure showing the air or gas distributing box in section. Fig. 4 is a perspective view of one of the boiler-sections, showing portions of its wall broken away, and a portion of the steam-drum connected thereto. Fig. 5 is a plan view of one of the boiler-sections. Fig. 6 is a cross-section substantially on line *y y*, Fig. 4, but including parts of two adjoining sections. Fig. 7 is a perspective view of the air or gas distributing box and its connections. Fig. 8 is a perspective view of one of the closing flue-caps. Fig. 9 is a transverse section through the base of one of the boiler-sections, substantially on the same line that Fig. 2 is taken.

In the drawings, A indicates the sections of the boiler, said sections being made, preferably, by casting and coring out in the manner well known to iron-founders. Said sections are to be of any number, as desired, there being shown in the present instance seven thereof in circular arrangement around the combustion-chamber B and ash-pit C of the apparatus, and each section is of a height equal to that of the boiler. As will be seen in Figs. 1 and 2, a space, D, is left between two of the sections at the front of the boiler, which is properly partitioned, as at *a*, through which are formed door-openings *b c*, leading to the combustion-chamber and ash-pit, and also permits of the disposition above the door *b* of a bin or receptacle, 7, for receiving comminuted or other fuel, which bin is also extended inwardly over the grate 6, and is to be provided with a mechanism for securing an automatic or other feed of the fuel into the combustion-chamber, which bin or fuel-box and mechanism constitute the subject-matter of a separate application for Letters Patent, filed June 16, 1888, Serial No. 277,358.

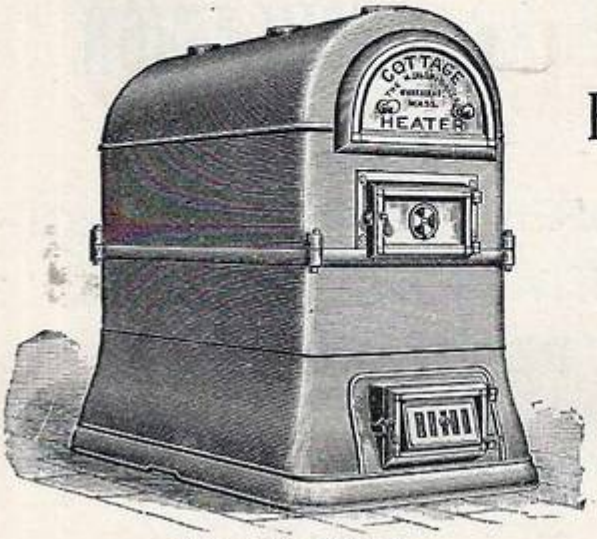
Each section A comprises an inclosed water-receptacle chamber, *d*, extending from its top *e* to its bottom *f*, and of varying widths radially in relation to the common center of the combustion-chamber at different heights thereof, its upper and vertically-central portion above the grate being inwardly extended, as at *g*, Figs. 3, 4, 5, and 6, and downwardly extended therefrom and in direct communication therewith to the bottom in a contracted hollow leg, as seen at 2. Figs. 1, 2, 3, 4, and 9, and as will be noted on reference to the cross-sectional contour of said central portions, *g*, of all the sections around and above the combustion-chamber they are inwardly converging, whereby the volume of the inclosed water is reduced and greater heat-impinging surface is secured; also comprised in each section A, at the portion of its height which is a little above the position of the grate, is one section, *h*, of a circular conduit or box, 5, to be hereinafter referred to; and also at the bottom of the section its walls are supplemented by inwardly-extending horizontal walls k^2 k^2 and the vertical partition-wall *k*, to form the section of a horizontal base exit, draft, and smoke-flue, 3, inside of the lower legs, 2, the said walls of said base-flue sections being open at their ends, so that when the several boiler-sections A comprising them are secured in place the continuous circular passage 3 will be formed, as seen in Fig. 2. When the sections are in place, their upper converging ends form in the top of the boiler a circular open-



H B Smith advertisement of 1900, featuring a Mills boiler (centre)

THE H. B. SMITH CO.,

133-135 CENTRE STREET, NEW YORK,



COTTAGE BOILER.

MANUFACTURERS

OF

HEATING APPARATUS

FOR

Warming All Classes of Buildings with

STEAM

OR

WATER.

MILL'S SAFETY SECTIONAL BOILER,

ADAPTED FOR STEAM OR WATER.

MERCER,
GOLD, and
COTTAGE

BOILERS,

Arranged for Hard or Soft Coal and Wood.

UNION,
ROYAL UNION,
CHAMPION,
CORONET, and
CROWN

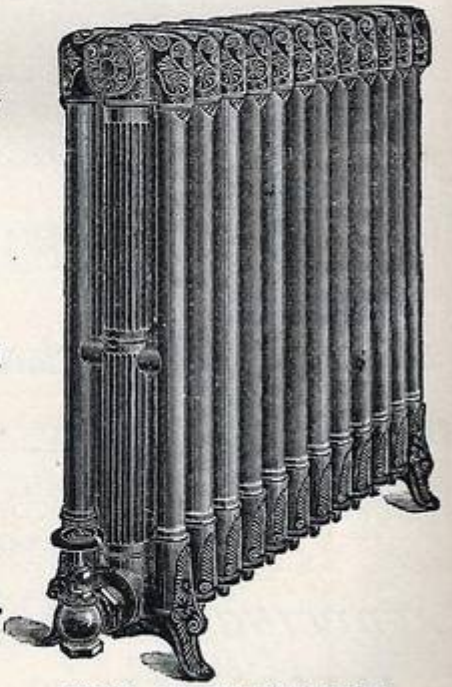
RADIATORS.

GOLD'S PIN INDIRECT RADIATORS.

New York, Providence, Philadelphia.

Foundry: WESTFIELD, MASS.

SEND FOR CIRCULAR.



ROYAL UNION RADIATOR.

H B Smith advertisement from an early heating textbook, showing a Mills safety sectional boiler (top)

Chas W Copeland
Aug 28 83

HEATING BY STEAM.

ITS BEST APPLICATION IN WARMING AND VENTILATING

Public Buildings,

FACTORIES and PRIVATE RESIDENCES,

WITH

ILLUSTRATED DESCRIPTIONS

OF

An Improved Method of Piping,

FOR

BOTH DIRECT AND INDIRECT RADIATION.

WITH

SOME USEFUL TABLES.

By JOHN H. MILLS, Trustee,

"Mill's Steam Heating Trust Association,"

BOSTON, MASS.

BOSTON:

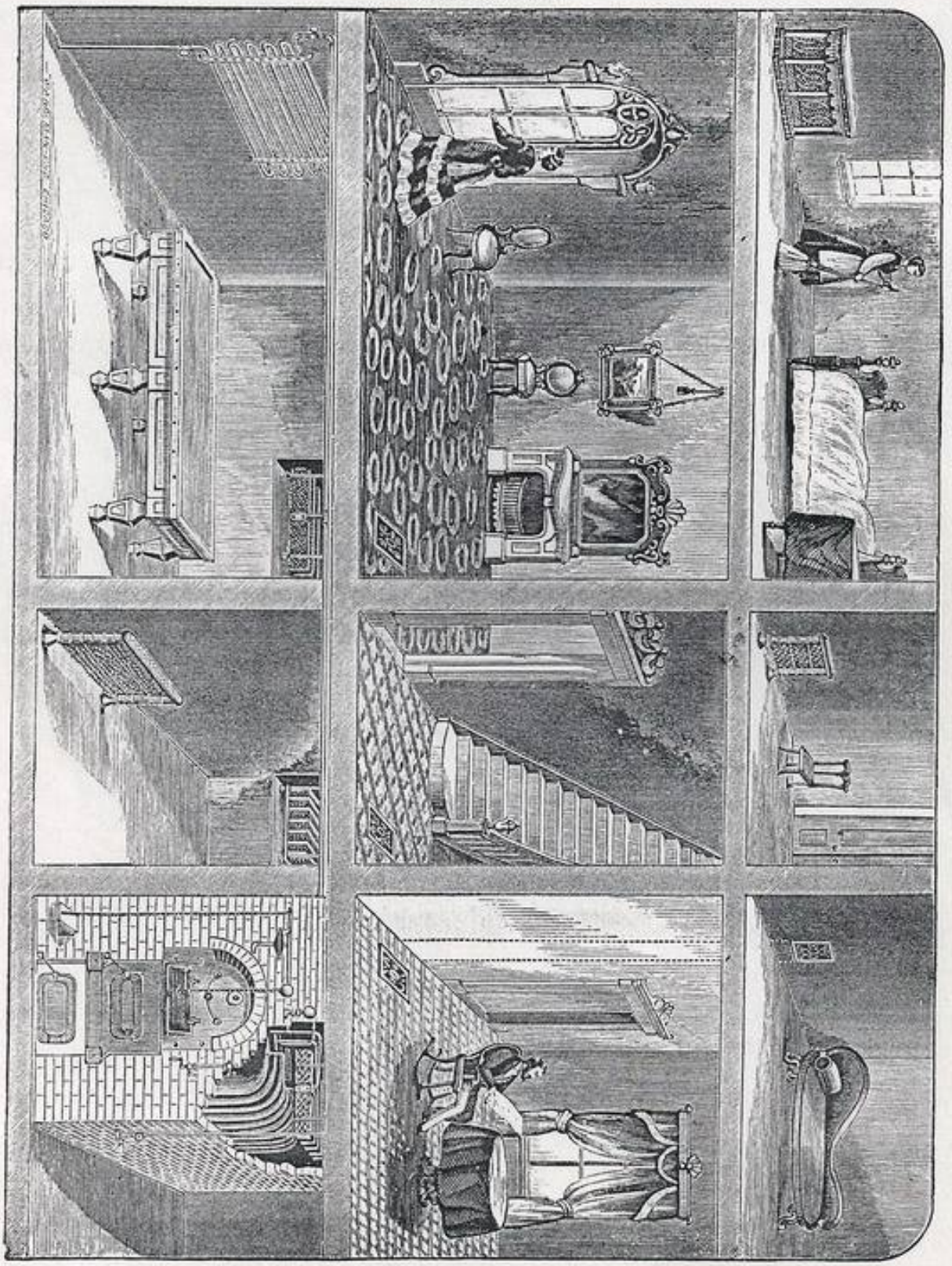
GUNN & BLISS, PRINTERS, No. 31 HAWLEY STREET,

1877.

Cover of Mills treatise of 1877

PLATE NO. 4.

HEATING BY STEAM.

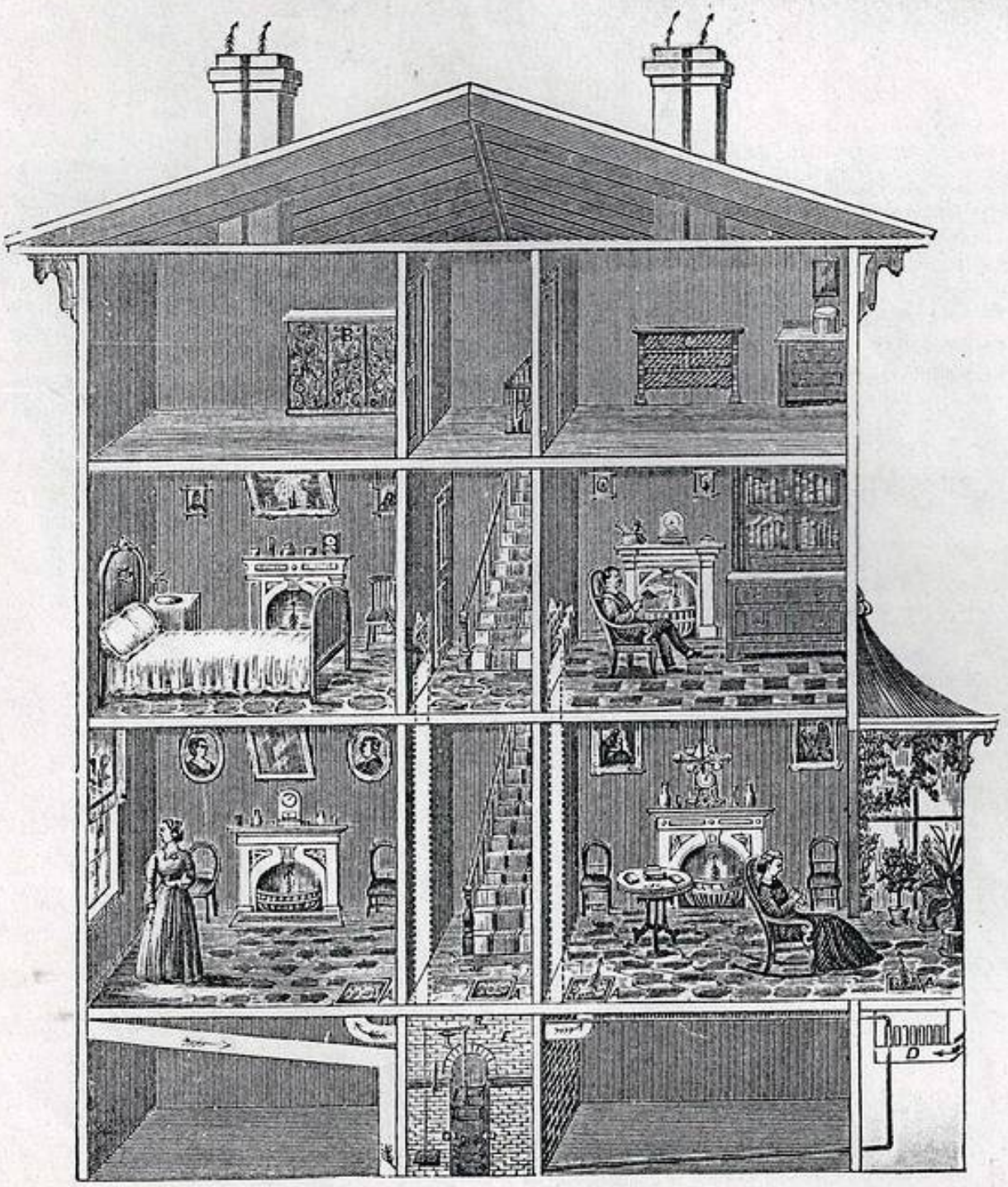


HEATING OF A PRIVATE DWELLING SHOWING GENERAL ARRANGEMENT OF BOILER, AND HEATING SURFACES

From Mills, 1877

PLATE NO. 5.

HEATING BY STEAM.



HEATING BY INDIRECT RADIATION, ALSO THE REMOVAL OF THE VITIATED AIR THROUGH THE CHIMNEYS.

From Mills, 1877

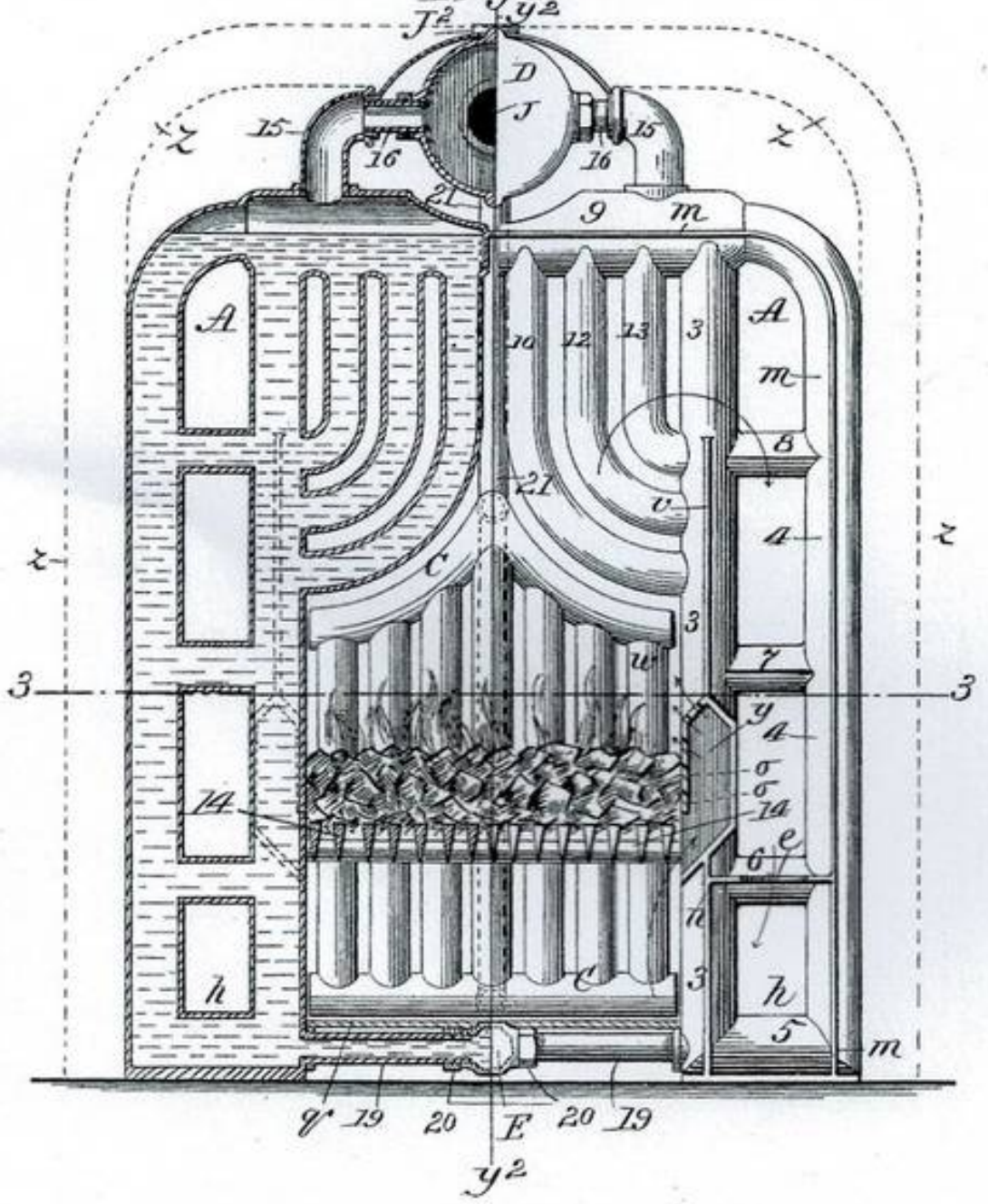
(No Model.) 4 Sheets—Sheet 1.

J. H. MILLS.

SECTIONAL BOILER.

No. 449,379. Patented Mar. 31, 1891.

Fig. 1.



Witnesses:

J. H. Chamberlain

Inventor,

John H. Mills

by Chapin & Co

Atty's.

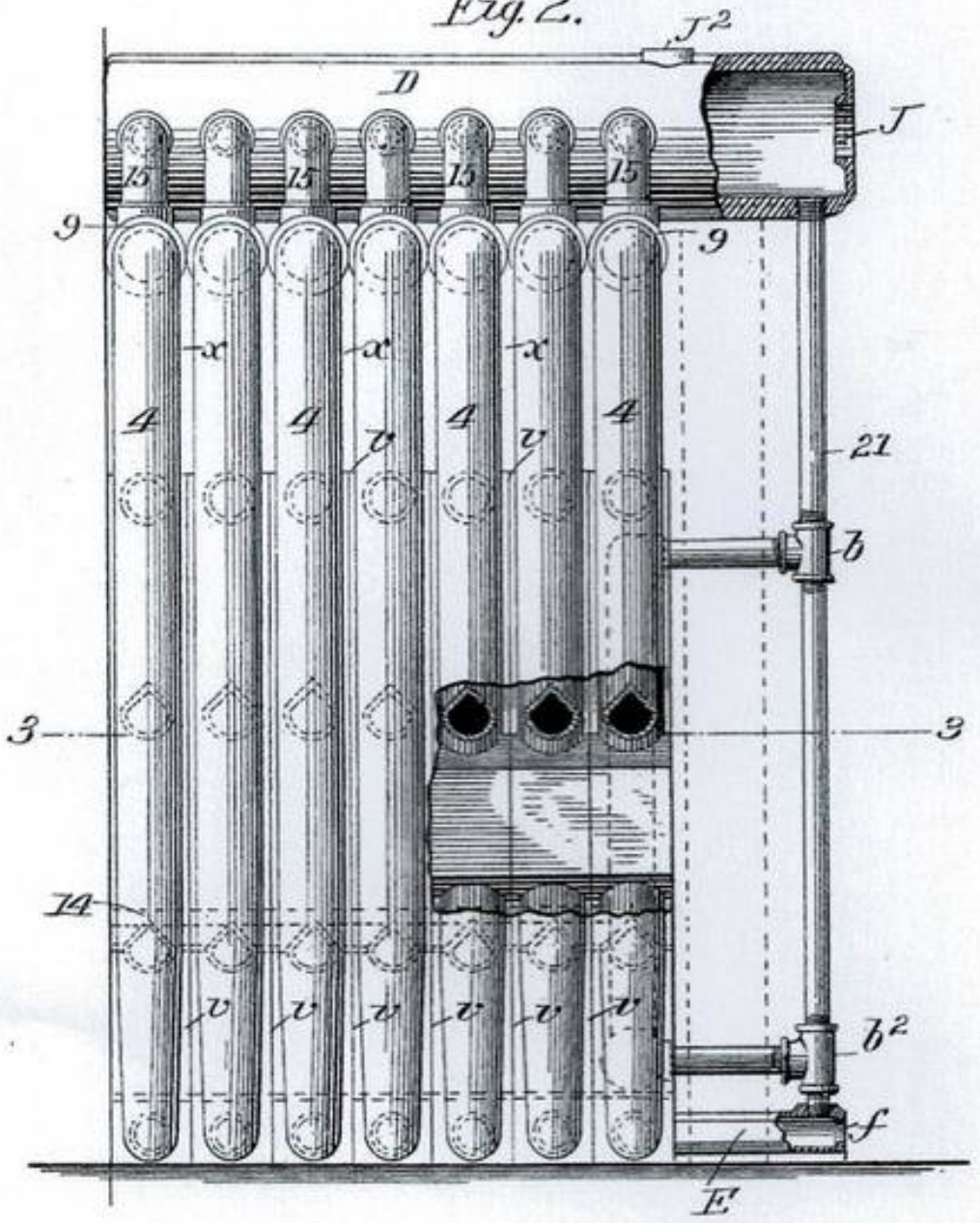
(No Model.) 4 Sheets—Sheet 2.

J. H. MILLS.

SECTIONAL BOILER.

No. 449,379. Patented Mar. 31, 1891.

Fig. 2.



Witnesses:
C. F. McCampbell
A. H. Chamberlain

Inventor;
John H. Mills
by Chapin & Co
Atty's.

(No Model.)

4 Sheets—Sheet 3.

J. H. MILLS.

SECTIONAL BOILER.

No. 449,379.

Patented Mar. 31, 1891.

Fig. 3.

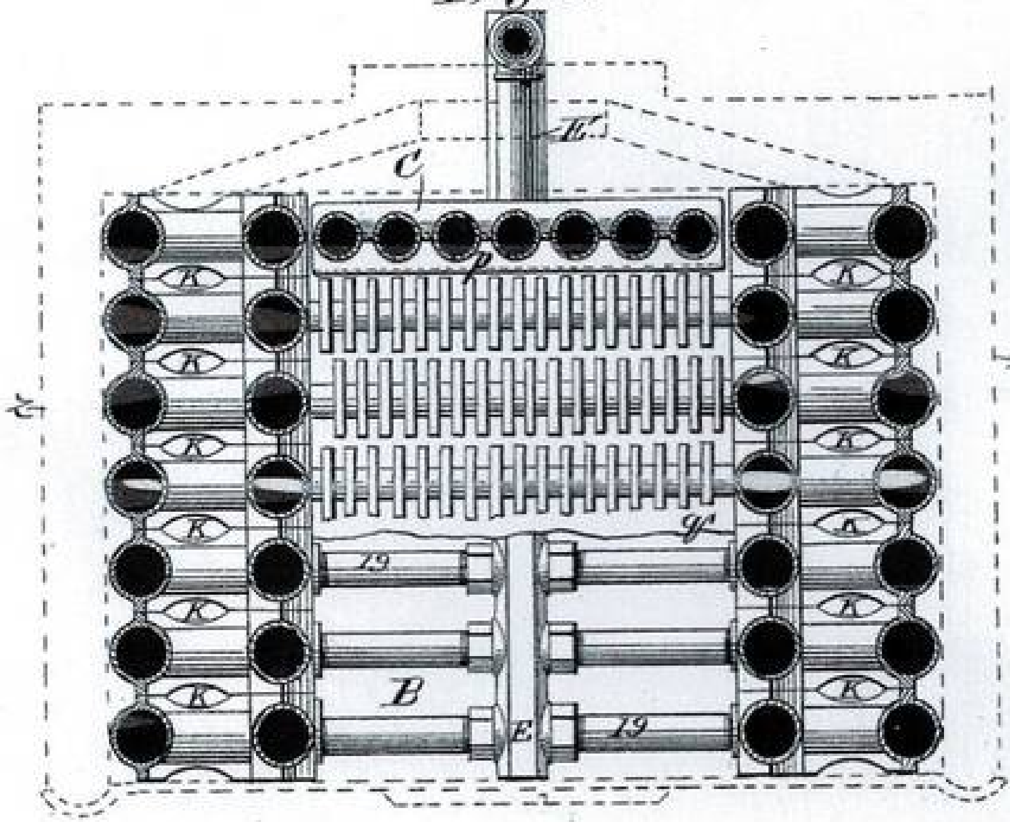
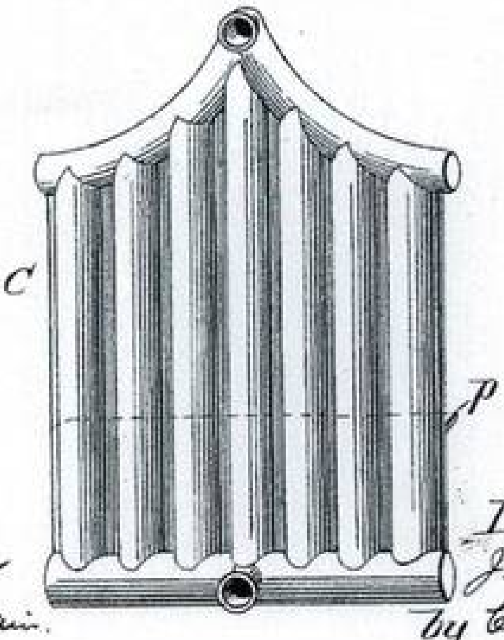


Fig. 4.



Witnesses:

Inventor.

J. H. Mills

by Chapin & Co

Att'ys

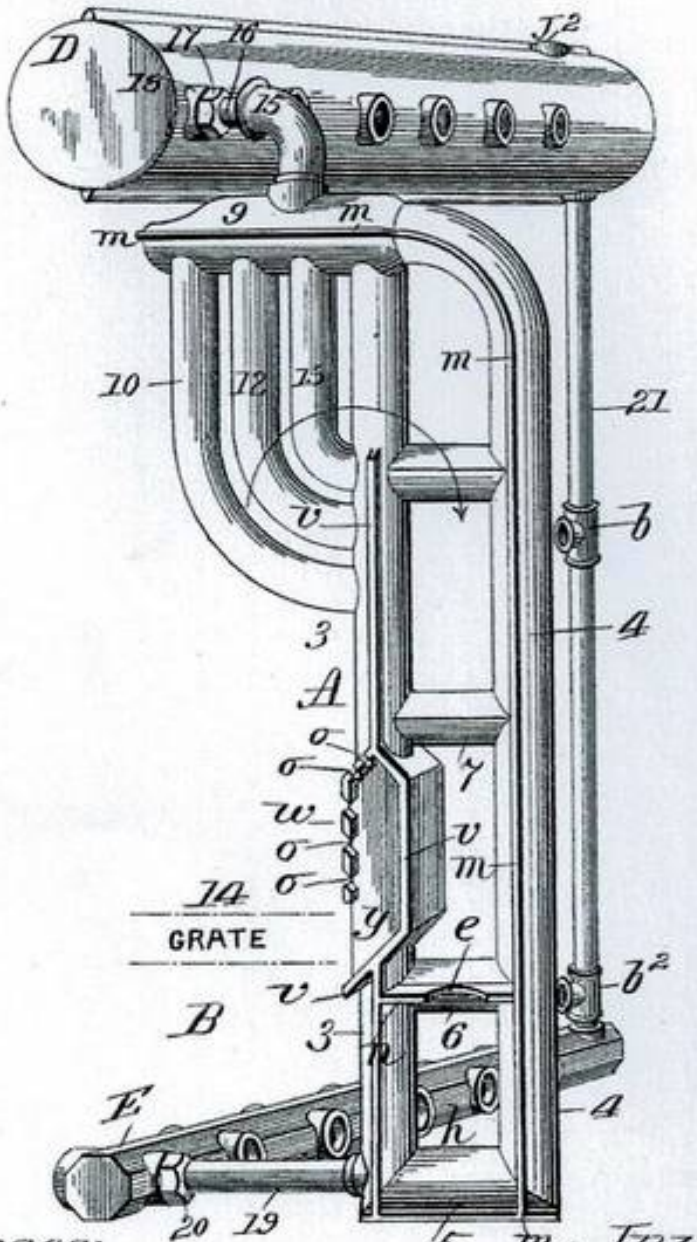
(No Model.) 4 Sheets—Sheet 4.

J. H. MILLS.

SECTIONAL BOILER.

No. 449,379. Patented Mar. 31, 1891.

Fig. 5.



Witnesses:
J. D. Gaspiel
G. M. Chamberlain.

Inventor,
John H. Mills
by Chapin & Co
Atty's

UNITED STATES PATENT OFFICE.

JOHN H. MILLS, OF BOSTON, MASSACHUSETTS.

SECTIONAL BOILER.

SPECIFICATION forming part of Letters Patent No. 449,379, dated March 31, 1891.

Application filed November 15, 1890. Serial No. 371,609. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. MILLS, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Sectional Boilers, of which the following is a specification.

This invention relates to sectional boilers, the object being to provide for steam and especially for hot-water-heating apparatus and analogous uses an improved boiler consisting of cast-iron hollow sections of peculiar construction and arrangement composing the individual units of such boiler, whereby increased heating-surface is obtained without increasing the cost of manufacture, all as hereinafter fully set forth.

In the drawings forming part of this specification, Figure 1 is a front elevation, partly in section, of a boiler embodying my improvements. Fig. 2 is a side elevation, partly in section. Fig. 3 is a sectional view about on line 3 3 of this figure. Fig. 4 is a rear view of a section located at the rear end of the grate-bars, as below described. Fig. 5 is a perspective view of one of the main sections of the boiler, the outflow and return drums with which all of the sections of the boiler communicate, and a pipe connection between said drums, the purpose of which is fully described below.

One essential object of this invention is to secure increased efficiency and power to absorb heat for a liquid circulation by placing a part of the heating-surface below the grate-line, which surface will be acted upon by the radiant heat of the coals on the grate and the high temperature of the ash-pit, but which heat is entirely lost in boilers having no heat-absorbing surface below said grate-line. While some wrought-iron or shell boilers have an extension of their water-spaces below the grate-line and to the floor, they do not and cannot also extend their smoke-flues to render available the surface so obtained.

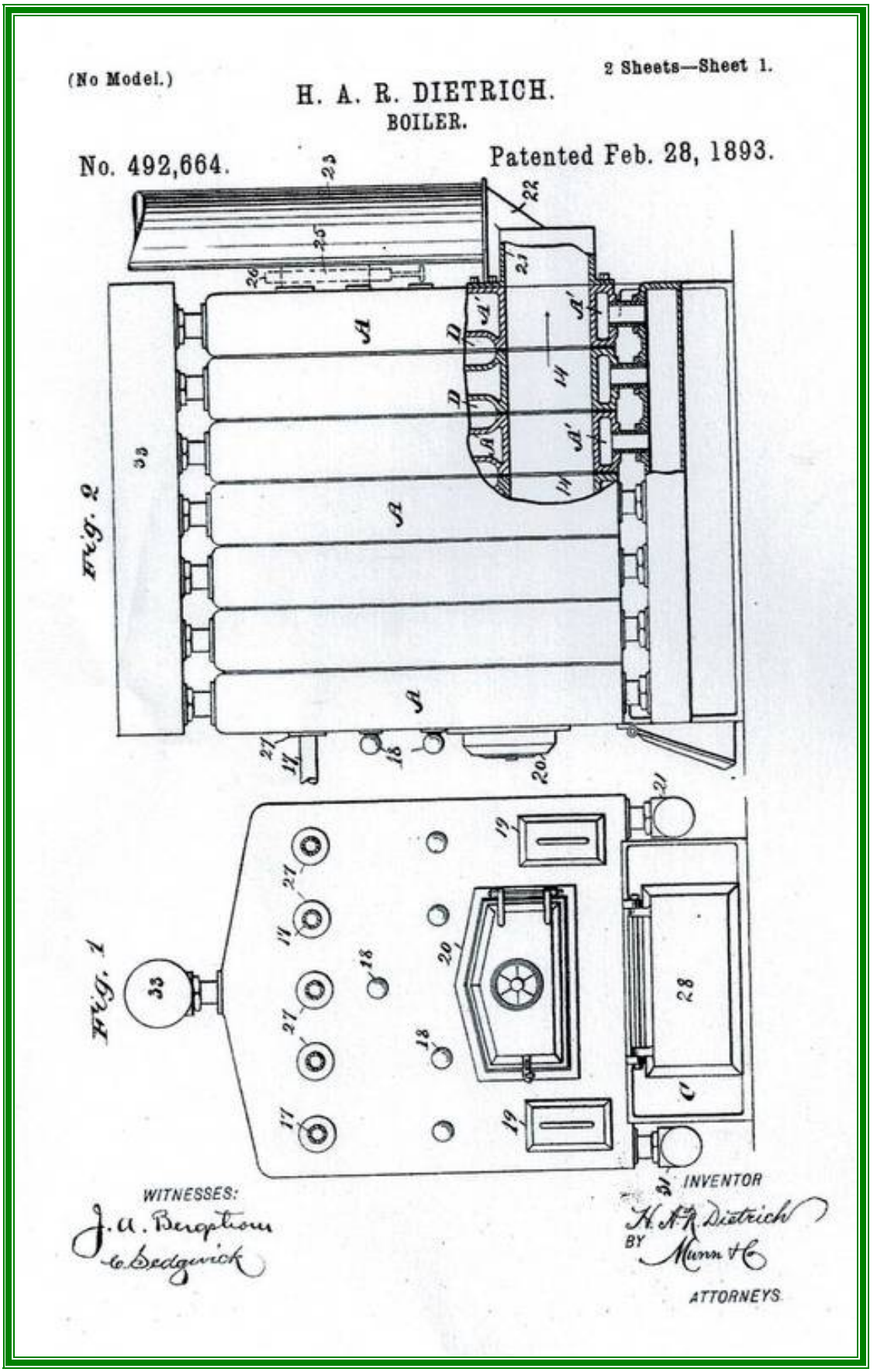
Heretofore in the construction of cast-metal boilers composed of separate sections they have been formed of certain tubes and flues designed to stand upon foundation-walls of brick or iron, such walls forming the ash-pit of the completed boiler.

While the sectional boiler just referred to has many desirable features of construction and operation as a steam-generator, they do not cover certain modern demands in the way of a heating apparatus not intended to generate steam as the heating agent, but to raise the temperature of the water simply and circulate it in pipes or radiators located in the rooms and spaces to be warmed. There is another and important advantage secured when using this boiler for circulating water instead of steam as a heat medium. This is the increased height of the columns of water acted upon by the heat due to the longer section obtained when starting from the floor and the fact that this pipe conveying the return circulation may enter the boiler also on the floor-level and without rising up and forming a loop in the return-pipe, which is a loss of power and efficiency proportioned to the distance which such return-pipe rises before entering the boiler.

Heretofore in the construction of sectional boilers, whether composed of whole sections spanning the grate and fire-chamber from side to side, or as divided sections covering one-half of the grate, the sections are constructed to be elevated and stand upon a brick or iron foundation, which also forms the ash-pit walls of the completed boiler. In my present invention, however, I dispense with all brick and iron foundations by constructing my boiler-sections to stand directly on the floor, the lower part of such sections below the grate-line forming their own foundation, and thus avoiding the expense of brick or iron ash-pit walls and the labor of elevating the heavy castings onto the foundation—generally half a yard above the floor. This method of constructing cast sectional boilers not only dispenses with said common but useless foundations as to heat effect upon the water in the boiler, but by forming the same from the sections themselves increased heating-surface is obtained in the pipes and tubes extending below the grate and forming the walls of the smoke-flues before described.

In the drawings, A indicates the main integral sections of the boiler, each of which is of cast-iron and hollow, and consists of (see Fig. 5) two substantially parallel vertical tubes 4 4, united by a hollow base 5 at their lower ends, and having extending therebe-

APPENDIX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H. A. R. DIETRICH.

BOILER.

No. 492,664. Patented Feb. 28, 1893.

Fig. 2

Fig. 1

WITNESSES:

J. A. Bergstrom

C. Bedgwick

INVENTOR

H. A. R. Dietrich

BY Munn & Co

ATTORNEYS

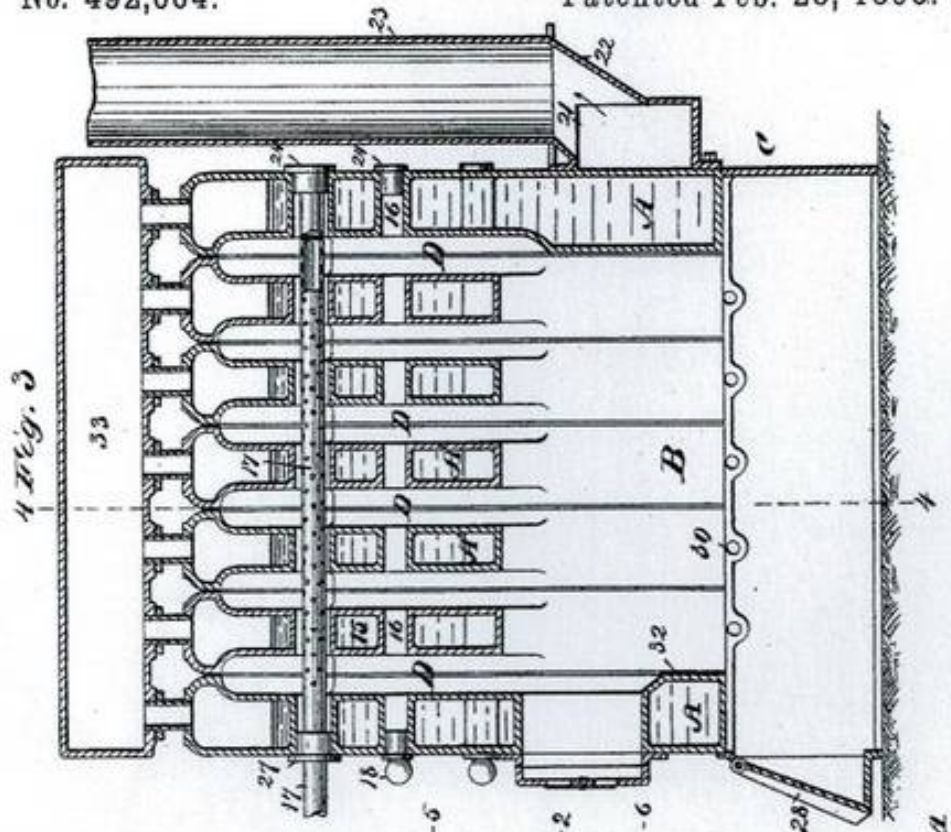
Patent of 1893 by Harry A R Dietrich for improvements to Mills patent of 1891

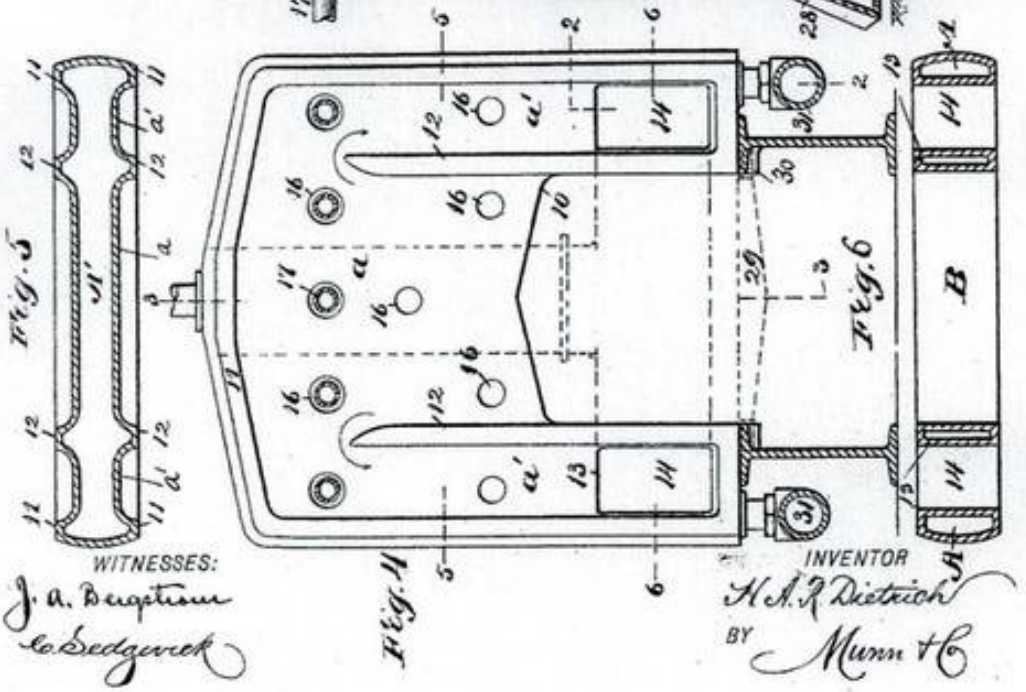
(No Model.) 2 Sheets—Sheet 2.

H. A. R. DIETRICH.

BOILER.

No. 492,664. Patented Feb. 28, 1893.





WITNESSES:

J. A. Deupuisne

C. Sedgwick

INVENTOR

H. A. R. Dietrich

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

HARRY A. R. DIETRICH, OF SOUTH BETHLEHEM, PENNSYLVANIA.

BOILER.

SPECIFICATION forming part of Letters Patent No. 492,664, dated February 28, 1893.

Application filed September 9, 1892. Serial No. 445,434. (No model.)

To all whom it may concern:

Be it known that I, HARRY A. R. DIETRICH, of South Bethlehem, in the county of Northampton and State of Pennsylvania, have invented a new and useful Improvement in Boilers, of which the following is a full, clear, and exact description.

My invention is an improvement upon the boiler of J. H. Mills, covered by patent dated March 31, 1891, No. 449,379.

The invention consists in the novel construction and combination of the several parts, as will be hereinafter fully set forth and pointed out in the claims.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar figures and letters of reference indicate corresponding parts in all the views.

Figure 1 is a front elevation of the boiler. Fig. 2 is a side view thereof, a portion of it being in section and the section being indicated by the line 2—2 of Fig. 4. Fig. 3 is a central, longitudinal vertical section, taken practically on the line 3—3 of Fig. 4. Fig. 4 is a transverse vertical section taken between two of the sections of the boiler, practically on the line 4—4 of Fig. 3. Fig. 5 is a transverse sectional view, taken through one of the sections of the boiler, essentially on the line 5—5 of Fig. 4; and Fig. 6 is a similar view to Fig. 5, but taken on the line 6—6 of Fig. 4, the said view showing the position of the smoke flues in the section.

The body of the boiler is constructed of a series of sections A, and any desired number of these sections may be employed. The sections differ from one another only in the fact that one face of the front section is shaped and constructed to constitute a front of the boiler, and the inner face of the rear section is properly shaped to constitute the rear face of the boiler. The intermediate sections have both of their side faces constructed alike. These sections may be given any desired exterior contour, preferably, however, they are made to approach in shape a rectangular figure, and viewed from their side a recess or opening 10 is produced in their central portions, the side walls of the openings being some distance from the outer sides of the sections, and the opening extends through the bottom of the section, and the top wall of the opening is preferably given an arched shape, as shown in Fig. 4.

Along the top and bottom and side edges of each face of each intermediate section a rib 11, is formed, and the rib after approaching the side walls of the openings 10 of a section, are carried vertically upward to a point preferably above the center of the section, as shown in both Figs. 4 and 5, and designated as 12. Thus a depressed central surface *a*, is located upon each side face of each intermediate section between the upwardly-extending inner ribs 12, and the depressed surface continues above these ribs, extending to the upper rib and upper portion of the upper side ribs; and side depressed surfaces *a'* are likewise produced, located between the outer side ribs and the inner ribs 12. The ribs are not solid and neither are the sections, as each section is hollow, forming an interior chamber A', and the ribs are, properly speaking, offsets from these chambers, as shown best in Fig. 5, and provide for extensions thereof.

The portions of the sections at each side of the central openings 10, may be denominated as legs, and the openings 10, are utilized to form a fire box B, when the sections are placed together. In each leg of each central section, at the lower portion of said legs, a tubular partition 13, is formed, open at each end and creating what may be denominated flues 14, and circular partitions or sleeves 15, are produced in the bodies of the sections, extending through from side to side and forming a series of openings 16. These sleeves or partitions are located in the sections in two or more sets or rows, and some of the openings 16, are ordinarily employed to receive tubes 17, closed at their inner ends but apertured throughout their length, as shown in Figs. 3 and 4, and these tubes are adapted to be used to improve combustion at these points by introducing air, the tubes being of much less diameter than the diameter of the openings in which they are located. The outer face of the front section of the boiler is not ribbed as are the faces of the inner sections, but the inner face of the front section is made to correspond to those of the intermediate or inner sections. The outer front section is provided with a like number of openings 16 as have

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