No. 742,477. PATENTED OCT. 27, 1903.

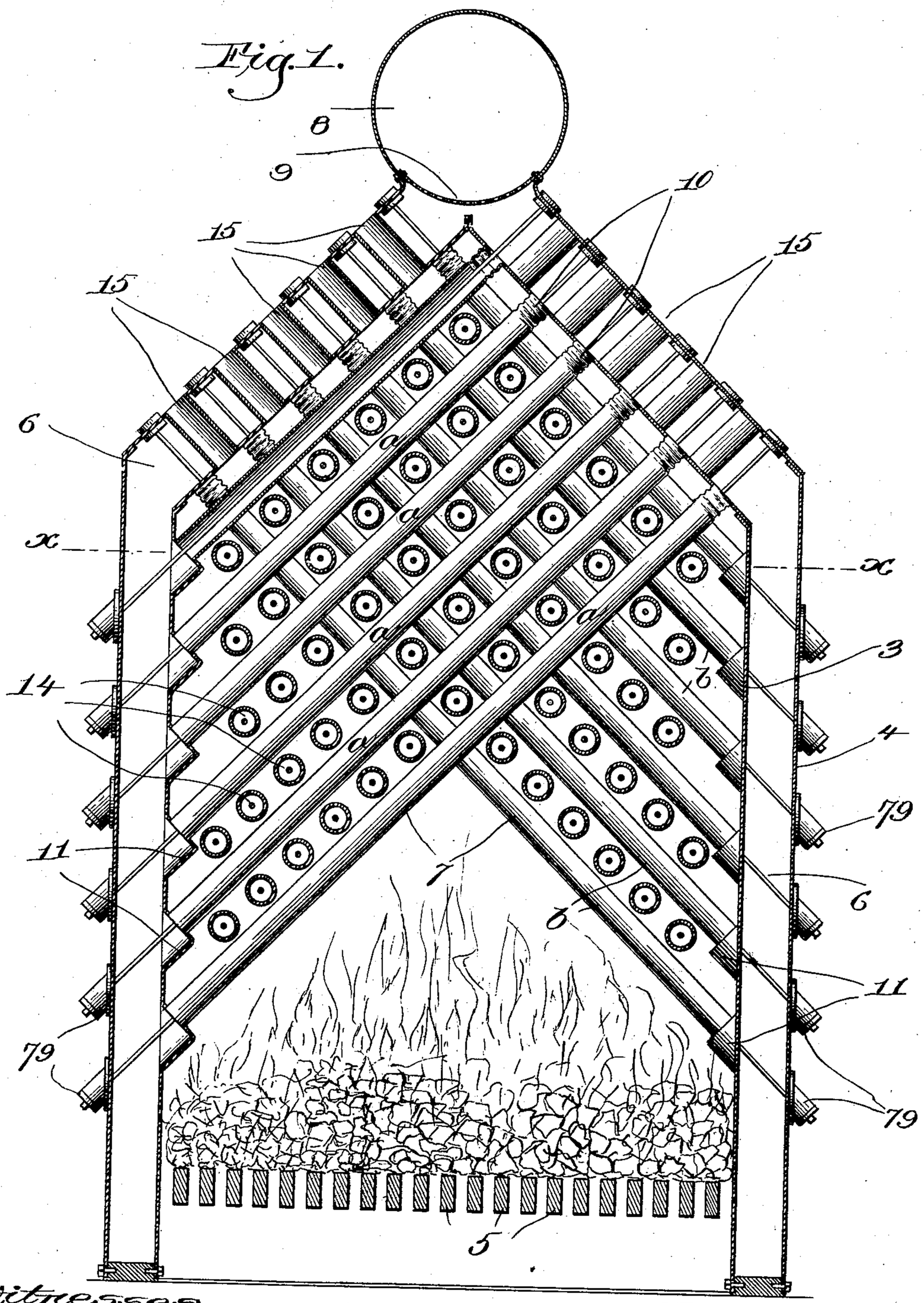
J. M. McCLELLON.

BOILER.

APPLICATION FILED AUG. 28, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

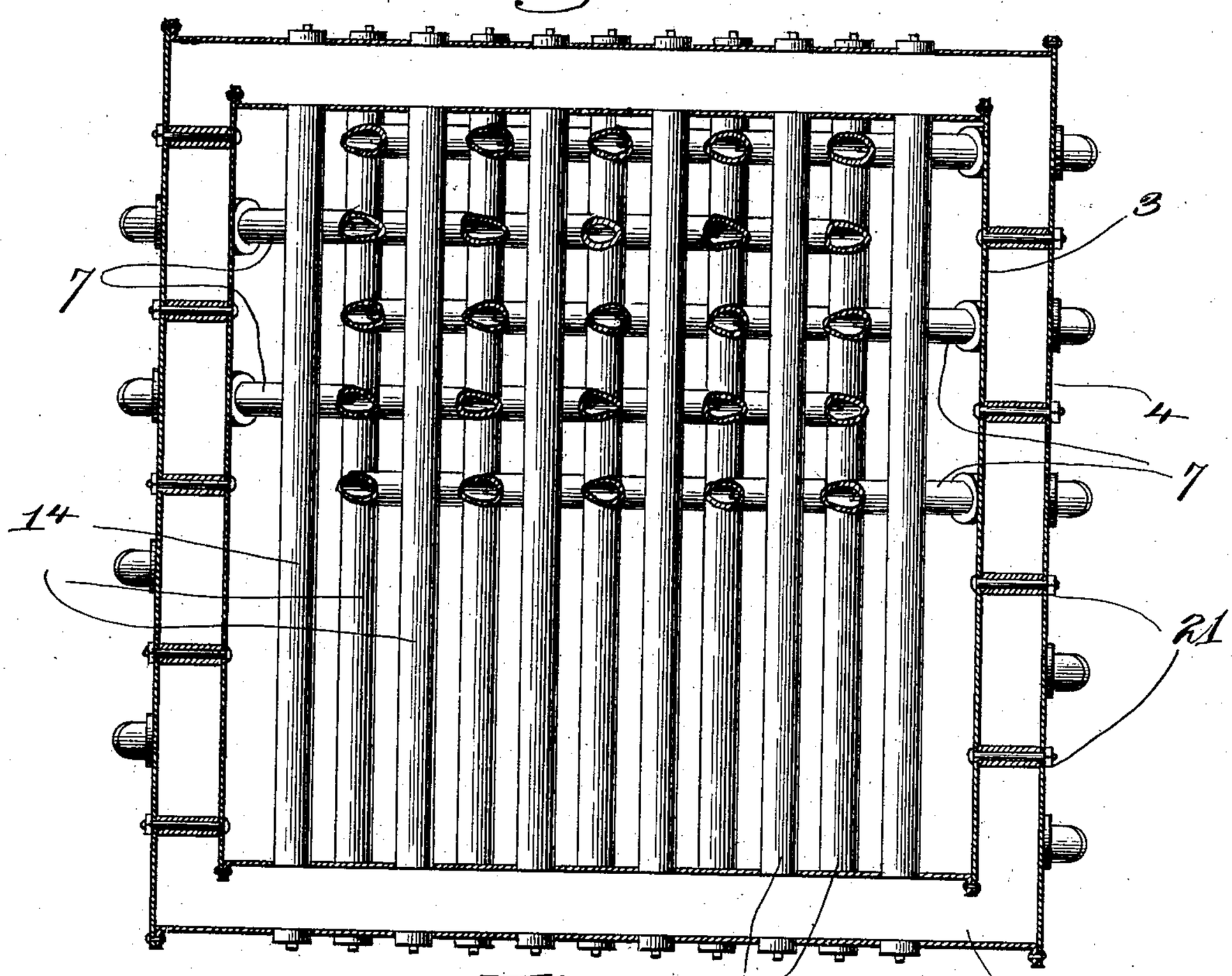


Fig. 3

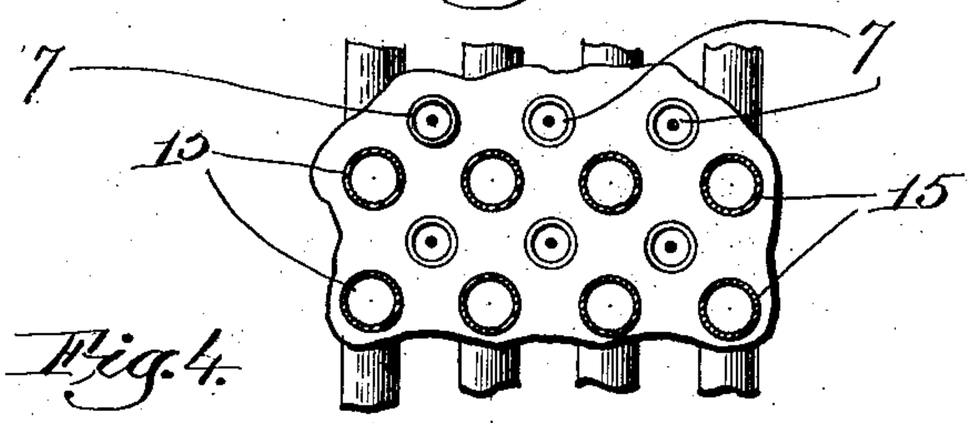
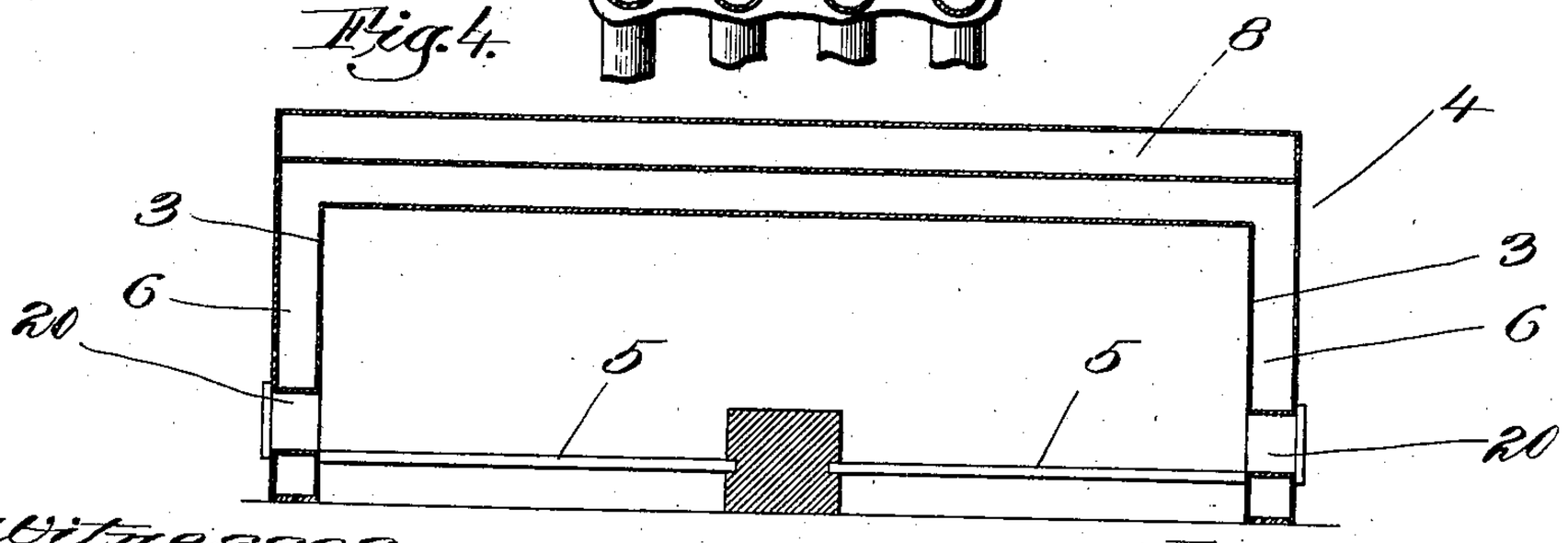


Fig. 4.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 5.

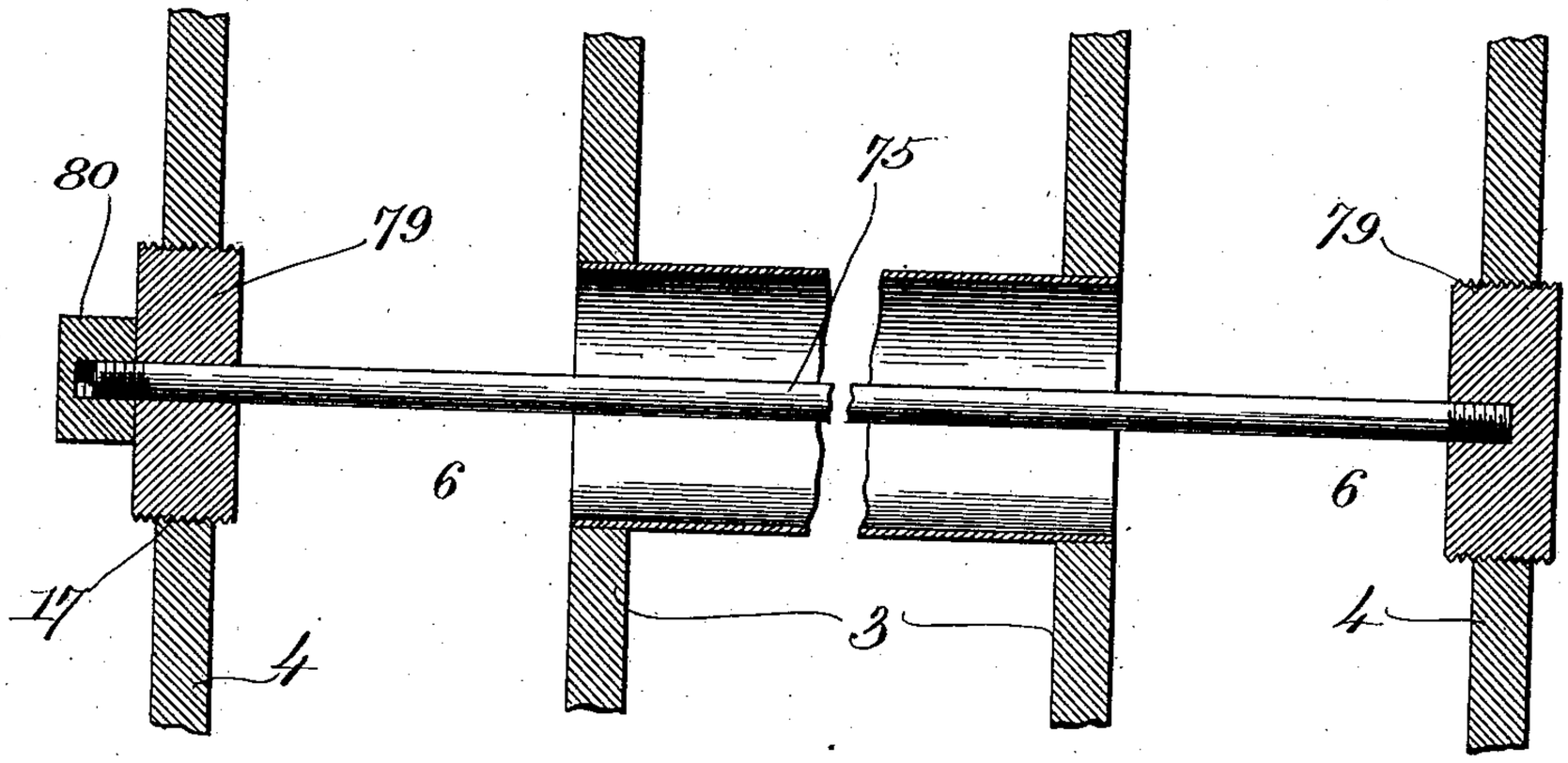
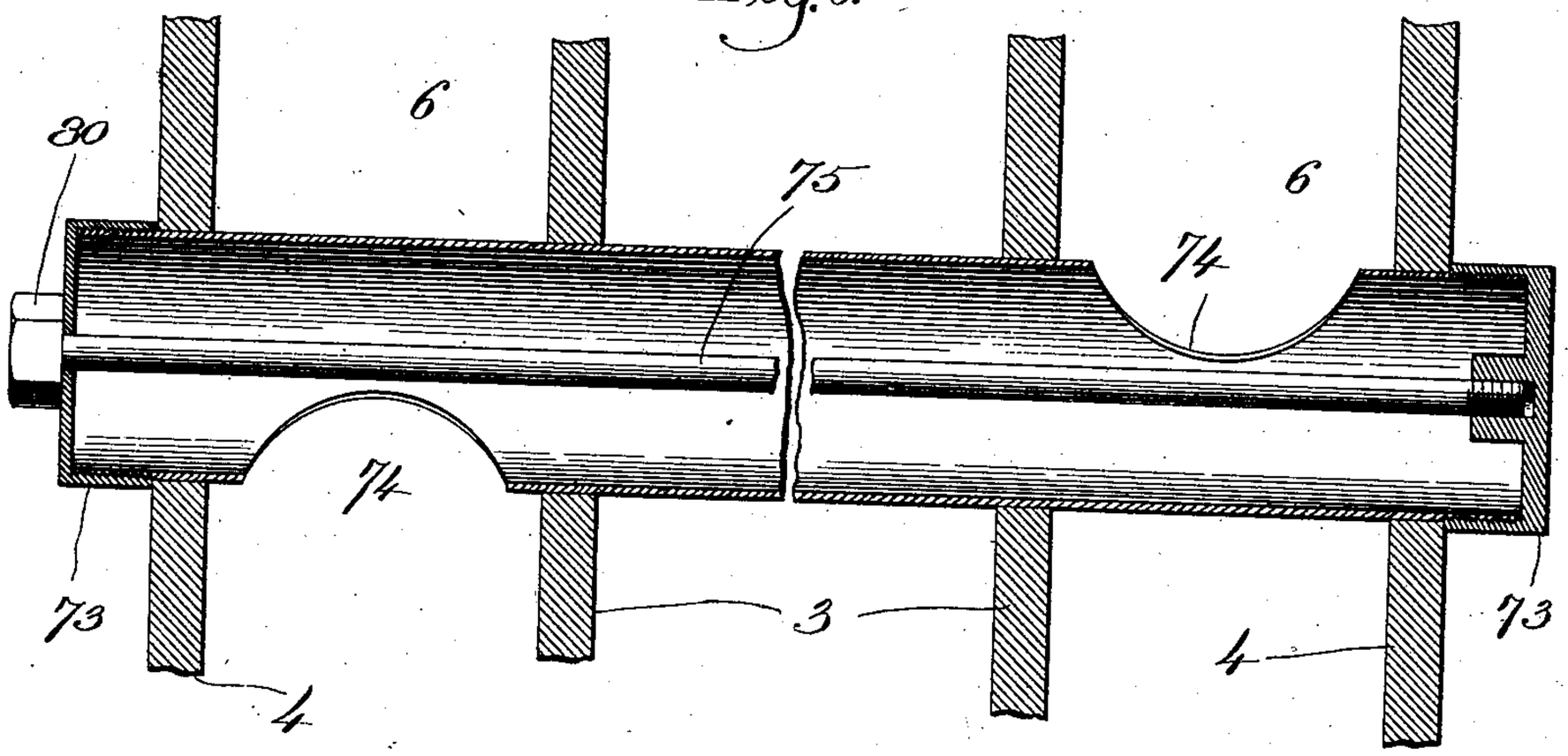


Fig. 6.



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No. 742,477. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS.

BOILER.

SPECIFICATION forming part of Letters Patent No. 742,477, dated October 27, 1903.

Application filed August 28, 1902. Serial No. 121,331. (No model.)

To all whom it may concern:

Be it known that I, JAMES M. McCLELLON, a citizen of the United States, residing at Everett, county of Middlesex, State of Massachusetts, have invented an Improvement in Boilers, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to boilers of the water-tube type, and has for its object to provide a novel structure of boiler which will be compact and in which the water-tubes are so arranged as to extract the greatest possible amount of heat from the products of combustion before the latter are delivered into the smoke-flue.

My improved boiler comprises an outer and an inner casing or shell forming between them a water-chamber and a plurality of tubes extending through the inner shell and connecting opposite sides of the water-chamber. The inner shell constitutes the combustion-chamber, and the products of combustion are delivered from the shell through a plurality of outlets or flues extending through the top of the two shells, the said flues being distributed over the entire grate-surface, so that the heated products of combustion pass through the combustion-chamber in a substantially vertical direction. The water-tubes connecting opposite sides of the water-chamber are so arranged with reference to each other as to retard the upward movement of the heated products of combustion, whereby the latter are held a longer time in contact with the tubes, and consequently more heat units are extracted from the products of combustion before they are delivered to the flue. For this purpose the water-tubes are so arranged that in whichever direction the heated products of combustion tend to move they encounter one or more water-tubes, and it is therefore impossible for any of the heated gases to escape without having first contacted with one or more of the tubes. The way in which I preferably arrange my water-tubes is to arrange them in series, each series comprising a plurality of parallel tubes and the tubes of adjacent series being oppositely inclined to each other. I will also preferably employ a plurality of horizontal tubes extending at substantially right angles to the inclined tubes and connecting the front and rear portions of the water-chamber.

Another feature of my invention relates to a novel way of staying the sides of the boiler.

Referring to the drawings, Figure 1 is a vertical section of one form of my improved boiler. Fig. 2 is a horizontal section on the line *x x*, Fig. 1. Fig. 3 is a detail hereinafter described. Fig. 4 shows a modified form of the boiler-shell, and Figs. 5 and 6 show different forms of my improved stay-bolt for preventing the sides of the boiler from spreading.

The boiler comprises the inner shell or casing 3 and the outer shell or casing 4, which are preferably substantially rectangular in cross-section, as best seen in Fig. 2. The inner shell 3 constitutes the combustion-chamber, and it will be provided with suitable grates 5, on which the fire is supported. The shells form between them an annular water-chamber 6, which is of a substantially uniform size throughout its extent, and the opposite sides of which will be connected by suitable water-tubes 7, as presently to be described. Preferably the upper portion of the sides of the shells will converge toward the center, thus making a ∧-shaped top to the boiler, as best seen in Fig. 1.

Extending the full length of the boiler, from the rear to the front thereof, is a suitable steam-dome 8, which communicates with the water-chamber and from which the steam is taken as it is used. The steam-dome may be of any suitable construction; but I have herein shown it as substantially circular in cross-section and as having its sides connected by the perforated tie member 9, which serves to prevent the upper part of the outer shell from spreading.

The water-tubes 7 are preferably arranged in series, the tubes in each series being parallel and the tubes of adjacent series being oppositely inclined. The tubes of one series are designated by *a* and the tubes of the next series by *b*. It will be seen from Fig. 1 that the tubes of one series—for instance, series *a*—are parallel to each other and connect the left-hand vertical portion of the water-cham-

ber with the upper portion of the right-hand side, while the tubes *b* of the next adjacent series are also parallel to each other, but inclined in an opposite direction, and serve to connect the right-hand vertical portion of the water-chamber with the left-hand inclined upper portion. These tubes may either extend across the inner casing only, as illustrated in Figs. 1 and 5, in which case they will be expanded at their ends into the walls of said inner casing in any usual way, or they may extend through the walls of the inner casing and into or through the walls of the outer casing, as illustrated in Fig. 6. In the latter case the tubes will be expanded into the walls of both casings, and the ends of the tubes will be closed by suitable plugs or caps 73, the portions of the tubes between the two casings or in the water-chamber 6 being provided with openings 74 to allow of the proper circulation. Preferably the ends of the tubes will be corrugated, as illustrated at 10, Fig. 1, so as to allow of expansion and contraction.

In practice I obtain best results by arranging the series of tubes with only a space of a quarter or half an inch or so between them, although in Fig. 2 I have illustrated a greater space between the adjacent series for the sake of clearness of illustration.

Preferably the sides of the ∧-shaped upper portion of the casings or shells are arranged at substantially right angles to each other, and the inclined tubes have an inclination of substantially forty-five degrees. The upper ends, therefore, of the tubes are substantially perpendicular to the portion of the shell into which they are expanded, while the lower ends of the tubes meet the vertical side walls of the inner casing at substantially forty-five degrees.

In Fig. 1 I have illustrated the vertical side walls of the inner casing as provided with the bosses 11, shaped to receive the lower ends of the water-tubes, said bosses being made by pressing the sheet metal of the casing into the required shape. If desired, however, I may construct these bosses from a separate piece, which will be bolted or riveted to the casing.

In addition to the inclined tubes above described I have provided a plurality of horizontal tubes 14, the said tubes extending across the inner casing and connecting the front and rear portions of the water-chamber. These horizontal tubes are interspersed between the inclined tubes, there being a plurality of such horizontal tubes extending between any two adjacent tubes in any series of inclined tubes.

I propose to connect the tubes 14 either to the walls of the inner casing, as seen in Fig. 5, or extend the ends of the tubes through the walls of both casings, as seen in Fig. 6 and as described with reference to the inclined tubes, according as circumstances may dictate.

Extending through the upper inclined portions of the water-chamber are a plurality of flues 15, through which the products of combustion escape, said flues preferably being distributed entirely over the inclined sides of the ∧-shaped top of the boiler. It will thus be seen that the heated products of combustion may rise in a substantially vertical direction from the grate and pass through the flues 15.

The space between the adjacent tubes in any series of inclined tubes is only a little greater than the diameter of the horizontal tubes, and since the adjacent series of inclined tubes are only slightly spaced apart it follows that while the products of combustion pass directly from the combustion-chamber into the outlets 15 yet during such passage they are continually encountering some one of the tubes, the tubes being arranged to retard the products of combustion before their exit through the flues.

By the above arrangement of tubes I have provided a maximum amount of heating-surface in a minimum space and have provided means for extracting the maximum number of heat units from the products of combustion before their escape, thus producing an extremely-efficient boiler.

It is very desirable that in case any water-tube becomes leaky or damaged such water-tube may be removed and a new one put in its place without the necessity of disturbing the other water-tubes or taking the heads off from the shells. When the tubes extend through the outer casing, as seen in Fig. 6, this may be accomplished by simply removing the caps or plugs 73, when the tube is open to admit of the use of the tools necessary for its removal, and after a new tube has been put in place the open end of the tube permits the use of a suitable expander for expanding the tube in the shells. When, however, the tube is expanded into the inner shell only, as in Figs. 1 and 5, I provide the outer shell at points in alinement with each of the tubes 7 and 14 with apertures or handholds 17, there being one such handhold opposite each end of each tube. These handholds will be closed by suitable removable plugs 79, which when removed give access to one end of the corresponding water-tube, whereby the said tube may be loosened from the inner shell and taken out.

The boiler shown in Figs. 1 and 2 is substantially square in horizontal cross-section; but my invention is not limited to this particular shape, as the boiler may be made of any desired length or width. Whatever the length of the boiler, however, I will preferably provide the inclined portions of the ∧-shaped top with outlet-flues 15, which are distributed entirely over the same, and will provide a grate-surface which is substantially coextensive with the base of the inner shell.

Where a large boiler is desired, I will arrange my grate-surface as shown in Fig. 4,

wherein two grate-surfaces are employed, and a door 20 is provided at each end of the boiler. The fuel may be supplied therefor from each end of the boiler and an even fire maintained throughout the entire combustion-chamber.

21 designates any usual stay-bolts, which operate to tie the two shells together and which may be employed, if desired. It is desirable, however, that the opposite sides of the boiler be tied together in some way to prevent any liability of their spreading, and accordingly I have provided the long stay bolts or rods 25, which extend clear through from one side of the boiler to the other. These long stay-rods are preferably placed inside of the water-tubes, and when the tubes are connected to the inner shells, as shown in Figs. 1 and 5, the stay-rods will have their ends secured to the removable plugs 79.

When the water-tubes are of the form shown in Fig. 6, the stay-rods will be secured to the caps 73 of said tubes. In order to prevent any leak around the stay-rods, I prefer to screw-thread one end of each rod into one of the plugs 79 or caps 73, as shown at the right in Figs. 5 and 6, and extend the other end of said rod through the corresponding plug or cap on the opposite side of the boiler and apply a cap-nut 80 thereto. This eliminates all possibility of leakage around the screw-threads of the bolt or rod, and as the face-joint between the nut 80 and plug 79 can readily be made tight there is no danger of leaky joints. It will be noted that these long stay-rods are entirely surrounded by water or steam and are not at any point exposed to the action of the heated products of combustion. Moreover their length gives them sufficient flexibility, so that there is absolutely no danger of their becoming sheared off or broken by the strains due to the unequal expansion or contraction of the two casings of the boiler.

When short stay-bolts, such as 21, are relied upon entirely for the purpose of preventing any springing or distortion of the boiler-casings, it not infrequently happens that the unequal expansion and contraction of the two casings shears off or breaks the bolts, which because of their short length are not sufficiently flexible to permit of the necessary movement between the casings. This is entirely overcome by the use of the long stay-bolts. If desired, I may omit the short stay-bolts entirely and rely entirely on the long stay-bolts to hold the boiler into shape.

The long stay-bolts 75 may be placed in both the inclined tubes 7 and in the horizontal tubes 14 or in only part of the tubes, and as few or as many of these bolts may be used as necessary to properly stay the boiler.

In addition to providing a maximum amount of heating-surface in a minimum space my improved boiler has the advantage of having comparatively few different lengths of tubes.

It will be noted that all the horizontal tubes 14, which extend from the front to the rear of the boiler, are of the same length and also that each series of inclined tubes has the same number and length of tubes. 7c

While I have herein shown one way in which the water-tubes may be arranged to accomplish the purpose I have in mind, yet I do not wish to be limited to the exact construction shown, as the water-tubes may be arranged in other ways and yet be within the scope of my invention as expressed in the appended claims.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A steam-boiler having similar inner and outer shells forming between them a water-chamber, each of said shells having vertical side walls and an inverted-**V**-shaped top the inclined surface of which stands at substantially forty-five degrees, and crossed water-tubes connecting opposite sides of the water-chamber and extending parallel to the inclined surface of the top.

2. A steam-boiler, having an inner and an outer shell, forming between them a water-chamber, crossed, inclined tubes connecting opposite sides of said water-chamber, and horizontal tubes interspersed between the crossed tubes and connecting opposite ends of the water-chamber.

3. A steam-boiler, having an inner and an outer shell, forming between them a water-chamber, and a plurality of series of inclined tubes connecting the opposite sides of said chamber, the tubes of adjacent series being inclined in opposite directions, and a plurality of horizontal tubes extending at right angles to and arranged between the tubes of each series.

4. A steam-boiler, having an inner and an outer shell, forming between them a water-chamber, a plurality of series of inclined tubes connecting the opposite sides of said water-chamber, the tubes of adjacent series being inclined in opposite directions, and a plurality of horizontal tubes arranged between the adjacent tubes of each series, and extending at right angles to the tubes of said series.

5. In a steam-boiler, two similar inner and outer shells forming between them a water-chamber, each of said shells being substantially rectangular in horizontal cross-section and having vertical side walls and an inverted-**V**-shaped top the inclined surface of which stands at substantially forty-five degrees, and water-tubes connecting opposite sides of the water-chamber and extending parallel to each inclined surface of the top.

6. A steam-boiler having similar inner and outer shells forming between them a water-chamber, each of said shells being substantially rectangular in horizontal cross-section and having vertical side walls and an inverted-**V**-shaped top the inclined surface of which stands at substantially forty-five degrees, and

inclined water-tubes connecting the inclined top portion of each side of the inner shell to the vertical portion at the opposite side of said shell.

7. A steam-boiler having similar inner and outer shells forming between them a water-chamber, each of said shells having vertical side walls and an inverted-V-shaped top the inclined surface of which stands at substantially forty-five degrees, and crossed water-tubes connecting opposite sides of the water-chamber and extending parallel to the inclined surface of the top, and a plurality of flues or outlets extending through the upper portion of the water-chamber and distributed over the entire top of the boiler.

8. A steam-boiler, having an inner casing and an outer casing, forming between them a water-chamber, said casings being substantially rectangular in horizontal cross-section and having vertical side walls, and substantially ∧-shaped top portions, and a plurality of inclined water-tubes extending across the inner casing and substantially parallel with the inclined portions of the top.

9. An upright boiler comprising an inner casing and an outer casing, each having vertical side walls and a substantially ∧-shaped top portion, a plurality of water-tubes extending across the inner casing, a portion of said tubes being parallel with each inclined side of the top portion, and means whereby any water-tube may be removed from the exterior of the boiler.

10. A steam-boiler comprising an inner and an outer casing each having vertical side walls and a substantially ∧-shaped top portion, water-tubes extending across the inner casing in a plurality of directions, and stay-bolts extending across the inner casing parallel with each of the water-tubes.

11. A steam-boiler having an inner casing and an outer casing forming between them a water-chamber, water-tubes extending across the inner casing in a plurality of directions and stay-bolts extending through the water-tubes and connecting each pair of opposite sides of the boiler.

12. A steam-boiler having an inner and an outer shell forming between them a water-chamber, crossed inclined tubes connecting opposite sides of said water-chamber, horizontal tubes interspersed between the crossed tubes and connecting opposite ends of the water-chamber, and stay-bolts extending across the inner casing parallel with each of the water-tubes.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JAMES M. McCLELLON.

Witnesses:
LOUIS C. SMITH,
GEO. W. GREGORY.