No. 741,529. PATENTED OCT. 13, 1903.

J. M. McCLELLON.

STEAM BOILER.

APPLICATION FILED MAY 6, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

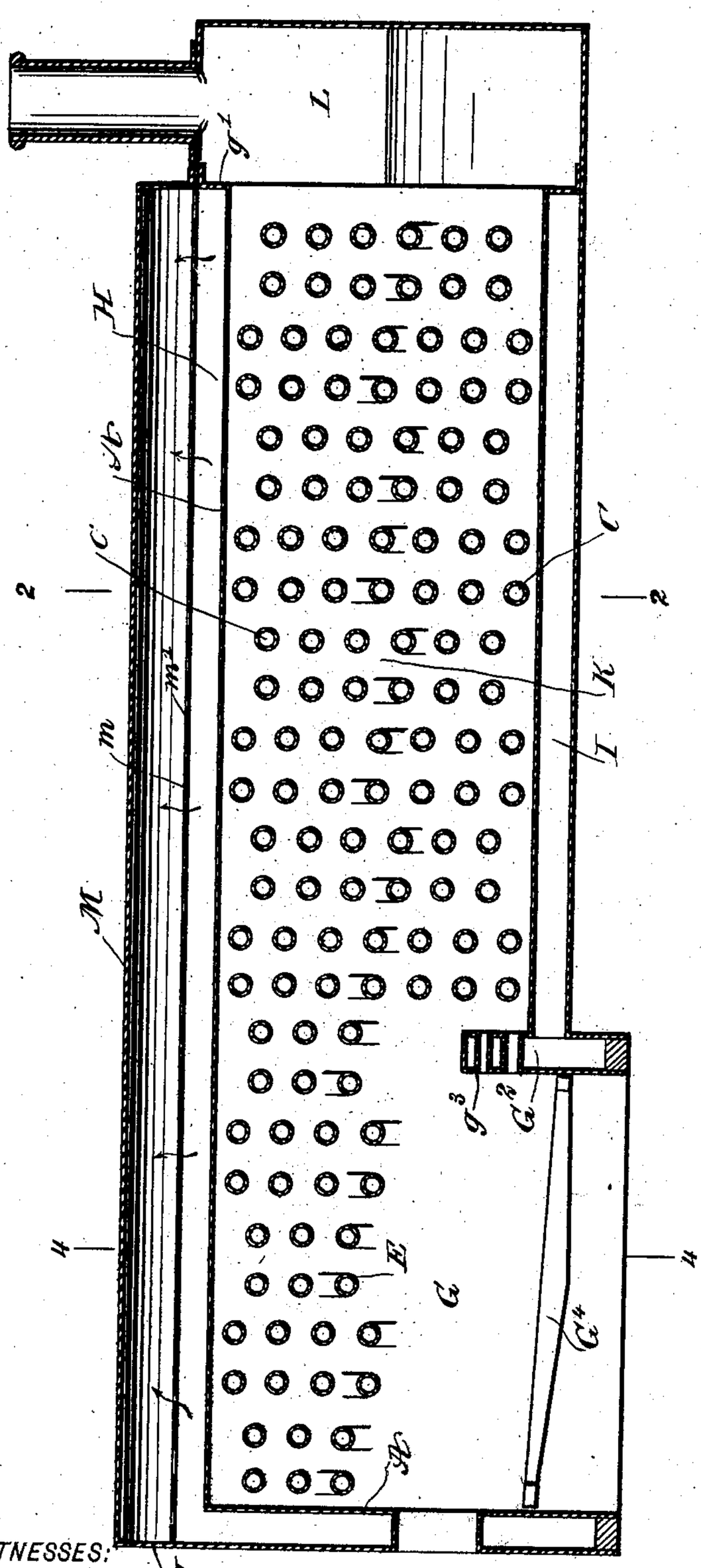


Fig. 1.

WITNESSES:

John A. Berglund

W. J. Berkhard

INVENTOR

James M. McClellon

BY Munn & Co.

ATTORNEYS.

No. 741,529. PATENTED OCT. 13, 1903.

J. M. McCLELLON.

STEAM BOILER.

APPLICATION FILED MAY 6, 1902.

NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2

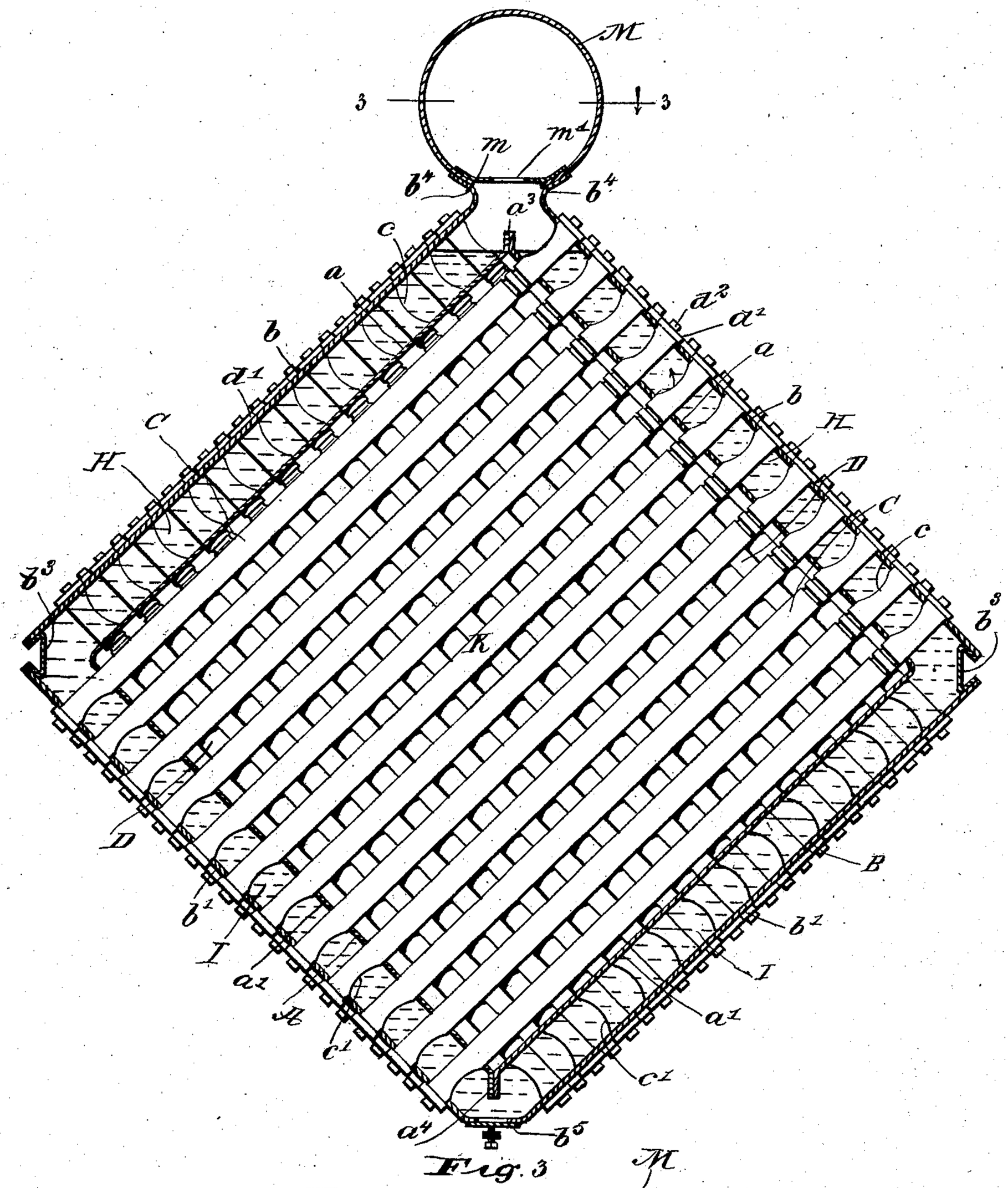
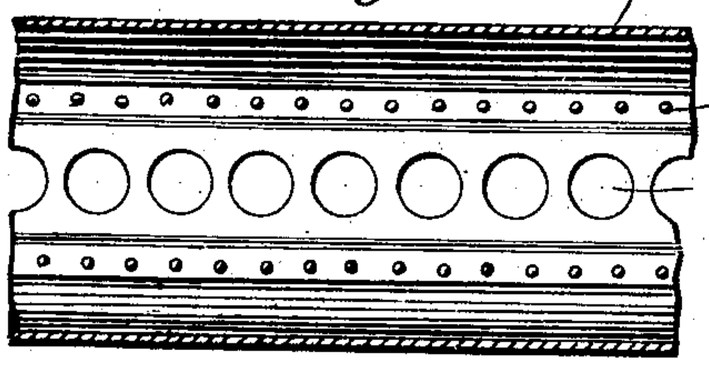


Fig. 3



WITNESSES:

John A. Brightson

W. J. Burchard

INVENTOR

James M. McClellon

BY Munn & Co.

ATTORNEYS.

No. 741,529. PATENTED OCT. 13, 1903.

J. M. McCLELLON.

STEAM BOILER.

APPLICATION FILED MAY 6, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 4

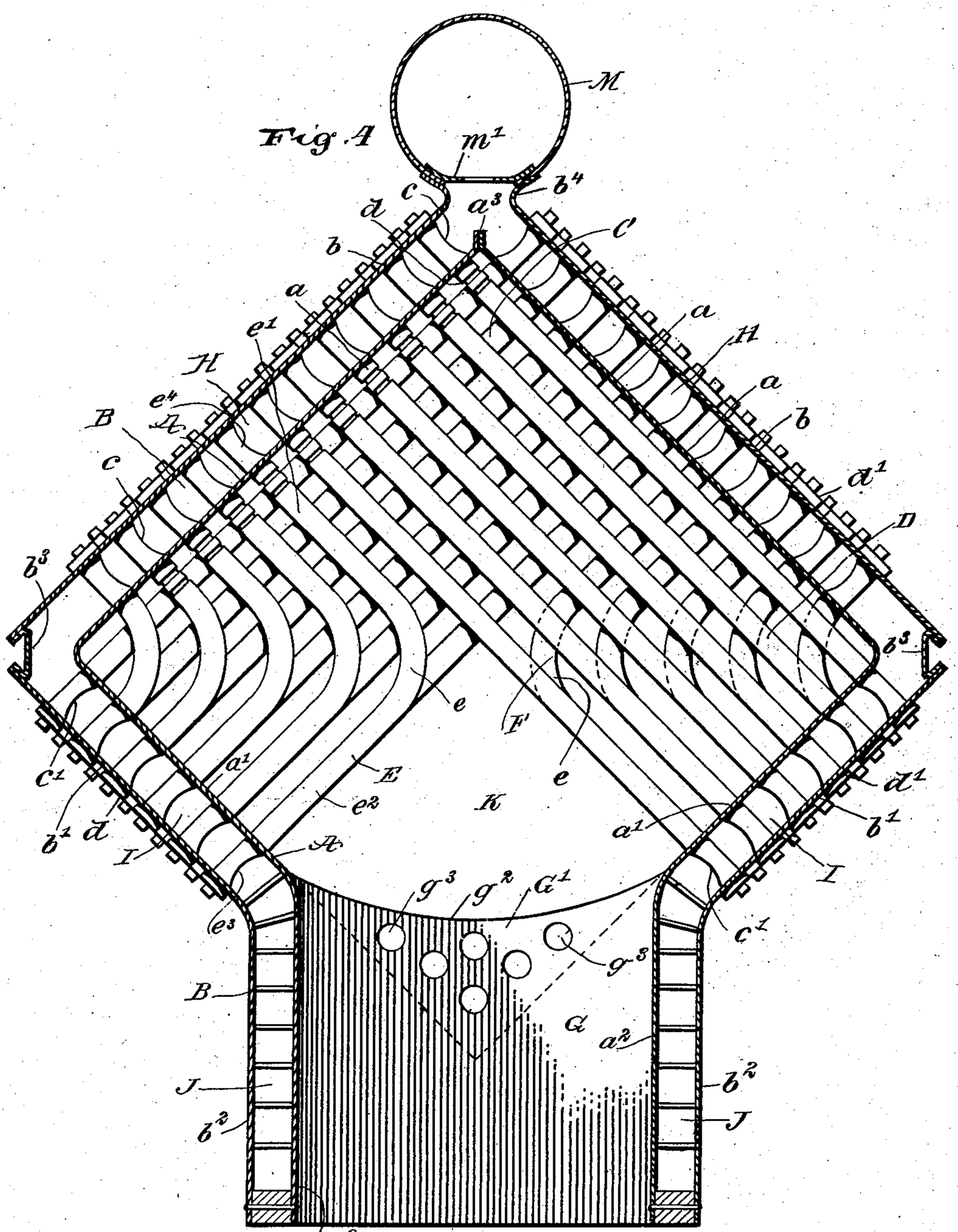


Fig. 5

WITNESSES:

John A. Berglund

W. J. Bruckner

INVENTOR

James M. McClellon

BY

Munn & Co.

ATTORNEYS.

No. 741,529. Patented October 13, 1903.

UNITED STATES PATENT OFFICE.

JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 741,529, dated October 13, 1903.

Application filed May 6, 1902. Serial No. 106,159. (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, in the county of Suffolk and State of Massachusetts, have invented a new and Improved Steam-Boiler, of which the following is a full, clear, and exact description.

My invention relates to improvements in steam-boilers, the same being more particularly directed to structures of that type adapted for use in locomotive-engines, although it is to be understood that parts of the invention may be utilized in the construction of other types of boilers.

One object of the invention is the production of an improved boiler having a heating-surface of large area and which secures the circulation of water in a natural manner by reason of the fact that partially-heated water is free to enter at the lower part of circulating-tubes, while the steam and hot water is discharged freely at the upper part of said tubes.

A further object of the invention is to provide for the easy removal of a leaky or burned-out tube and its replacement by a fresh tube with ease and facility, all of the tubes being accessible from the outside of the boiler.

A further object of the invention is the production of a novel form of boiler which has great strength and in which the water-tubes are all of the same length and are therefore interchangeable.

A still further object of the invention is the production of a novel form of boiler which while having a large heating-surface is so constructed that it can be set comparatively low upon the engine without interfering with the operation of the drivers.

With these ends in view the invention consists in the novel combination, construction, and arrangement of parts, which will be hereinafter fully described, and the actual scope of the invention will be defined by the claims.

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

Figure 1 is a longitudinal sectional elevation through a water-tube steam-boiler of the locomotive type embodying my improvements. Fig. 2 is a vertical transverse sectional elevation taken in the plane indicated by the dotted line 2 2 of Fig. 1. Fig. 3 is a detail horizontal section through the steam-dome and taken in the plane of the dotted line 3 3 of Fig. 2 with parts broken away. Fig. 4 is a sectional elevation taken in the plane of the grate-chamber and indicated by the dotted line 4 4 of Fig. 1, and Fig. 5 is a detail sectional view through the upper part of one of the water-circulating tubes in order to more clearly show the construction thereof.

The boiler consists of an inner shell, (indicated in its entirety by the letter A,) an outer shell B, a plurality of rows of inclined tubes C D, which are preferably arranged in crossing relation, and other rows of bent tubes E F. The shells are concentrically arranged and are polygonal in cross-section and form between them a water-chamber, which entirely surrounds the inner shell.

In the present embodiment of my invention the shells are shown as being substantially square in cross-section and will be arranged so that the sides of the square stand at substantially forty-five degrees, although my invention would not be departed from if the shells were given some other polygonal shape. The square cross-sectional shape is preferred, however, because the water-tubes employed are all of the same length, and by arranging the boiler so that the sides of the shell stand at substantially forty-five degrees the tubes have the proper inclination for the best and freest circulation of the water.

By making a locomotive-boiler having cross-sectional shape (shown in Figs. 2 and 4) it is possible to set the boiler lower upon the engine without interfering with the drivers than would be possible if the boiler were cylindrical in cross-section.

The inner shell A may be formed in any suitable way; but, as herein shown, it consists of two sheets, each of which is bent to form the members $a\,a'$, and these sheets at the fire-box end of the boiler are bent or fashioned so as to produce the depending portions a^2.

The members $a\,a'$ of the parts or sheets comprising the inner shell are bent substantially at right angles to each other, and the

upper edges of the members a, forming the sheets of the inner shell, are disposed to have overlapping relation, as at a^3, while the lower portions of the members a' of the sheets or parts of the inner shell are arranged to meet each other beyond the fire-box in order to form the joint a^4, (indicated in Fig. 2,) whereby the parts or sheets of said inner shell may be united together in any suitable way, so as to produce water and steam tight joints.

It is evident that the joints between the members of the inner shell can be packed and riveted in any way known to the art; but this detail of construction may be modified within the skill of a mechanic.

The parts a^2 of the members forming the inner shell are disposed parallel to each other along the sides of the grate-chamber G, and these parallel portions bound or form the side walls of said grate-chamber.

I have herein shown the outer shell B as consisting of the two upper plates b, forming the upper sides of the boiler, and the plates b', which are arranged at substantially right angles to each other and form the under side of the boiler. The plates b' are united together beyond the fire-box by a union-strip b^5, and union-strips b^3 serve to unite the plates b b'. When thus formed, the outer shell has a square cross-sectional shape which surrounds and is concentric with the substantially square inner shell.

At one end of the boiler the plates b' are formed to present the depending portions b^2, which are disposed in parallelism with the depending portions a^2 of the inner shell and which form, with said portions a^2, water-legs J, surrounding the fire-box.

Any suitable or well-known construction may be resorted to in order to secure water and steam tight joints between the various plates forming the outer shell.

By thus arranging the inner and outer shells concentrically a water-chamber is formed between the shells which has substantially uniform depth, the said water-chamber comprising the upper water-spaces H, the lower water-spaces I, and the water-legs J at the sides of the fire-box or grate-chamber, the said water-chamber entirely inclosing the inner shell, which constitutes the furnace-flue K and leads from the combustion or grate chamber G to the smoke-box L, situated at the front end of the boiler, as is usual in structures of the locomotive type.

The space between the inner and outer shells A B at the rear end of the boiler is closed by the employment of a head g, which may be of the usual or any preferred pattern, said head making provision for access to the grate-chamber G through the usual firing-door, although any suitable devices may be employed at this end of the boiler. The front end of the outer shell B is extended or prolonged beyond the corresponding end of the inner shell A in order to form the smoke-box L, the latter having direct communication with the longitudinal flue K, and the space between the front end of the inner shell and the outer shell is closed by the employment of a head g', the latter being so constructed that free communication between the smoke-box L and the flue K is secured. The grate-chamber G is provided with a bridge-wall G', which is preferably formed with a curved top edge g^2. This top edge of the bridge-wall is concave in order to allow the free escape of the products of combustion, and to prevent the bridge-wall from rapidly deteriorating under the influence of the heat I prefer to make it of chambered construction, thereby providing a water-leg G^2, which lies directly in the path of the escaping heat. This water-leg is in direct communication with the water-legs J at the sides of the grate-chamber, and the circulation of water from one side leg through the bridge-wall water-leg to the other side leg is thus obtained. This circulation is not only advantageous in heating the water, but it prevents the bridge-wall from burning out when exposed to the heat of the furnace. If desired, the fire-tubes g^3 may be provided in the chambered bridge-wall or front water-leg G^2, said tubes being disposed above the plane of the grate G^4 and making provision for the direct application of a part of the heat to the water contained in the leg G^2.

The steam-dome M extends practically the full length of the boiler, and, as shown by Figs. 2 and 4, this dome consists of a shell which is substantially circular in cross-section, the continuity of the shell being broken or interrupted at the lower side thereof in order to provide two longitudinal edges separated by an intervening gap or space. The edges of the shell are disposed in overlapping relation to the flanges b^4 of the upper members forming parts of the outer shell B, and these overlapping edges of the shell B and the steam-dome are united together by steam-tight joints. The shell of the steam-dome is thus attached directly to the angular outer shell of the boiler, and this steam-dome communicates throughout its length with the upper chamber H, which is formed by and between the inner and outer shells A B.

I have found it desirable to provide means which reinforce the steam-dome shell interiorly thereof, so that the pressure of the steam will not have a tendency to destroy the water-tight joint between the shell of said dome and the outer shell B. In one embodiment of the reinforcing device a stay-plate m is employed, the same being situated near the lower part of the dome and having its edges arranged to lap the lower edges of the slotted shell. This stay may be united to the shell in any suitable way along its joints with the boiler-shell B, and said stay extends the full length of the steam-dome, as shown by Fig. 1. The stay is provided with orifices

m', which allow the free and uninterrupted passage of the steam from the chambers H into the dome M. (See Figs. 2, 3, and 4.)

In the flue K, which leads from the grate-chamber to the smoke-box L, is arranged a plurality of rows of straight inclined water-circulating tubes C D, as shown more clearly by Fig. 2, the tubes of one row being disposed in crossing relation to the tubes of the adjacent rows and all these tubes lying directly in the path of the escaping products of combustion as they circulate through the flue K on their way from the grate-chamber G into the smoke-box L. The tubes C and D extend parallel to the sides of the boiler, each tube therefore extending across the diameter of the boiler, and as the shells of the boiler are square in cross-sectional area it follows that all of the tubes are of the same length. This is quite an advantage, as it avoids the necessity of employing tubes of various length, as would be the case if the boiler were cylindrical in cross-section. As herein shown, each tube passes at its ends through the inner shell A, across the water-chamber between the shells, and has its end secured to the outer shell, said tubes being united to the shells by water and steam tight joints in any approved way, preferably by expanding said tubes into the shells, as usual in boilers. By thus extending each of the tubes through the water-chamber and securing its ends in the outer shell I have provided for properly staying the outer shell to prevent the opposite sides of the latter from being spread by the pressure in the boiler. Where the boiler-shells are rectangular in cross-section, it is imperative that some special means be employed for thus staying the outer shell, and by means of my construction I accomplish this by means of the water-tubes. The upper side of the upper end of each tube is provided with a circulating-opening c, and the under side of the lower end of each tube has a corresponding water-inlet or circulating-opening c'. This furnishes a communication between each end of the tube and the water-chamber, and the special position of the circulating-opening $c\,c'$ is designed to facilitate the entrance of the water from the lower portions I of the water-chamber into the tubes and the exit of the water and steam from the upper ends of said tubes into the upper portions H of the water-chamber. The end of each of the tubes is carried entirely through the outer shell B, and said ends are closed in any suitable way, as by means of caps d', each of which is provided with an angular or polygonal stud or projection d^2 for the purpose of enabling the cap to be removed or placed in position by means of a suitable wrench. This special construction and position of the tubes makes provision for the inlet and egress of the water in a perfectly natural manner, because the partially-heated water is free to pass from the lower portions I of the water-chamber into each tube in which the water is more highly heated by reason of the impingement of the products of combustion against the tube, and the heated water and steam can escape freely and in an upward direction through the outlet-opening c into one of the upper portions H of the water-chamber. Each tube C or D is furthermore constructed with an expansible portion d near its upper end, said expansible portion d being provided by the formation of a proper number of corrugations in the tube at a point adjacent to its union with the member a of the inner shell. This corrugated portion d of each tube is thus disposed within the longitudinal flue K, wherein the tube is subjected to the action of the products of combustion, and the provision of this corrugated part of the tube compensates for expansion and contraction of the tube due to the action of the heated gases and the circulation of the water, thereby minimizing any tendency of the expansion or contraction to loosen the tubes in the shells of the boiler.

In that portion of the boiler beyond the fire-box the inner shell is substantially filled with the inclined crossing tubes, as above stated, these tubes being arranged in rows, the tubes of one row being designated by D and the other row by C. The tubes of adjacent rows are inclined in opposite directions and stand substantially at right angles to each other, while the tubes of alternate rows are parallel to each other.

At the portion of the inner shell over the fire-box it would be impossible to extend all of the tubes of any row entirely across the inner shell without choking the grate-chamber, this being due to the peculiar construction of the fire-box.

It will be noted that the depending portions $a^2\,b^2$ of the shells which form the fire-box are situated at a point about midway of the plates d', so that the total width of the fire-box is very much less than the distance between the outer corners or angles of the boiler. In other words, the shells of the boiler flare outwardly at a point above the fire-box to meet the union-strips b^3, as best seen in Fig. 4. With this construction it is possible to employ straight tubes having uniform length to form a portion of the row of tubes over the fire-box, as illustrated by the tubes at the upper side of the row nearest the observer in Fig. 4.

In order to obtain the greatest possible area of effective heating-surface and at the same time not to choke the grate-chamber, I employ in addition to the straight tubes which form part of the rows over the fire-box the bent tubes E F. Each tube of the row of bent tubes is curved at a point intermediate of its length, as indicated at e, and forms two limbs or members $e'\,e^2$. The lower end of the limb e^2 of each bent tube is provided with an inlet-opening e^3, is fastened to the shells at the lower part of the boiler, so as to have its opening communicate with one of the chambers

I, and is provided with a cap similar to the cap d'. The other limb e' is passed through and united to the shells of the boiler, is provided with an orifice e^4, and is provided with a cap, thus making provision for the escape of the heated water into one of the upper spaces H. The tubes forming each row of bent tubes gradually increase in length, as shown by Fig. 4, and these tubes are disposed in alternate relations to other straight tubes, which extend entirely across the flue K and have communication with the spaces H I. Each row of tubes, therefore, over the grate-chamber is composed partially of straight tubes and partially of bent tubes, this construction leaving a free open space for proper combustion of the fuel. Owing to the opposite inclination of adjacent rows of tubes, the bent tubes E of one row are adjacent the straight tubes C of the next adjacent row, while the straight tubes D of any row are opposite or adjacent the bent tubes F of the next adjacent row.

In the practical construction of the boiler it is my purpose to have the water-tubes of each series C or D disposed in staggered or alternate relation—that is, one row of tubes C are in alternate relation to the tubes of one or more rows of adjacent tubes C, such arrangement also applying to the tubes D and, if desired, to the tubes E and F. Such staggering of the tubes prevents the heat and gases from escaping directly through straight passages; but, on the contrary, the escaping gases are deflected by impinging the tubes, so that they will be caused to pursue a tortuous course. By extending each tube clear across the water-chamber and expanding the same into the outer shell the tubes have the function of stay members and serve to hold the shells in shape and prevent them from spreading. With this construction, therefore, it is unnecessary to employ any stay-bolts whatever except at points where tubes do not extend—as, for instance, around the water-legs. Moreover, by thus extending the tubes through the outer shell each tube is made readily accessible from the outside of the boiler, and by merely removing the cap on the end of any one tube said tube can be cleaned or can be removed without in any way disturbing any of the other tubes. This I consider to be quite an important feature of my invention, as with the present type of locomotive-boilers it is necessary to practically dismantle the boiler in order to get access to a damaged tube. With my improved boiler, however, any damaged tube may be removed in a very short space of time and a new tube put in its place without in any way disturbing any of the other tubes. Another very important advantage secured by my improved form of locomotive-boiler is the fact that a boiler having a large heating-surface can be set comparatively low upon the engine-frame without interfering with the drivers, for it will be observed that by shaping the boiler so that the diagonals thereon extend vertically and horizontally the lower apex of the boiler may be received between the driving-wheels, and thus permit the boiler to be set lower on the frame than would be possible with the same size cylindrical boiler.

While I have herein disclosed the best form of my invention now known to me, I do not wish to be limited to this construction, as various changes may be made in the construction of parts without departing from the spirit of my invention.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A locomotive-boiler having an inner shell polygonal in cross-section and constituting a flue, one end of said shell being shaped to form a fire-box, an outer shell concentric with the inner shell and forming with the latter a water-chamber between said shells, inclined water-tubes extending across the inner shell and communicating with the water-chamber, and means to prevent the sides of the outer shell from spreading.

2. A locomotive-boiler having an inner shell rectangular in cross-section, one end of said shell being shaped to form a fire-box, an outer shell also rectangular in cross-section and arranged with its sides in parallelism with those of the inner shell, the space between the shells forming a water-chamber, inclined water-tubes extending across the inner shell and connecting the opposite sides of the water-chamber, and means to hold the opposite sides of the outer shell from spreading.

3. A locomotive-boiler having concentric inner and outer shells forming between them a water-chamber the inner shell being shaped at one end to form a fire-box, said shells both being substantially rectangular in cross-section and arranged with their diagonals in substantially vertical and horizontal planes, inclined tubes extending across the inner shell parallel with the sides of the said shell, and means to hold the opposite sides of the outer shell from spreading.

4. A locomotive-boiler having inner and outer shells which are rectangular in cross-section and which form between them a water-chamber, said inner shell being shaped at one end to form a fire-box, and inclined water-tubes extending through the inner shell, each of said tubes having its end portions extending through the water-chamber and secured to the outer shell.

5. A steam-boiler having concentric inner and outer shells which are rectangular in cross-section, and which form between them a water-chamber, and inclined crossing tubes extending transversely through the inner shell, each of said tubes having its end portions extended through the water-chamber and secured to the outer shell, and an inlet-opening in the lower side of the lower end of each tube and an outlet in the upper side of the upper end of each tube.

6. A steam-boiler consisting of a fire-box, a flue extending forwardly therefrom, a water-chamber surrounding the flue and fire-box, straight inclined tubes disposed transversely to the flue, certain of said tubes being situated over the fire-box, and bent tubes disposed in series to overhang the fire-box, said bent tubes alternating with the straight tubes which are situated over the fire-box.

7. A steam-boiler having a fire-box, a flue extending forwardly therefrom, a water-chamber surrounding the flue and fire-box, rows of bent tubes overhanging the fire-box and having their end portions in communication with said water-chamber, and crossing rows of straight tubes disposed across the fire-box and flue, the end portions of said tubes being in communication with the water-chamber.

8. A steam-boiler having inner and outer shells forming between them water-spaces, a steam-dome extending longitudinally of the boiler, and having direct communication with said water-spaces throughout its entire extent, and inclined tubes disposed between said casing, and communicating with the water-spaces at points below the steam-dome.

9. A horizontal boiler having water-spaces at the sides thereof, a steam-dome extending longitudinally of the boiler and having direct communication with the water-spaces throughout its entire extent, and a perforated stay spanning the throat of the dome.

10. A steam-boiler having shells polygonal in cross-section, and disposed in parallel relation, and forming between them a water-chamber which surrounds a longitudinal flue and the sides of a fire-box, a hollow bridge-wall forming a water-leg in communication with the water-chamber, a steam-dome united to the outer shell and communicating directly with the water-chamber and water-circulating tubes extending through the outer shell, certain of said tubes overhanging the fire-box.

11. A steam-boiler having concentric inner and outer shells substantially square in cross-section, and forming between them a water-chamber, said shells at one end having depending portions forming a fire-box of a width less than the diameter of the boiler, and means connecting opposite sides of said shell and operating to prevent them from spreading.

12. In a boiler, two concentric shells forming between them a water-chamber, said shells being substantially rectangular in cross-section and situated with their sides at an angle of substantially forty-five degrees, a steam-dome extending along the apex of the outer shell and having each side thereof secured to and forming in effect a continuation of the adjacent side wall of said outer shell, and a stay member spanning a throat of the dome.

13. In a boiler, two concentric shells forming between them a water-chamber, each shell being substantially rectangular in cross-section and situated with its sides at an angle of substantially forty-five degrees, a partic-ylindrical steam-dome extending longitudinally of the boiler and having each side secured to the edge of the adjacent side wall of the outer shell.

14. In a locomotive-boiler, two concentric shells forming between them a water-chamber, each shell being substantially square in cross-section and having its diagonals situated vertically and horizontally respectively, a steam-dome extending longitudinally of the boiler and connected thereto throughout its length, each side of the dome being secured to the edge of the adjacent side wall of the outer shell, and a stay member spanning the throat of the dome.

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

JAMES M. McCLELLON.

Witnesses:
H. F. BERNHARD,
EVERARD BOLTON MARSHALL.