(No Model.)

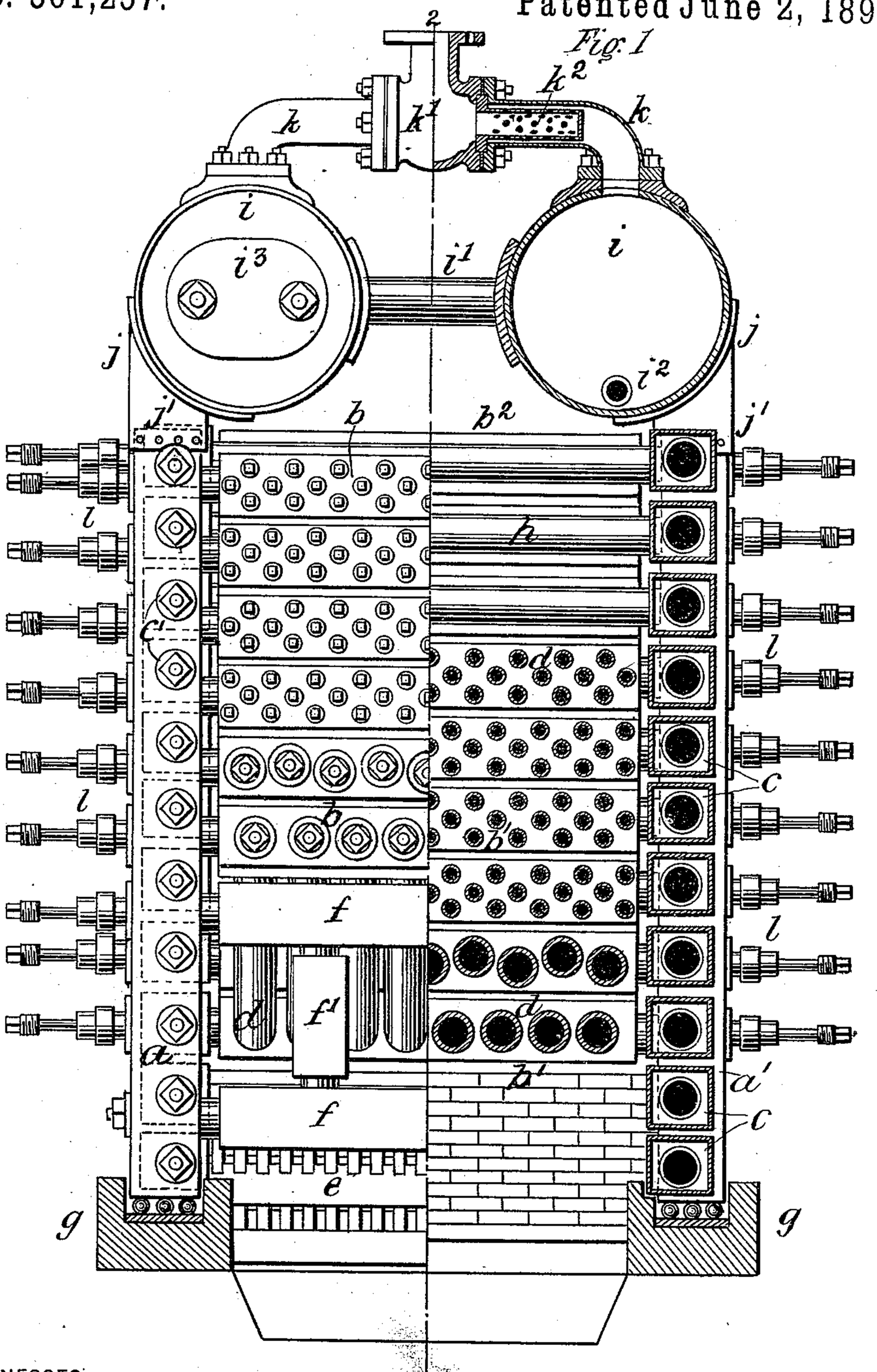
4 Sheets—Sheet 1.

J. J. CAIN.

SECTIONAL BOILER.

No. 561,257. Patented June 2, 1896.

Fig. 1



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(No Model.)

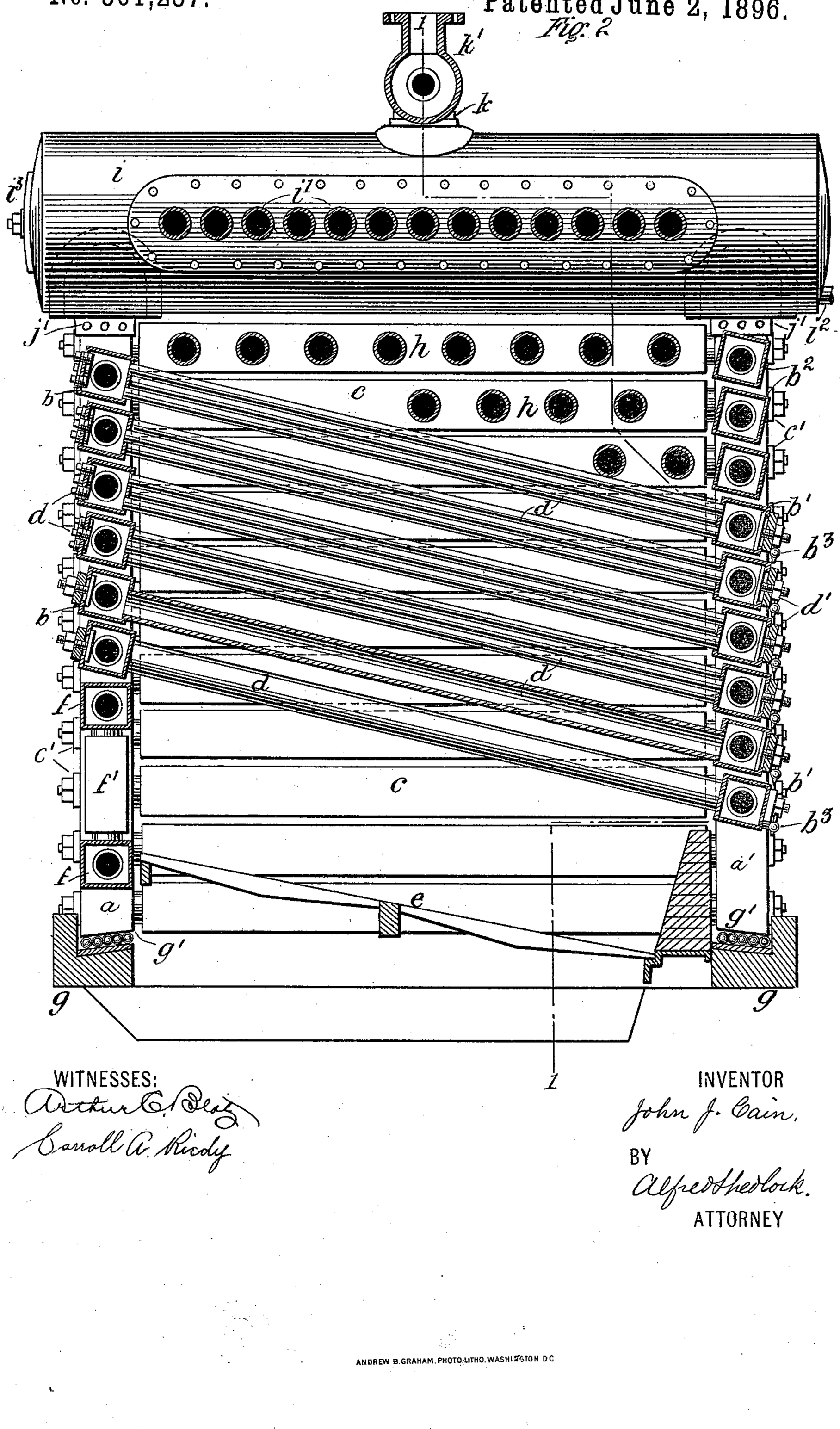
4 Sheets—Sheet 2.

J. J. CAIN.

SECTIONAL BOILER.

No. 561,257. Patented June 2, 1896.

Fig. 2



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SECTIONAL BOILER.

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Fig. 3

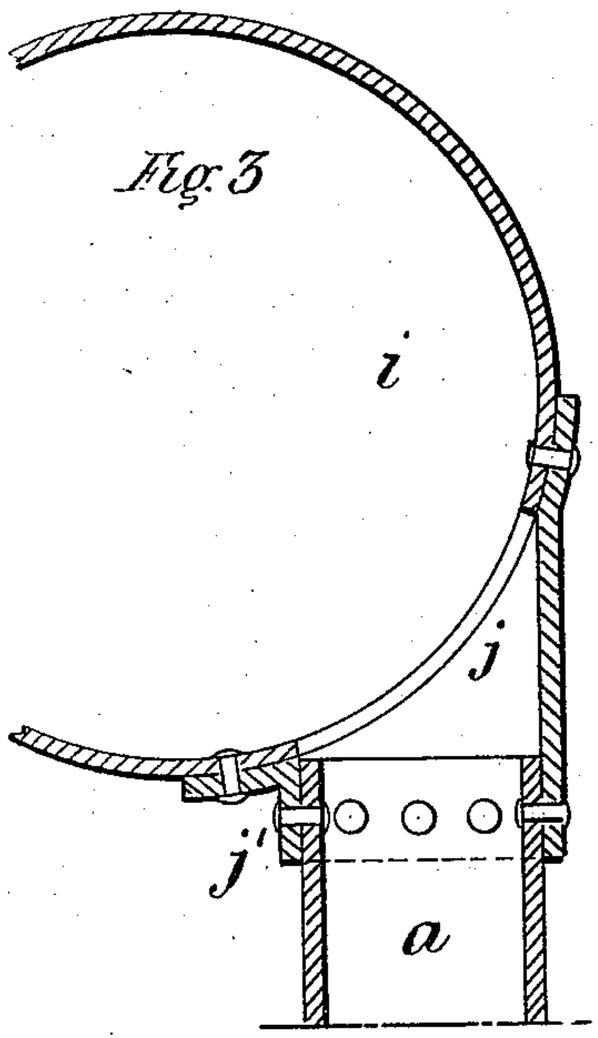


Fig. 4

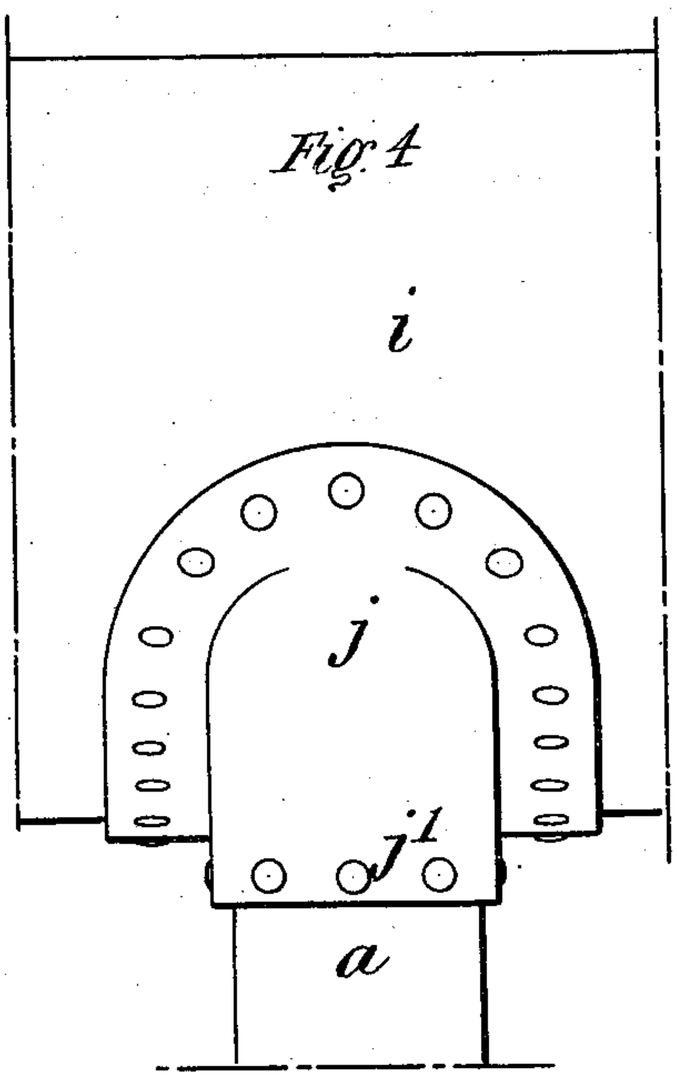


Fig. 5

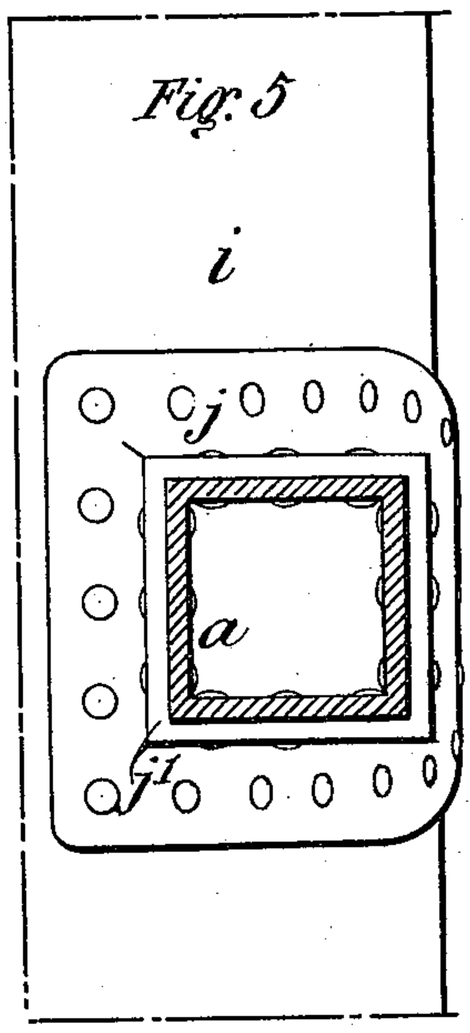


Fig. 7

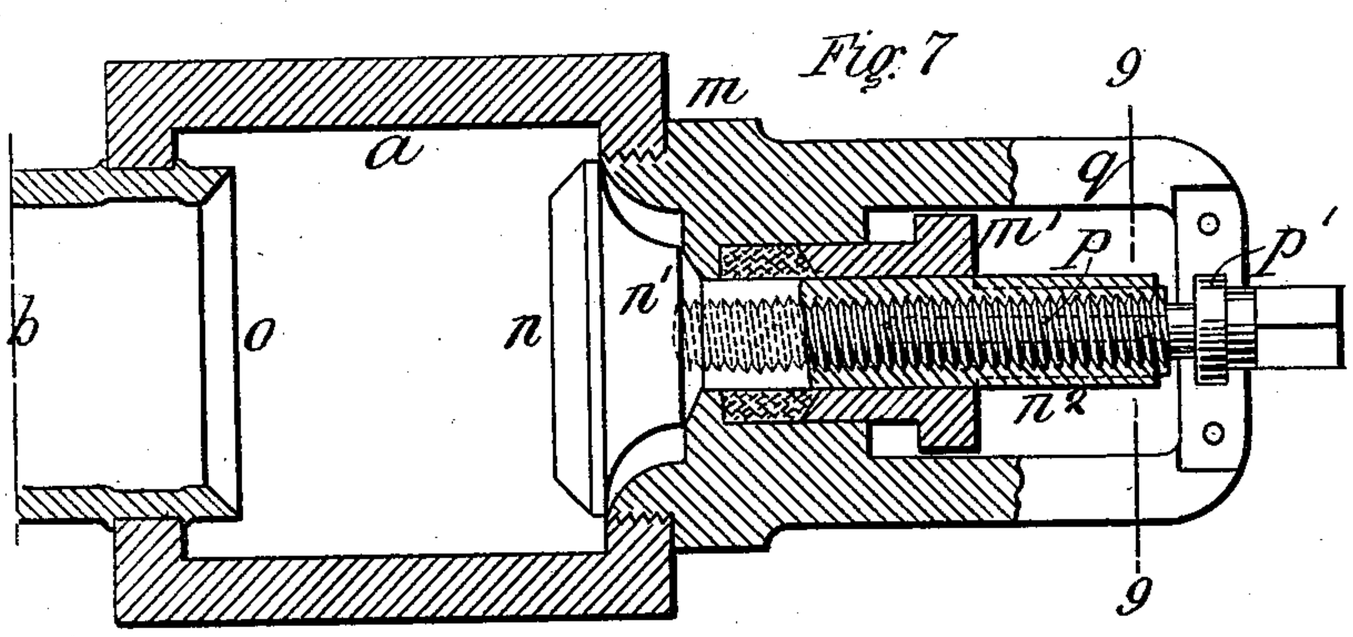


Fig. 8

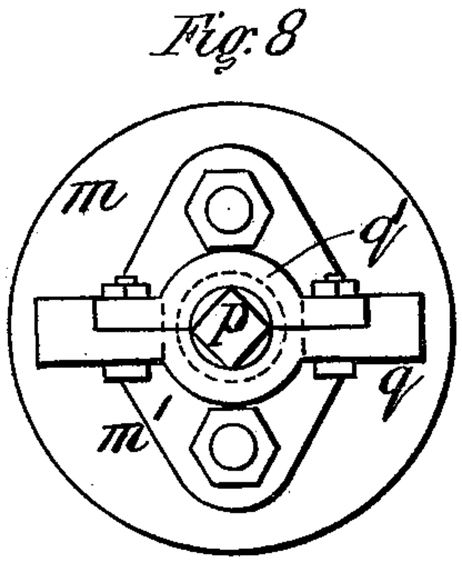
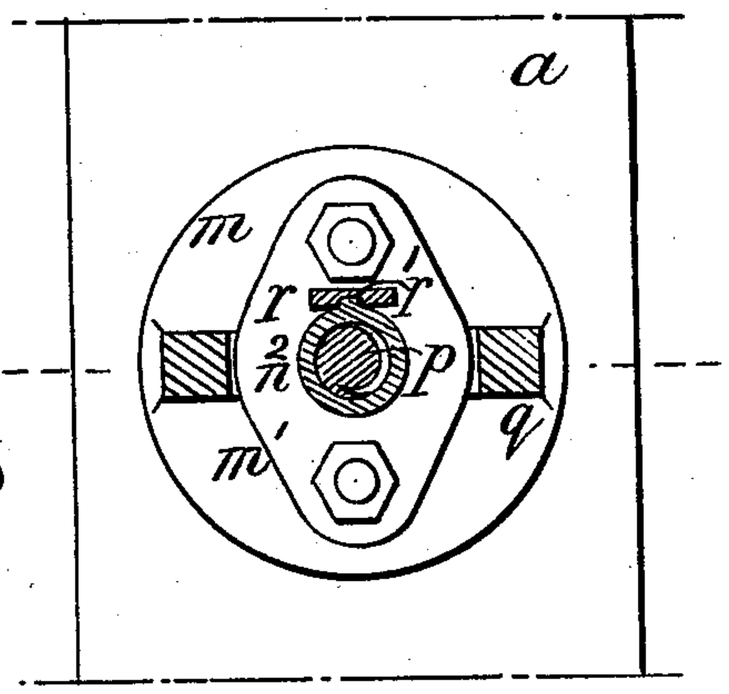


Fig. 9



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(No Model.) 4 Sheets—Sheet 4.

J. J. CAIN.

SECTIONAL BOILER.

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Fig. 11

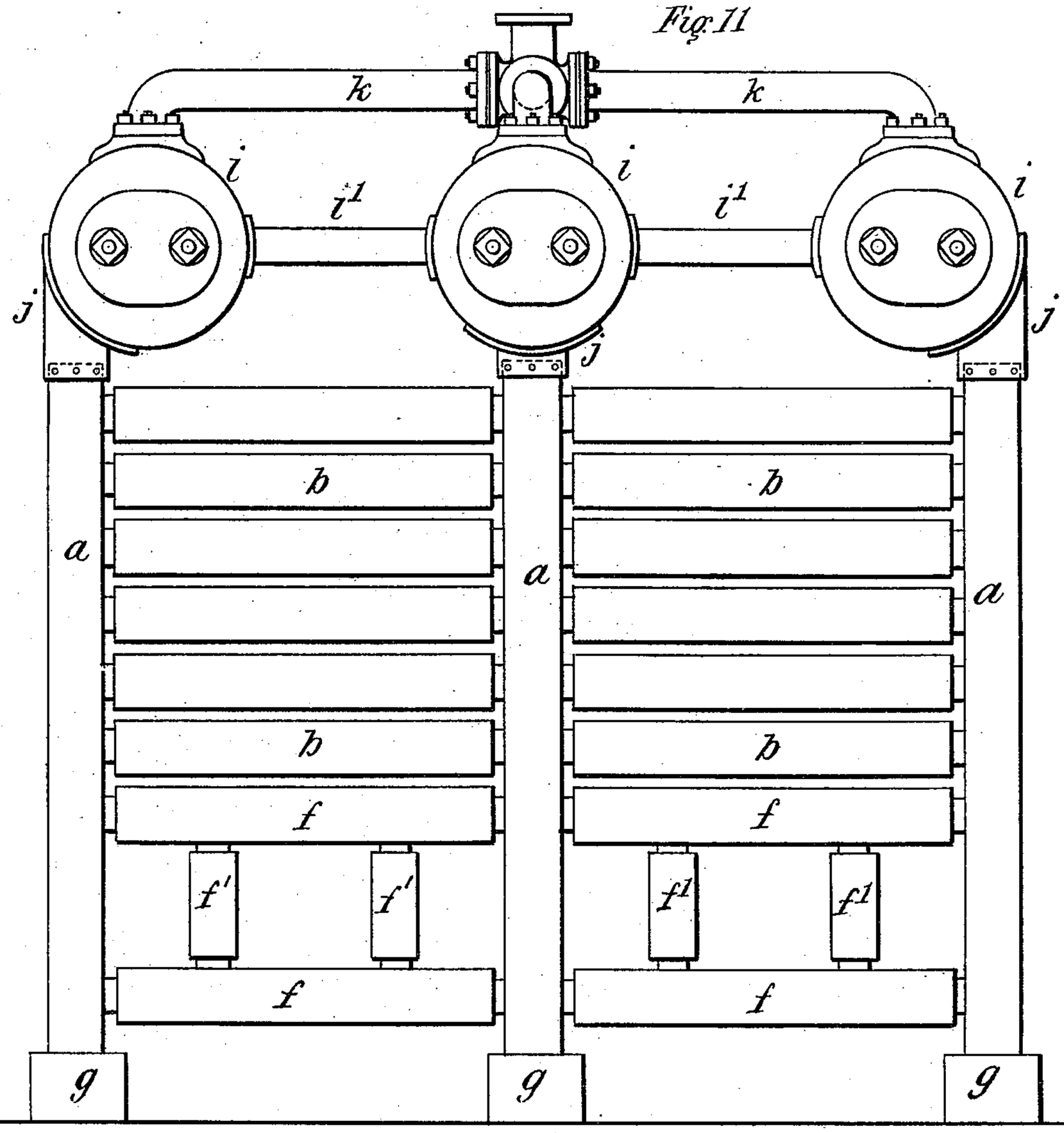

Fig. 6

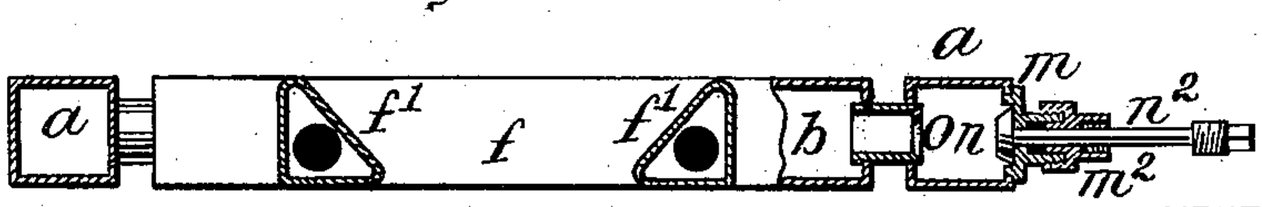

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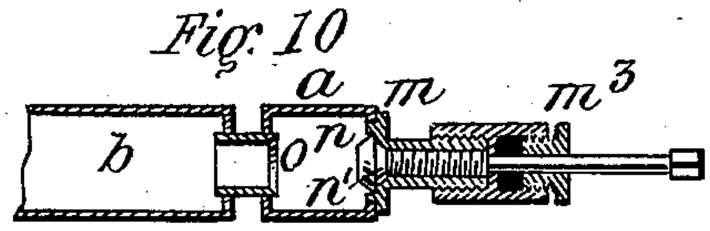
Fig. 10



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UNITED STATES PATENT OFFICE.

JOHN J. CAIN, OF BAYONNE, NEW JERSEY.

SECTIONAL BOILER.

SPECIFICATION forming part of Letters Patent No. 561,257, dated June 2, 1896.

Application filed December 11, 1895. Serial No. 571,727. (No model.)

To all whom it may concern:

Be it known that I, JOHN J. CAIN, a citizen of the United States, and a resident of Bayonne, county of Hudson, State of New Jersey, have invented certain new and useful Improvements in Sectional Boilers, of which the following is a specification.

This invention relates to sectional tubular boilers, and embodies such improvements in the construction and arrangements of the various parts that for a given area or space occupied by the boiler a maximum heating-surface and resulting useful effect are provided; that any section or series of tubes may be closed or cut off from the circulating system, thereby permitting repairs being made or the renewal of injured or destroyed tubes without necessitating the complete discharge of the water from the boiler or the delay for the boiler to cool, the section needing repair being the only part of the boiler from which the water needs be discharged, thus imparting a valuable feature to this class of boilers, particularly when such are used for marine purposes; that a full and complete water circulation is insured in and throughout the water-tubes and their connecting parts; that all parts of the structure perform functions toward the general effectiveness or steam-producing capacity of the boiler, and that dry steam is delivered by the boiler.

In general my improved boiler consists of vertical boxes or water-legs, horizontal headers, preferably rectangular in cross-section, secured to and connecting together the vertical boxes at the front of the boiler and the vertical boxes at the rear of the boiler, said headers being angularly arranged, so that the inner face of each of the front headers is opposite and parallel to the inner face of a rear header—that is, in a lower plane—and tubes connected to the pairs of headers through their parallel faces, and thus being longitudinally arranged with their front ends higher than their rear ends, each pair of headers with their series of connecting-tubes constituting a section of the boiler; valve devices attached to the vertical boxes at the sides of the boiler and in alinement with the ends of the horizontal headers or their connecting-nipples and adapted to be seated against said nipples and thus provide for the closing of the ends of the headers of any section, which may then be emptied by means of a petcock or valve in the lower rear header without disturbing the water in the other parts of the boiler; and drums at the upper part of the boiler, longitudinally arranged, supported by and connected at their under sides to the upper ends of the vertical boxes only; said drums being water and steam drums and connected together by tubes at the water-level. Water is thus supplied from the drums to the front as well as the rear vertical boxes, so that all headers and pipes connected to the vertical boxes are fully and continuously supplied with water and the discharge of water therefrom rendered practically impossible.

Saddles or support-pieces of peculiar construction are provided to connect the vertical boxes to the drums, the same being formed to fit the drums, and are secured thereto by rivets and provided with sockets that fit snugly over the upper ends of the vertical boxes, said boxes being preferably rectangular and are rigidly connected to the support-pieces by rivets passed through their sides and the sockets, thus providing very strong and rigid connections and supports for the drums and at the same time providing passage-ways between the drums and the vertical boxes equal in area to the cross-sections of the vertical boxes, so that no obstruction is offered to the movement of the water and steam.

Horizontal boxes or pipes are arranged between and connected to the front and rear vertical boxes, thus constituting the side walls of the boiler, said boxes being set inwardly beyond the inner faces of the vertical boxes, so as to reduce as much as possible the spaces at the sides of the longitudinal water-tubes.

Horizontal transversely-arranged tubes occupy the space between the inclined longitudinal tubes and the drums and connect the upper side horizontal boxes together, thus adding considerably to the heating-surface of the boiler and retarding the passage of the heated gases from the furnace through the boiler, and dry pipes are located in the steam-pipes extending from the tops of the drums, said dry pipes being closed at one end and perforated and having flanges at their other ends adapted to be clamped between the

flanges of the steam-pipes from the drums and the flanges of a central connection or T-piece. To describe these and other features more particularly, I will refer to the accompanying drawings, in which—

Figure 1 is a part front elevation and part vertical section of my improved boiler, the said sectional part being taken on the irregular line 1 1, Fig. 2. Fig. 2 is a vertical longitudinal sectional view taken on the line 2 2, Fig. 1. Fig. 3 is a sectional view, on an enlarged scale, of one of the saddles or support-pieces which connect the drums to the vertical boxes. Fig. 4 is a side view of the same. Fig. 5 is an underneath view of the same. Fig. 6 is a horizontal section of the feed-opening of the furnace, also showing one form of valve for closing the ends of the headers. Fig. 7 is a longitudinal section of the preferred form of valve for closing the ends of the headers. Fig. 8 is an end view of the same. Fig. 9 is a sectional view of the same, taken on the line 9 9, Fig. 7. Fig. 10 is a sectional view of a modified form of valve; and Fig. 11 is a front elevation of a double boiler, illustrating my improvements applied thereto.

In Fig. 1 are shown four vertical boxes or water-legs $a\ a\ a'\ a'$, one at each corner of the boiler, said boxes being preferably rectangular in cross-section and provided with holes and openings for the connection thereto of the other parts of the boiler, as hereinafter described.

Horizontal headers $b\ b$ are arranged between and connected to the front vertical boxes $a\ a$. Similar headers $b'\ b'$ are arranged between and connected to the rear vertical boxes $a'\ a'$, and side boxes or pipes $c\ c$ are horizontally arranged between and connected to the vertical boxes $a\ a$ and $a'\ a'$. All of the headers $b\ b$ and boxes $c\ c$ are preferably made square or rectangular in cross-section, and all the connections with the vertical boxes are made by means of nipples, expanded in place in a well-known manner through openings formed in the outer walls of the vertical boxes, which openings are closed by caps or plates, as shown at $c'\ c'$. The boxes $c\ c$ are located so that their inner sides extend within the plane of the inner walls of the boxes $a\ a$, the object of which is to reduce as much as possible the space between the tubes $d\ d$ and the side walls.

The headers $b\ b$ are, as shown at Fig. 2, set in angular positions, all of the front headers and an equal number of the lower rear headers being provided with holes, in which are expanded the series of tubes $d\ d$, the outer holes in the headers, through which the tubes are manipulated, being closed by means of caps and plugs $d'\ d'$ in the usual manner. The angular arrangement of the headers $b\ b'$ is such that the inner face of each front header is opposite and parallel to the inner face of a back header, which is located in a lower plane, so that the tubes $d\ d$ are inclined downwardly from the front to the rear, as shown. The upper rear boxes $b^2\ b^2$ are plain. They connect together the upper parts of the vertical boxes $a'\ a'$ and complete the rear wall of the boiler.

Beneath the tubes $d\ d$ is located the furnace, consisting of grate-bars e, supports, and rear wall, of the usual construction.

The feed-opening of the furnace is provided with a water circulation and is constructed as follows: Two horizontal rectangular boxes $f\ f$ are secured to the inner walls of the front vertical boxes $a\ a$ by means of nipples, as ordinarily, and the central parts of these boxes $f\ f$ constitute the upper and lower boundaries of the feed-opening, the side boundaries of said opening being formed by the triangular boxes $f'\ f'$, connected in vertical positions between the boxes $f\ f$, affording free communication between them for the circulation of water, said triangular boxes $f'\ f'$ being so arranged that the feed-opening inwardly increases in width, as shown at Fig. 6, thus affording better facilities for distributing the coal over the fire than if the inner vertical walls of said opening were parallel.

To eliminate strains on the various parts of the boiler, due to expansion and contraction, it is thought advisable to leave the lower supporting ends of the vertical boxes a and a' free on the base-supports $g\ g$, and to incline the bearing-surfaces, as at $g'\ g'$, said inclined bearings being, as shown at Fig. 2, reversely arranged, the effect of said arrangement being that as the boiler expands longitudinally the lower part of it will descend commensurate about with the increase of the vertical expansion, so that upper braces or fastenings used to hold the upper part of the boiler in position will not be subjected to strains due to the vertical expansion of the boiler. The inclined bearings $g'\ g'$ are shown provided with antifriction devices. These are not essential, but may be advantageous in some cases.

The angular space above the longitudinal tubes $d\ d$ is utilized for heating purposes by locating therein tubes $h\ h$, transversely arranged and secured at their ends to the upper side boxes $c\ c$.

Above the vertical boxes $a\ a'$ are placed the drums $i\ i$, horizontally and longitudinally arranged with a connecting-opening between a front and a rear vertical box and each of said drums, said drums being connected together by means of the pipes $i'\ i'$, located at the water-level of said drums, and feed-water is supplied to the boiler at the drums by means of feed-pipe i^2. $i^3\ i^3$ represent the manhole-coverings.

To provide a strong and free passage connection between the drums and the vertical boxes, I have devised a saddle or support-piece j. (Clearly shown in the enlarged views, Figs. 3, 4, and 5.) This support-piece is preferably a forging and is formed with a flange to conform to the contour of the drum, a tight

joint being made between them by means of rivets and calking, and a socket j', shaped to fit over the end of the vertical box, which in the case shown is rectangular in form. This socket and vertical box are rigidly secured together by means of rivets, as shown, and calking in the usual manner. Another advantage of this construction, other than the strength and rigidity afforded by it, is that the upper ends of the vertical boxes may be left open, thus providing a free unobstructed passage for the steam and water, which is equal to the full area or cross-section of the vertical box. Besides being stronger than the usual way of making such connections by means of expanded nipples, it is much cheaper, as the heading of the tube and the use of the nipple are avoided.

To the upper sides of the drums i i are secured the elbow-pipes k k, they being secured at the ends of their horizontal parts to the central connection or T-piece k', and in the horizontal parts of k k are located the dry pipes k^2 k^2, closed at one end, and provided at the other end with a flange, which is clamped between the flanged connection k and k'. These pipes k^2 are perforated with a number of holes, the aggregate area of which equal the areas of the pipes k k.

The means devised for closing or cutting out of the circulation any one of the sections of tubes without requiring a complete emptying of the boiler consist of permanently-attached valve devices l l, located in the vertical boxes opposite the openings or nipple connections of the headers b b, said valves being normally held away from said nipples, but adapted, when occasion requires, to be seated against the nipples and so close the openings of the headers of the section needing repairs, the lower header of each section being provided with a petcock or plug b^3 for the discharge of the water from the sections. The preferred style of valve adapted for this purpose is shown in detail at Figs. 7, 8, and 9, all the parts thereof being attached to or carried by the caps or covers m m, used to close the opening in the boxes a a' through which the nipple connections are manipulated, said caps or covers being shown secured in place by means of screw-threads. The cover m has a central bore provided with a packing-box and gland m', the inner end of the bore being formed into a valve-seat. The valve is double—that is, it has two active parts n and n', the main part n being adapted to fit into the seat o, formed in the end of the nipple of the header b, when the header is to be closed, and the other part n' formed to fit the seat formed in the cover m when the valve is in normal position, as shown, thereby insuring against leakage from these parts of the boiler.

The stem n^2 of the valve is bored and screw-threaded from its outer end, and in this stem fits the screw p, which is provided with the collar p' and a squared end for the application thereto of an operating-wrench. This screw p has a bearing in the end of the bridge-piece q, attached to or forming part of the cover m, the collar of the screw fitting into a groove formed in the bearing in such manner that the screw is free to rotate without having any end play. q' is the cap of this bearing, but is not shown in Fig. 7. Now it will be readily seen that when the screw p is rotated the valve n n' will be moved toward or from the seat o, according to the direction of rotation of the screw, and to prevent the valve from turning with the screw, should the friction of its stem in the packing-box not be sufficient for this purpose, I provide a grooved guide r, extending from the gland m', said groove extending some distance into the bore of the gland, and a pin r', projecting from the stem near its end, arranged to fit into the groove of the guide r.

Any suitable form of valve or closing device for the headers may be used, a modified form being shown at Fig. 6, in which the valve-stem n^2 is plain and provided with a short screw at its outer end, which is screwed into the gland m^2 of the packing-box when the valve n is near its seat o by being brought into this position by pressure applied to the end of its stem, the perfect seating of the valve being then accomplished by rotating the valve by its stem. In Fig. 10, which is another modification, the bore of the cap or cover m is screw-threaded, a corresponding screw-thread being formed on the stem of the valve n n', the packing-box m^3 being at the outer end of the bore of the cover, and the outer part of the stem of the plain to fit in and slide through the packing-box.

The casing and wall packings of the boiler are omitted from the drawings. Any of the common constructions of such parts as now applied to this class of boilers may be used in conjunction with my improvements.

While the various improvements in the sectional tubular boilers here described and hereinafter claimed, when combined, coöperate to produce a boiler having sterling practical qualities, it will be understood that one or more of the improved parts may be readily applied to boilers without the other improved parts and the advantages of their structural functions utilized in such other applications.

I claim as my invention—

1. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, and a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler.

2. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, and horizontal rectangular boxes or pipes secured to and connecting together the front and rear vertical boxes arranged to project within the plane of the inner faces of the vertical boxes and constituting the side walls of the boiler.

3. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, horizontal rectangular boxes or pipes secured to and connecting together the front and rear vertical boxes arranged to project within the plane of the inner faces of the vertical boxes and constituting the side walls of the boiler, and transverse horizontal tubes located above the longitudinal tubes and connected to and forming communications between the upper side boxes of the boiler.

4. In a sectional tubular boiler, the combination of vertical boxes or chambers, headers connected thereto and tubes between the headers, a furnace beneath the tubes, horizontal boxes secured to and forming communications between the front vertical boxes and constituting the upper and lower boundaries of the feed-opening of the furnace, and vertical boxes triangular in cross-section secured to and forming communications between the horizontal boxes, constituting the side boundaries of the feed-opening, and arranged so that the width of said opening inwardly increases.

5. In a sectional tubular boiler, the combination of vertical boxes or chambers located at the corners thereof, headers connected to the front vertical boxes, headers connected to the rear vertical boxes, a series of tubes longitudinally arranged and connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, and valve mechanisms arranged opposite the main or end openings of the headers and adapted to be seated therein, whereby any section of the boiler may be closed and cut out of the circulating system of the boiler.

6. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers located between them, nipples connecting together the vertical boxes and headers, the outer ends of said nipples being formed into valve-seats, tubes connecting together the headers in pairs, and valves attached to the vertical boxes at the sides of the boiler and adapted to be pressed in and seated on the ends of the said connecting-nipples, whereby any pair of headers and their connecting-tubes, constituting a section of the boiler, may be cut out of the circulating system of the boiler.

7. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers located between them, nipples connecting together the vertical boxes and headers, the outer ends of said nipples being formed into valve-seats, tubes connecting together the headers in pairs, hand-holes formed in the vertical boxes at the sides of the boiler opposite the openings of the horizontal headers, caps for closing said hand-holes and valves carried by the caps with their stems extending therethrough and adapted to be pressed into seats on the ends of the nipples connecting the vertical boxes and the headers, whereby any pair of headers and their connecting-tubes, constituting a section of the boiler, may be cut out of the circulating system of the boiler.

8. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers located between them, nipples connecting together the vertical boxes and headers, the outer ends of said nipples being formed into valve-seats, tubes connecting together the headers in pairs, hand-holes formed in the vertical boxes at the sides of the boiler opposite the openings of the horizontal headers, caps for closing said hand-holes having a central opening with valve-seats formed at the inner ends thereof, and double valves, the stems of which fit in the central openings of the caps, said valves being normally held with one of their parts seated against the caps and adapted to be pressed in to cause their other parts to be seated against the ends of the nipples connecting together the vertical boxes and the headers, whereby any pair of headers and their connecting-tubes, constituting a section of the boiler, may be cut out of the circulating system of the boiler.

9. In a valve for steam-boilers, the combination of the valve having a hollow stem internally screw-threaded, a cap with a packing-box through which the stem of the valve extends, a bridge-piece extending from the cap over the packing-box and a screw-spindle fitting in the hollow stem of the valve and having a bearing in the bridge-piece so as to rotate therein without longitudinal movement.

10. In a valve for steam-boilers, the combi-

nation of the valve having a hollow stem internally screw-threaded, a cap with a packing-box through which the stem of the valve extends, a bridge-piece extending from the cap over the packing-box, a screw-spindle fitting in the hollow stem of the valve and having a bearing in the bridge-piece, so as to rotate therein without longitudinal movement, a grooved guide on the gland of the packing-box, and a pin projecting from the stem of the valve and working in the grooved guide.

11. In a sectional tubular boiler comprising vertical boxes or chambers, transversely-arranged headers secured thereto, series of tubes secured to and connecting together the headers in pairs, the combination therewith of longitudinally-arranged horizontal drums, each drum being connected at each of its ends to and having free communication with the upper end of a vertical box only, and connecting-tubes between the drums at the water-level.

12. In a sectional tubular boiler comprising vertical boxes or chambers, transversely-arranged headers secured thereto, series of tubes secured to and connecting together the headers in pairs, the combination therewith of longitudinally-arranged horizontal drums, each drum being connected at each of its ends to and having free communication with the upper end of a vertical box only, and connecting-tubes between the drums at the water-level, and supports or saddles forming the connections between the drums and the vertical boxes said supports having sockets to fit the upper ends of the vertical boxes and formed with flanges to fit the under sides of the drums, the supports or saddles being secured to the vertical boxes and to the drums by means of rivets.

13. In a steam-boiler, the combination of vertical boxes or water-legs, a saddle or supporting-piece for each vertical box formed with a socket at its lower side to fit over the upper end thereof, and having a curvilinear flange at the upper side, and horizontal drums, each supported by two of the vertical boxes by resting at its ends on the curvilinear flanges of the saddles, the said saddles or supporting-pieces affording free communication between the vertical boxes and the drums and being rigidly connected to them by means of rivets.

14. In a sectional tubular boiler comprising vertical boxes or chambers, headers secured thereto, series of tubes secured to and connecting together the headers in pairs, horizontal drums supported by and connected to the vertical boxes, flanged elbows extending from the upper parts of the drums, a T-piece connected between the horizontal parts of the elbows, and perforated dry pipes extending in the horizontal parts of the elbows and having flanges clamped between the flanges of the elbows and the T connecting-piece.

15. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, horizontal rectangular boxes or pipes secured to and connecting together the front and rear vertical boxes arranged to project within the plane of the inner faces of the vertical boxes and constituting the side walls of the boiler, horizontal drums longitudinally arranged supported by and connected to the upper ends of the vertical boxes, and connecting-tubes between the drums at the water-level.

16. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, horizontal rectangular boxes or pipes secured to and connecting together the front and rear vertical boxes arranged to project within the plane of the inner faces of the vertical boxes and constituting the side walls of the boiler, horizontal drums longitudinally arranged supported by and connected to the upper ends of the vertical boxes, and connecting-tubes between the drums at the water-level, and supports or saddles forming the connections between the drums and the vertical boxes, having sockets to fit the upper ends of the vertical boxes by which they are secured thereto by rivets and formed with flanges to fit the under sides of the drums.

17. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, horizontal rectangular boxes or pipes secured to and connecting together the front and rear vertical boxes arranged to project within the

plane of the inner faces of the vertical boxes and constituting the side walls of the boiler, horizontal drums longitudinally arranged supported by and connected to the upper ends of the vertical boxes, connecting-tubes between the drums at the water-level, flanged elbows extending from the upper parts of the drums, a T-piece connected between the horizontal parts of the elbows, and perforated dry pipes extending in the horizontal parts of the elbows and having flanges clamped between the flanges of the elbows and the T connecting-piece.

18. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal, rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connected at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, a furnace beneath the tubes, horizontal boxes secured to and forming communications between the front vertical boxes and constituting the upper and lower boundaries of the feed-opening of the furnace, and vertical boxes triangular in cross-section secured to and forming communications between the horizontal boxes, constituting the side boundaries of the feed-opening, and arranged so that the width of said opening inwardly increases.

19. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal, rectangular headers connected to and securing together the front vertical boxes, horizontal rectangular headers connected to and securing together the rear vertical boxes, said headers being angularly set so that the inner faces of the front headers are opposite and parallel to the inner faces of the rear headers in lower planes, a series of tubes longitudinally and angularly arranged connecting at their ends to each opposite pair of headers, each series of tubes and their connected headers constituting a section of the boiler, a furnace beneath the tubes, horizontal boxes secured to and forming communications between the front vertical boxes and constituting the upper and lower boundaries of the feed-opening of the furnace, vertical boxes triangular in cross-section secured to and forming communications between the horizontal boxes, constituting the side boundaries of the feed-opening, and arranged so that the width of said opening inwardly increases, longitudinally-arranged horizontal drums, each connected at each of its ends to the upper end of one of the vertical boxes, and connecting-tubes between the drums at the water-level.

20. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers connected to the vertical boxes, tubes secured to and connecting together the horizontal headers in pairs, valves attached to the vertical boxes in positions opposite the openings of the horizontal headers, longitudinally-arranged horizontal drums each connected at each of its ends to the upper end of one of the vertical boxes, and connecting-tubes between the drums at the water-level.

21. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers connected to the vertical boxes, tubes secured to and connecting together the horizontal headers in pairs, valves attached to the vertical boxes in positions opposite the openings of the horizontal headers, a furnace beneath the tubes, horizontal boxes secured to and forming communications between the front vertical boxes and constituting the upper and lower boundaries of the feed-opening of the furnace, vertical boxes triangular in cross-section secured to and forming communications between the horizontal boxes, constituting the side boundaries of the feed-opening and arranged so that the width of said opening inwardly increases, longitudinally-arranged horizontal drums each connected at each of its ends to the upper end of one of the vertical boxes, and connecting-tubes between the drums at the water-level.

22. In a steam-boiler, the combination of front and rear vertical boxes or water-legs with their bottom supporting-faces reversely inclined, the water-tubes and main parts of the boiler being carried by the said vertical boxes, and base-pieces on which the vertical boxes rest correspondingly inclined.

23. In a sectional tubular boiler, the combination of vertical boxes or chambers, horizontal headers connected to the vertical boxes, tubes secured to and connecting together the horizontal headers in pairs, valves attached to the vertical boxes in positions opposite the openings of the horizontal headers, and pet-cocks or plugs fitted in the rear headers for drawing off the water from the sections of which said headers form parts.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 10th day of December, 1895.

JOHN J. CAIN.

Witnesses:
ALFRED SHEDLOCK,
ARTHUR C. BLATZ.