(No Model.) 3 Sheets—Sheet 1.

A. WORTHINGTON.

SECTIONAL STEAM BOILER.

No. 412,820. Patented Oct. 15, 1889.

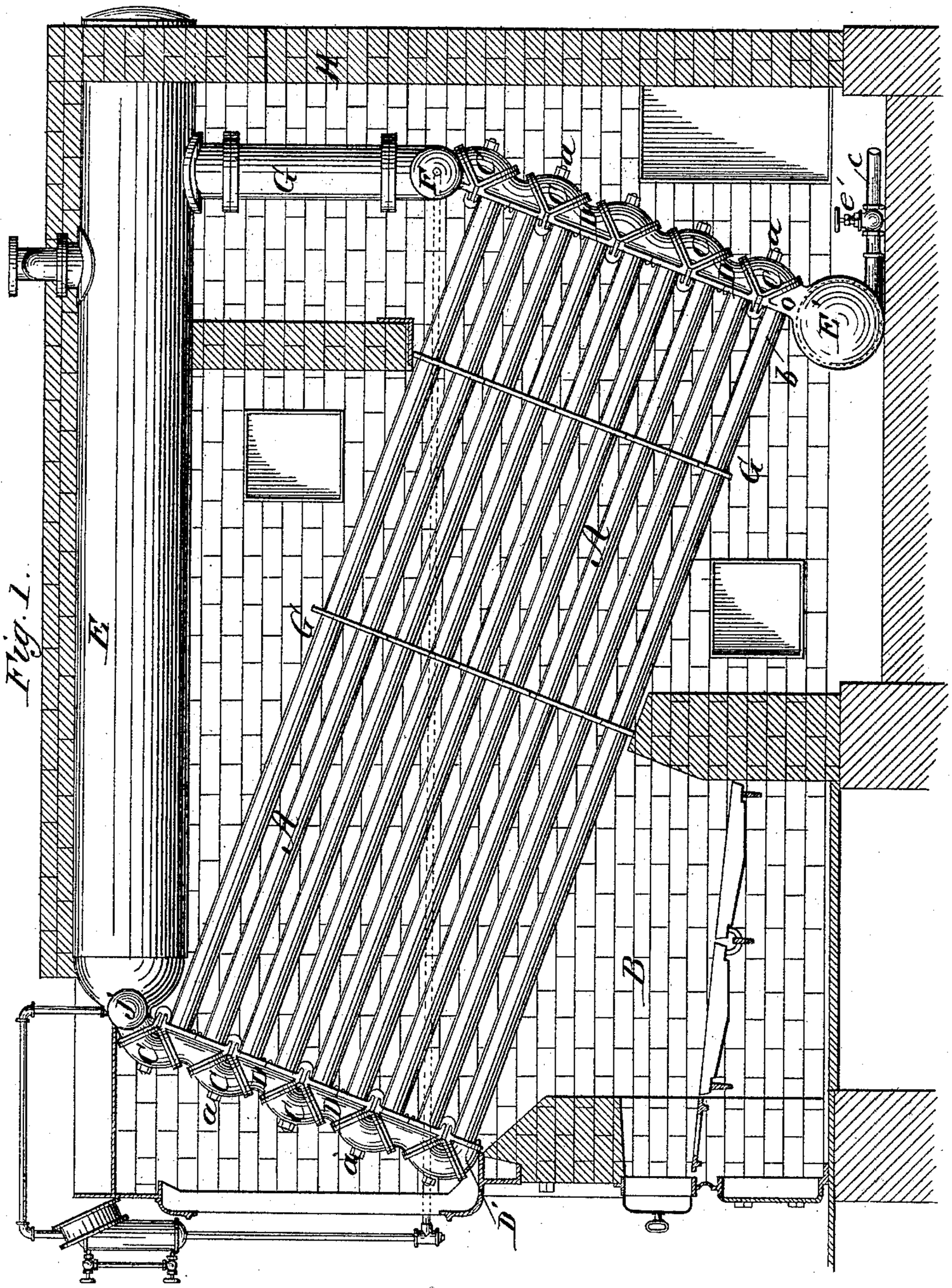

Fig. 1.

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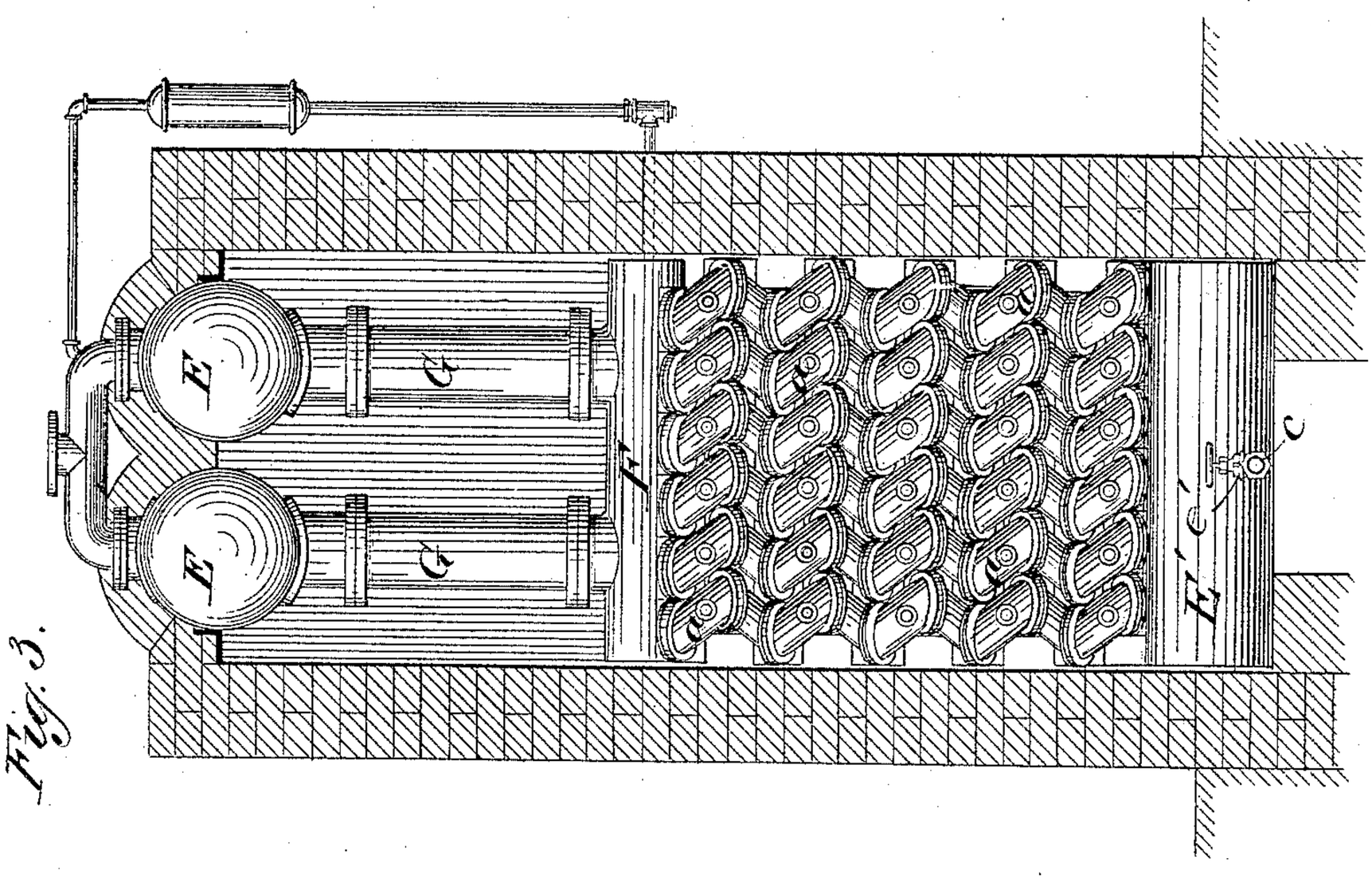

Fig. 3.

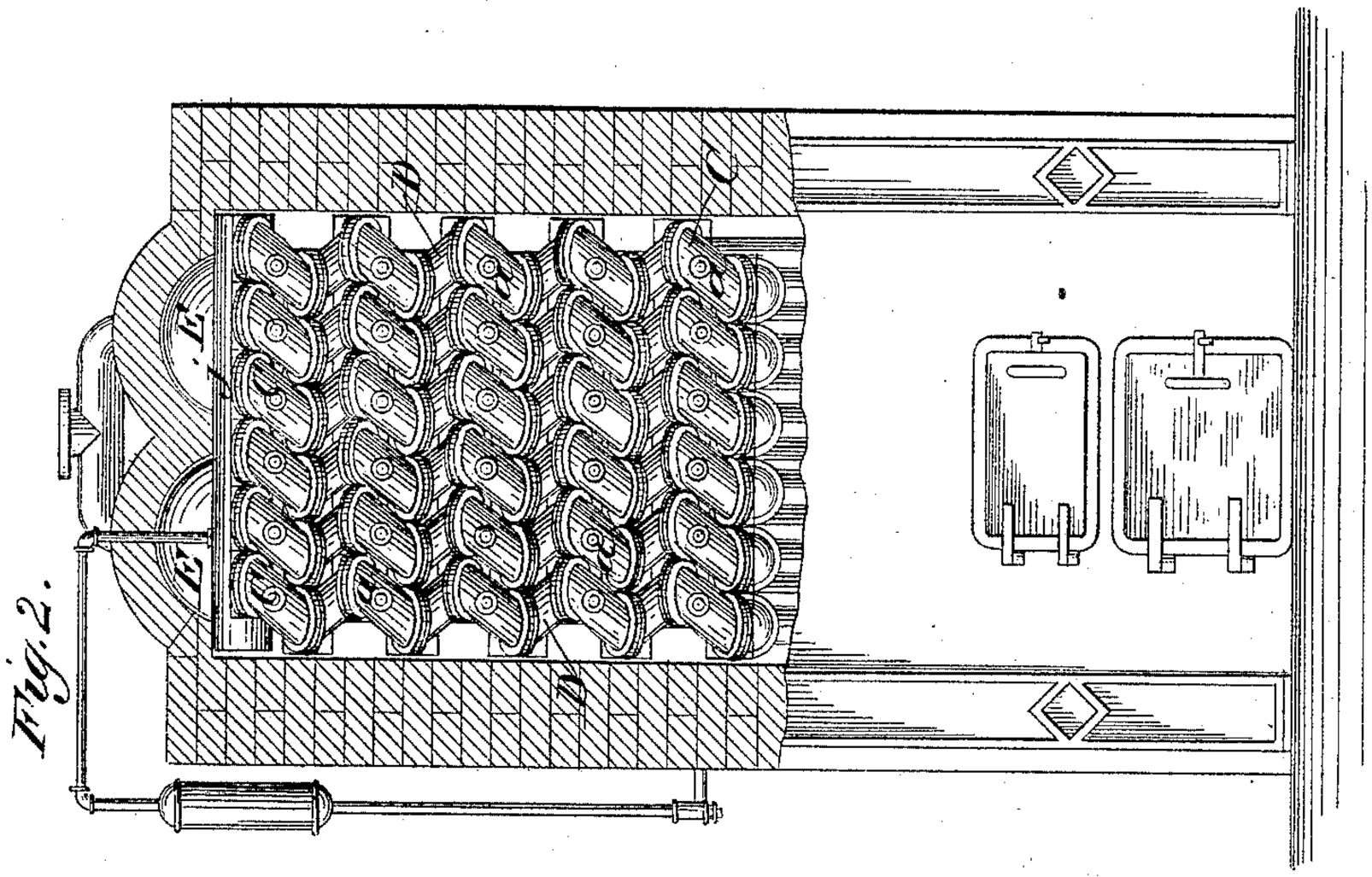

Fig. 2.

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Fig. 4.

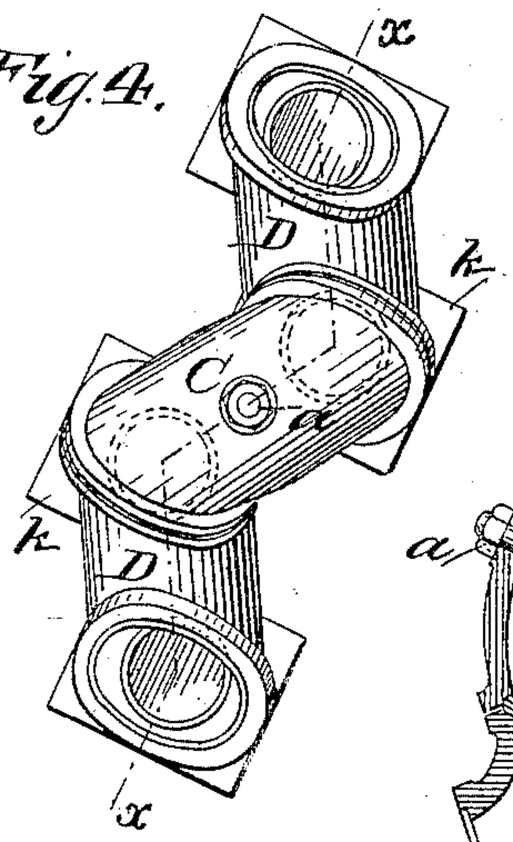


Fig. 5.

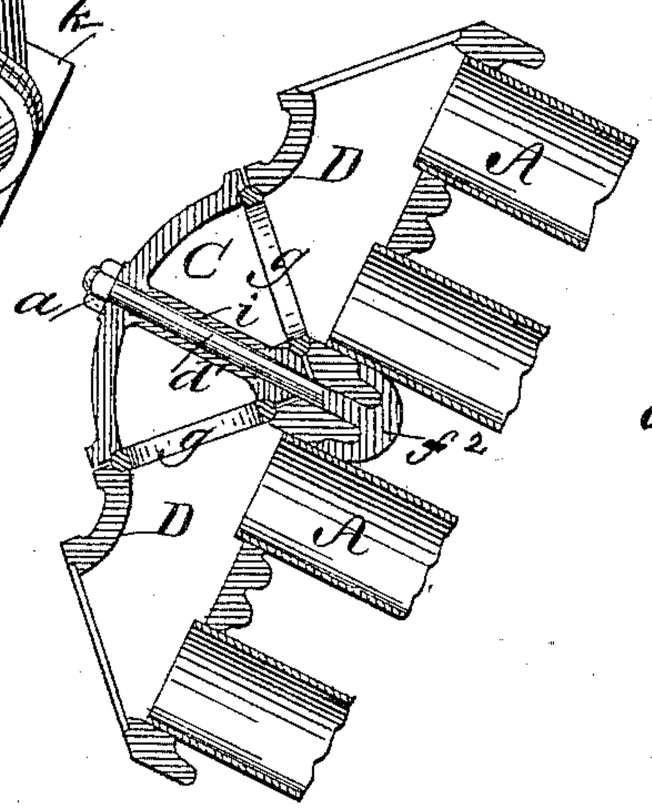


Fig. 6.

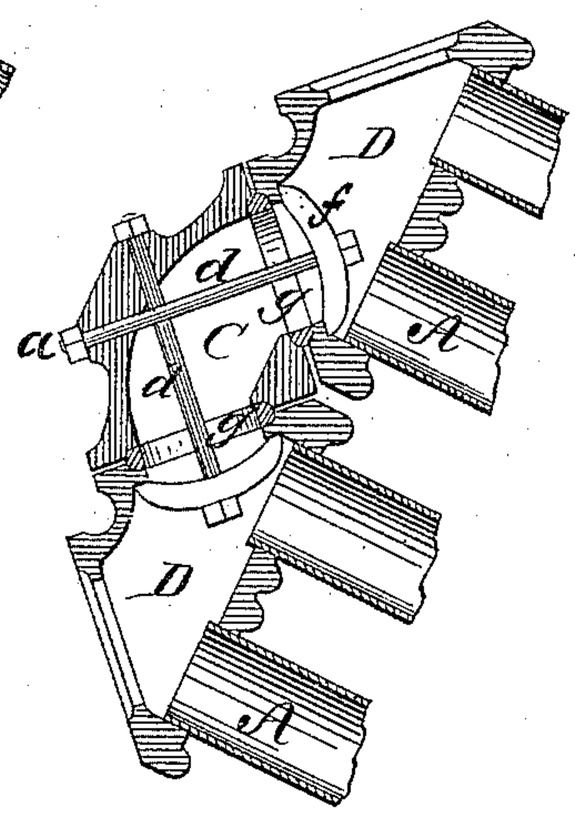


Fig. 8.

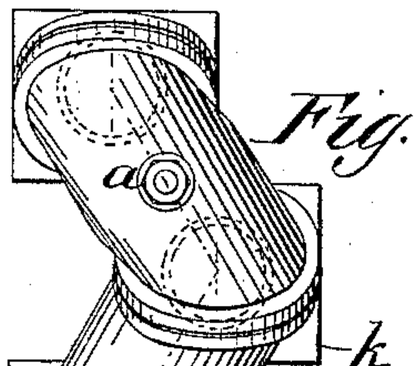


Fig. 7.

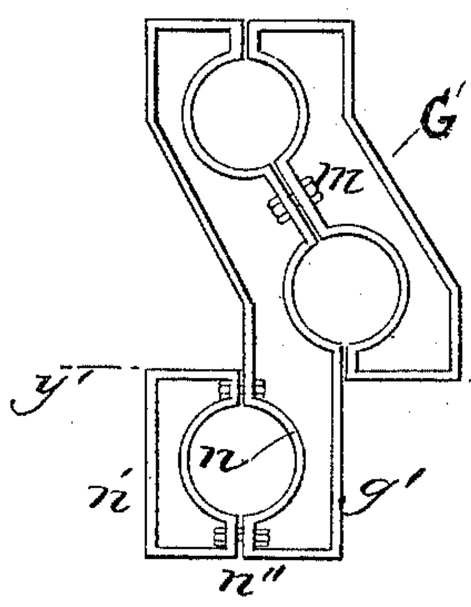
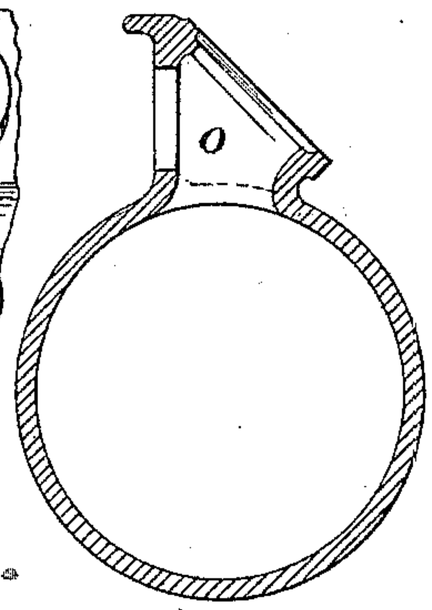


Fig. 9.



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AMASA WORTHINGTON, OF BROOKLYN, NEW YORK.

SECTIONAL STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 412,820, dated October 15, 1889.

Application filed September 13, 1888. Serial No. 285,290. (No model.)

To all whom it may concern:

Be it known that I, AMASA WORTHINGTON, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Sectional Steam-Boilers, of which the following is a specification.

This invention relates to that class of steam-generators in which the water is caused to circulate through tubes, in which the tubes are inclined to promote circulation, and in which the tubes are assembled in series that are staggered, as viewed in cross-section, with vertical relation to each other to promote the heating efficiency of the flame, hot products of combustion, &c., passing between them.

In order that others may understand my invention, I will first proceed to describe the same, and subsequently to point out its novel characteristics in the claims.

Referring to the accompanying drawings, forming a part of this specification, and in which similar letters of reference indicate corresponding parts throughout the several views, Figure 1 is a longitudinal sectional elevation of a water-tube boiler embodying the principal features of my invention; Fig. 2, a front elevation having the boiler-front partly removed; Fig. 3, a rear elevation having the rear brick wall wholly removed. Figs. 4, 5, and 6 are enlarged front and sectional detail views, respectively, of the sectional headers, as more fully hereinafter described. Fig. 7 is a detail view showing the construction of the bridge-blocks that secure the lower range of tubes; Fig. 8, a detail view of the mud-drum and its connection with the adjacent headers, and Fig. 9 a cross-section of a portion of Fig. 8 on the line *z z*.

A A A, Fig. 1, indicate the successive series of inclined tubes, their positions as would appear in cross-section being indicated by the position of the cap-nuts *a* in Figs. 2 and 3, which, as will hereinafter appear, are substantially coincident with the axes of the tubes. As viewed in cross-section, the tubes lie in successive horizontal series, the tubes of any one series being placed vertically opposite the spaces of the adjacent series above or beneath them, whereby the staggered relation of the tubes vertically is obtained in the manner common in water-tube boilers. The tubes are placed in the ordinary inclined position, highest at the front and lowest at the back, with the furnace B, of any usual or suitable general construction, underneath the front or elevated end, as shown in Fig. 1. The passage of the hot products of combustion takes place in the usual manner, circulating in an undulating course between the staggered tubes A, above and beneath the respective bridge-block partitions G′ G′, and thence finding its exit through the passage H to the chimney.

The adjacent ends of the tubes A are connected correspondingly at the front and rear ends of the structure by means of the sectional headers C D, and the sections or units D of the said headers incline universally in a common direction at both ends of the structure to receive and connect the ends of adjacent tubes in pairs. The ends of the tubes are expanded or otherwise rigidly secured to the sections D of the headers, and the pairs of tubes thus independently connected at both ends by said sections D therefore constitute separable units of the structure.

The adjacent members of different pairs of tubes, which pairs are united by the sections D, are brought into communication with one another by means of the connecting-bends C, that connect the adjacent ends of the said sections D at points opposite the entrance thereto of the said tubes. The bends C incline universally in an opposite direction from that of the sections D, whereby the pairs of tubes held by the said sections D are connected in a single series in vertical order of succession throughout the height of the structure—that is to say, one tube from each horizontal cross-series is placed in communication with an individual inlet or outlet of the headers at the top or bottom thereof.

j j are manifolds or connecting-boxes built upon or forming a part of the front heads of the steam-drums E, which latter, as at present illustrated, are employed two in number, but may obviously be employed singly, or in any number other than two, in connection with the sectional headers, each drum being provided with a separate manifold *j*; or the drums may be connected in series to a com-

mon transverse manifold. To these manifolds or connecting-boxes *j* are connected by means of suitable clamping-bolts the uppermost connecting bends or sections C of the sectional vertical headers severally.

To the rear and undermost portion or water-space of the steam-drums E are connected the downtake-pipes G, terminating at their lower extremities with a manifold F. To this manifold F the uppermost connecting bends or sections C of the sectional vertical headers at the rear ends of the tubes A are connected severally by bolts in a similar manner to that employed in connection with the manifolds *j*.

E′ is the mud-drum, that is connected intermediately between the lowermost series of connecting-bends C of the sectional headers severally at the back of the boiler and the corresponding ends *b* of the lowermost horizontal cross-series of inclined tubes A.

The drum E′ has an upwardly-extended chambered portion or series of chambered portions *o*, adapted to receive the connections of the tubes A and the bends C. The chambered portions *o* are made of a form to correspond with the dimensions and location of the sections D of the headers, that rest with their flanges *k* upon the flange or ridge *p* of the mud-drum, the latter feature appearing more clearly in Fig. 8, and the opposite or forward ends of the lower series of water-tubes are received by semi-sections D′, that correspond in their position longitudinally of the tubes with that of the said chambered portions *o* of the mud-drum.

The circulation of the water when expanded by heat from the furnace occurs forward and upward through the inclined tubes A, circulating in each vertical series assigned to the respective sectional headers simultaneously and independently; passing upward through the front system of headers in an uninterrupted vertical course toward the manifolds *j*. Thence after passage through the steam-drum E the circulation follows the downtake-pipes G, and the water is distributed again to the series of vertical sectional headers at the rear, through which the passage occurs in an uninterrupted downward course. The enlarged volume of the sections D reduces the velocity of the water while passing through them, and as portions of the currents are delivered upward from the rear headers through the inclined tubes A leading from them the retained portions of water permit the gravitation of impurities held in mechanical suspension therein and precipitate them downward from one section to another until the chambered portion of the mud-drum is reached, when, owing to the greatly-increased volume therein, the separation of sediment is rendered complete, settling to the bottom of the drum, and being removed from time to time in the ordinary manner—as, for example, through an outlet-pipe *e*, having a suitable blow-off cock *e′*.

It is of course essential that as little obstruction as possible should be offered to the passage through the sections and return-bends of the headers. To insure this the parts are to be constructed in detail, as illustrated in Figs. 4 and 5, or 6, in which Fig. 4 is a front view of two of the headers D, joined by a bend C; Fig. 5, a sectional view taken in a direction longitudinal with the tubes and in the line *x x* of Fig. 4, and Fig. 6 a similar view of a modified construction of the clamping-bolts. The open ends of the connecting-bends C are clamped upon the adjacent openings, by which communication is established between them and the interior of the sections D at points opposite the water-tubes by the bolts *d′*, Figs. 4 and 5, which pass through the crowns of said bends C, and have cap-nuts *a*, that seat pressure-tight upon the adjacent surfaces of said crowns.

The seating surfaces or joints between the sections D of the headers and the connecting-bends C are placed at an angle, as shown in Figs. 5 and 6, and the inclined sides of each connecting-bend C coincide with the inclined ends of the contiguous shells D, whereby the said joints are brought into position to form a direct water-course, reducing friction incident to rapid circulation. The openings that are clamped together are packed with suitable gaskets or with metal packing-rings *g*, such as will render the joints free from leakage.

In order to clamp the beveled joints in a direction parallel with the axes of the openings thereof, I may employ independent bolts *d*, as illustrated in Fig. 6, said bolts being coincident with the axes of the openings through which they extend, and being operated independently to clamp the connecting-bends upon their oppositely-beveled seats, the crabs *f*, through which the bolts are passed, catching under the openings of the sections D. I prefer, however, to employ the construction illustrated by Fig. 5, in which the single bolt *d′* is utilized to perform the clamping of the joints in a manner equivalent to that aforesaid. The bolt *d′* passes through a hollow core, as *i*, integral with the connecting-bend C, and it terminates with an anchor-shaped head f^2, which presents diverging inclined faces, that engage with corresponding converging inclined faces, projecting upon the adjacent exterior margins of the separate sections D, between which the bolt *d′* extends. The clamping of the nut *a* will thereby draw in a direction axial to the bolt, and simultaneously draw the adjacent sections D together in a direction at right angles to the axis of the bolt, producing compression in lines corresponding with the axes of the oppositely-inclined openings composing the joints.

The sections D of the headers are provided with squared flanges *k*, by means of which they are built upon one another and the draft-passages separated from the interior chambers at the ends of the structure. The margins of the squared flanges *k* are constructed

to stand at an angle to the lines of inclination of the sections D, whereby the same are sustained at the desired position of inclination.

In Fig. 7 is represented the means by which the lowermost tubes, which are the most exposed to the fire, are suspended at or near their centers from those above, which are less exposed to the heat, and consequently less liable to flexure. The bridge-block G′, as concerns those parts above the dotted line *y′ y′*, is of the ordinary construction—that is to say, composed of two coincident flanged plates, the inner sides of which are formed with coincident recesses or semicircular cavities, which, when the parts are clamped in position about tubes A, extending through each of the cavities, attach the bridge-blocks to said tubes, the two parts being held together by a bolt and nut *m*, easily inserted through the open side of the device. I add to the parts just referred to and illustrated in that portion of Fig. 7 above the dotted line *y′ y′* a hanger *g′*, recessed at *n*, and provided with a cap *n′*, bolted thereto, as shown at *n″*, this hanger being constructed to receive and sustain a lower tube passed through the socket or bearing provided by the coincident halves of the cavity *n*, the part above the dotted line *y′ y′* being attached, say, to the second and third from the bottom of the tubes A. The said lower tube is thus suspended and firmly held from above, each of the tubes of the bottom horizontal cross-series being likewise provided for throughout the width of the boiler.

By the practice heretofore a prolonged and indirect course of the flow of water occurs between the period of its exposure to maximum heat within the inclined tubes A and the period at which the steam is separated within the steam-drum, involving a proportionate loss of efficiency. By the herein-described direct water-course connection of the headers the flowage is substantially in a direct and uninterrupted line from the ends of the inclined tubes to the steam-drum, admitting of an increased velocity of circulation.

I therefore claim as my invention—

1. The herein-described sectional header, adapted to connect staggered tubes of a water-tube boiler in a single vertical series, as described, said header consisting of a series of inclined sections or units that receive the tubes, and a series of oppositely-inclined connecting-bends that connect the adjacent ends of said sections or units at points opposite the entrance thereto of the said tubes, said inclined sections and oppositely-inclined connecting-bends being united by seating surfaces or joints that lie in planes at the described opposite angles to the axes of the boiler-tubes connected to said sections, whereby a substantially straight-way vertical water-course is obtained.

2. In a sectional header adapted to connect staggered boiler-tubes, the combination, with the series of inclined sections thereof and oppositely-inclined connecting-bends that are united to said sections by seating surfaces or joints at angles to each other, as described, of clamping-bolts extending through the crowns of said connecting-bends to and between adjacent portions of said sections provided with lugs, said bolts having anchor-shaped heads that act upon said lugs with acting-surfaces that are convergent in the direction of draft of said bolts, whereby the contraction of the said seating-surfaces is effected in directions parallel with the axes of the openings thereof.

3. The combination, with the inclined water-tubes of a water-tube boiler and the vertical headers connecting the ends thereof, of a mud-drum interposed and directly connected between the lower ends of the bottom series of said inclined water-tubes and the lower ends of their adjacent headers.

4. The herein-described mud-drum, having a chambered upper portion or series of chambered portions adapted to receive and intercept the ends of the bottom series of inclined water-tubes of a water-tube boiler and the terminal openings of an adjacent series of headers, through which water-circulation is delivered to bottom series of said tubes, said chambered upper portion or portions of the drum opening vertically to the lower or main portion of the drum to permit the gravitation therein of the heavier water impurities.

5. In a water-tube steam-boiler, the combination, with the inclined water-tubes, the sectional headers having sections adapted to connect the ends of said tubes in pairs, and the connecting-bends adapted to connect said sections in vertical series, of a mud-drum having a chamber or series of chambers in its upper portion adapted to connect with a terminal series of connecting-bends of sectional headers at the rear of the boiler, a terminal series of semi-sections of said sectional headers at the front of the boiler, located opposite said drum-chambers, and a bottom series of inclined water-tubes connecting between the drum-chambers and the corresponding series of semi-sections adapted to effect a portion of the circulation through the drum.

6. In a water-tube boiler, the sectional bridge-block, as G′, composed of half-sections that embrace the water-tubes by pairs, one section whereof, as *g′*, is downwardly elongated to form a hanger that is adapted, as by a cap *n′*, to embrace a third tube and to retain the same with reference to the adjacent tubes above, as set forth.

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