

No. 711,860.

Patented Oct. 21, 1902.

W. HOPKINS, Dec'd.

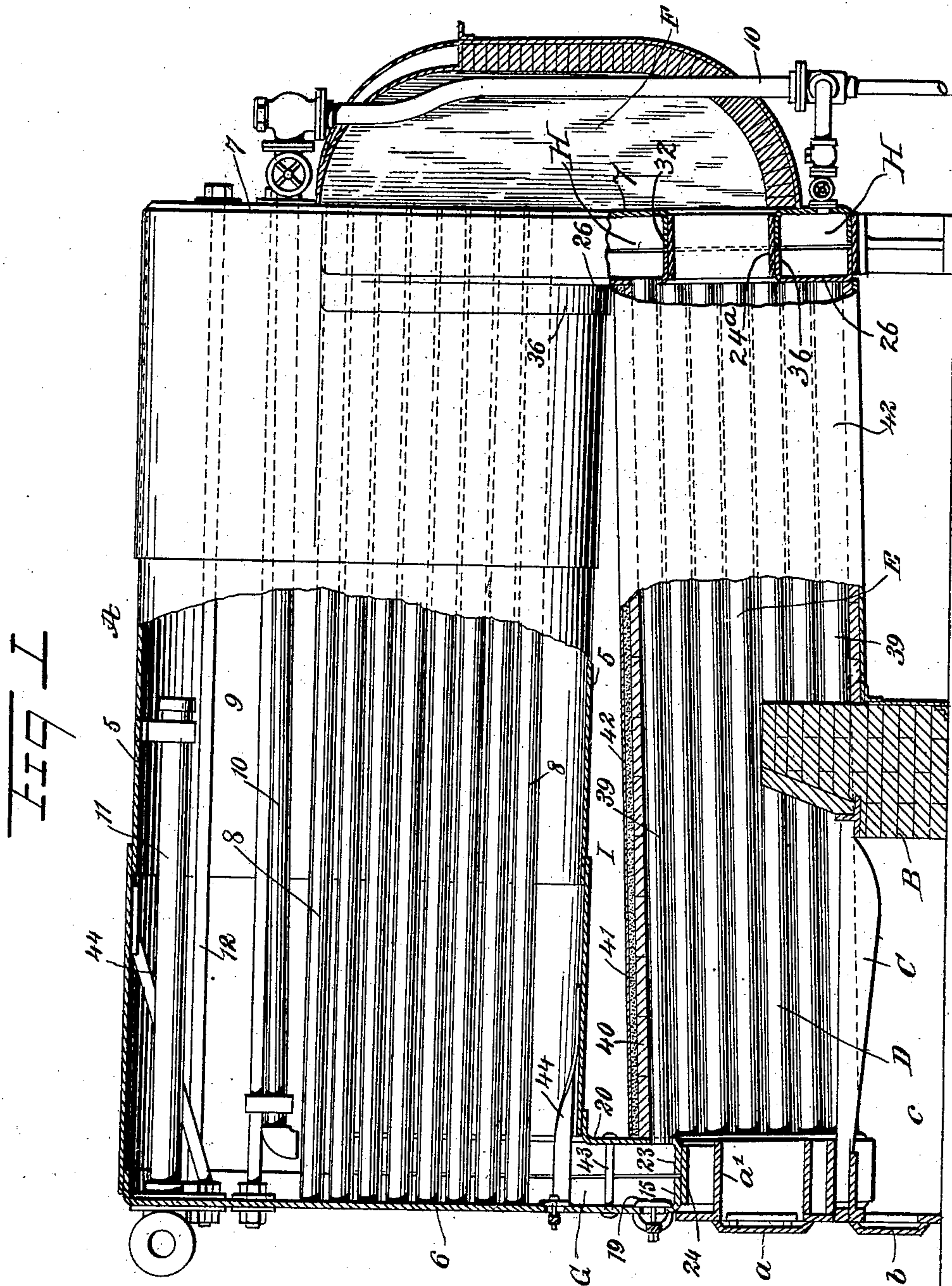
J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

(No Model.)

6 Sheets—Sheet 1.



WITNESSES:

H. Walker

H. B. Burchard

INVENTOR

Jeanne Hopkins

Executrix of the Estate of William Hopkins
Deceased

BY

M. M. M.

ATTORNEYS.

No. 711,860.

Patented Oct. 21, 1902.

W. HOPKINS, Dec'd.

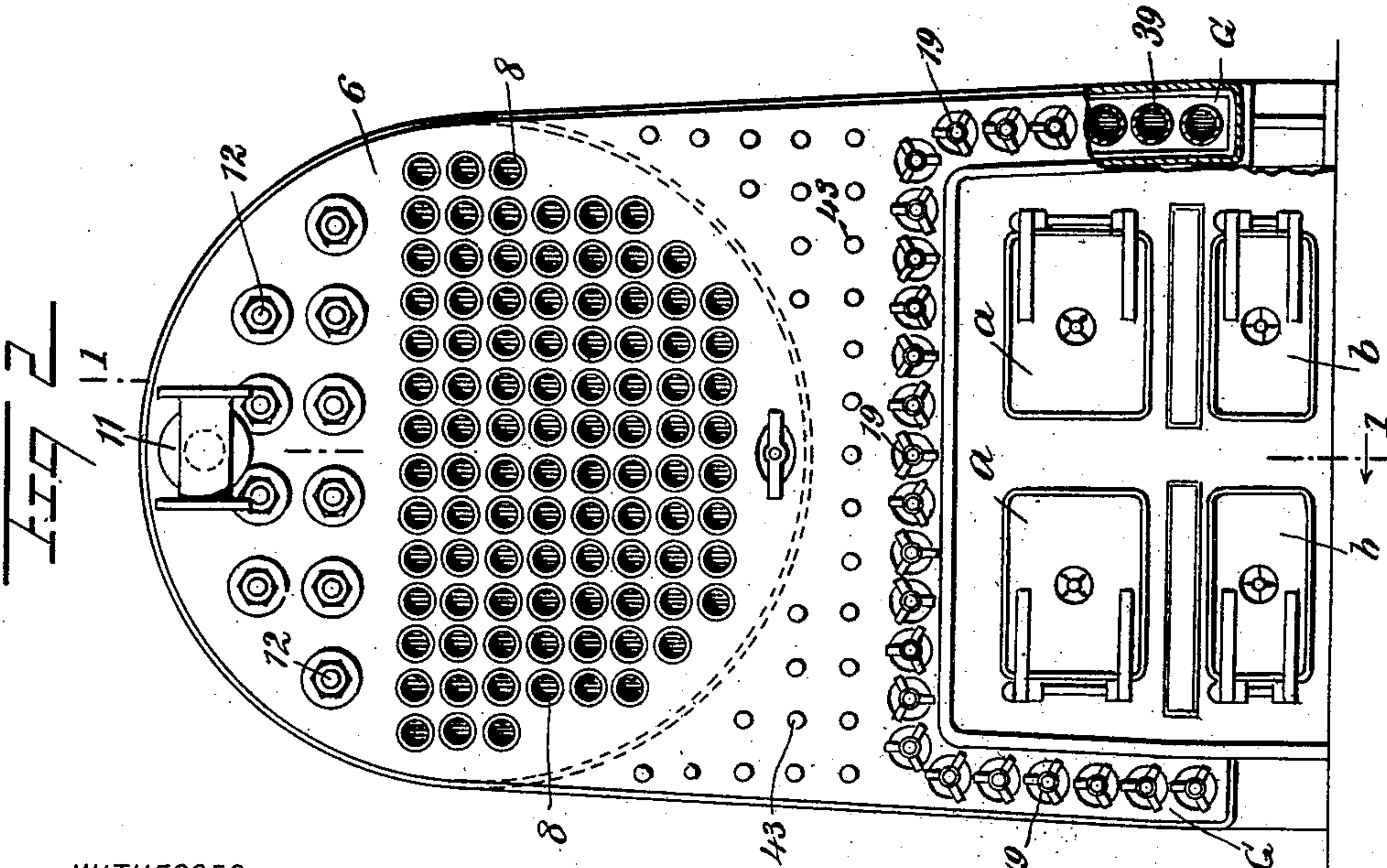
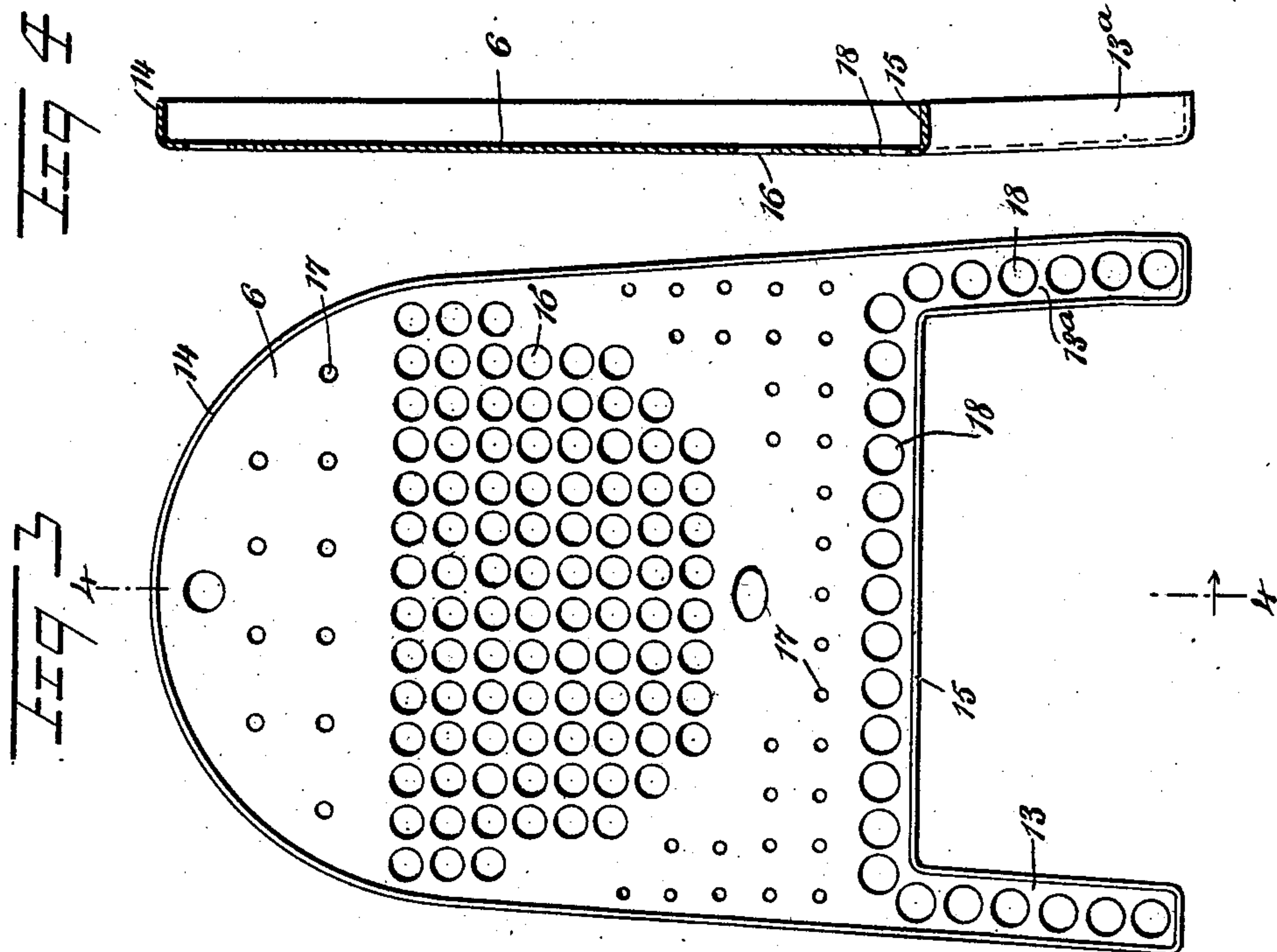
J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

(No Model.)

6 Sheets—Sheet 2.



WITNESSES:

H. Walker
H. Berchard

INVENTOR
Jeanne Hopkins
Executrix of the Estate of William Hopkins
Deceased
BY
Mum
ATTORNEY

W. HOPKINS, Dec'd.

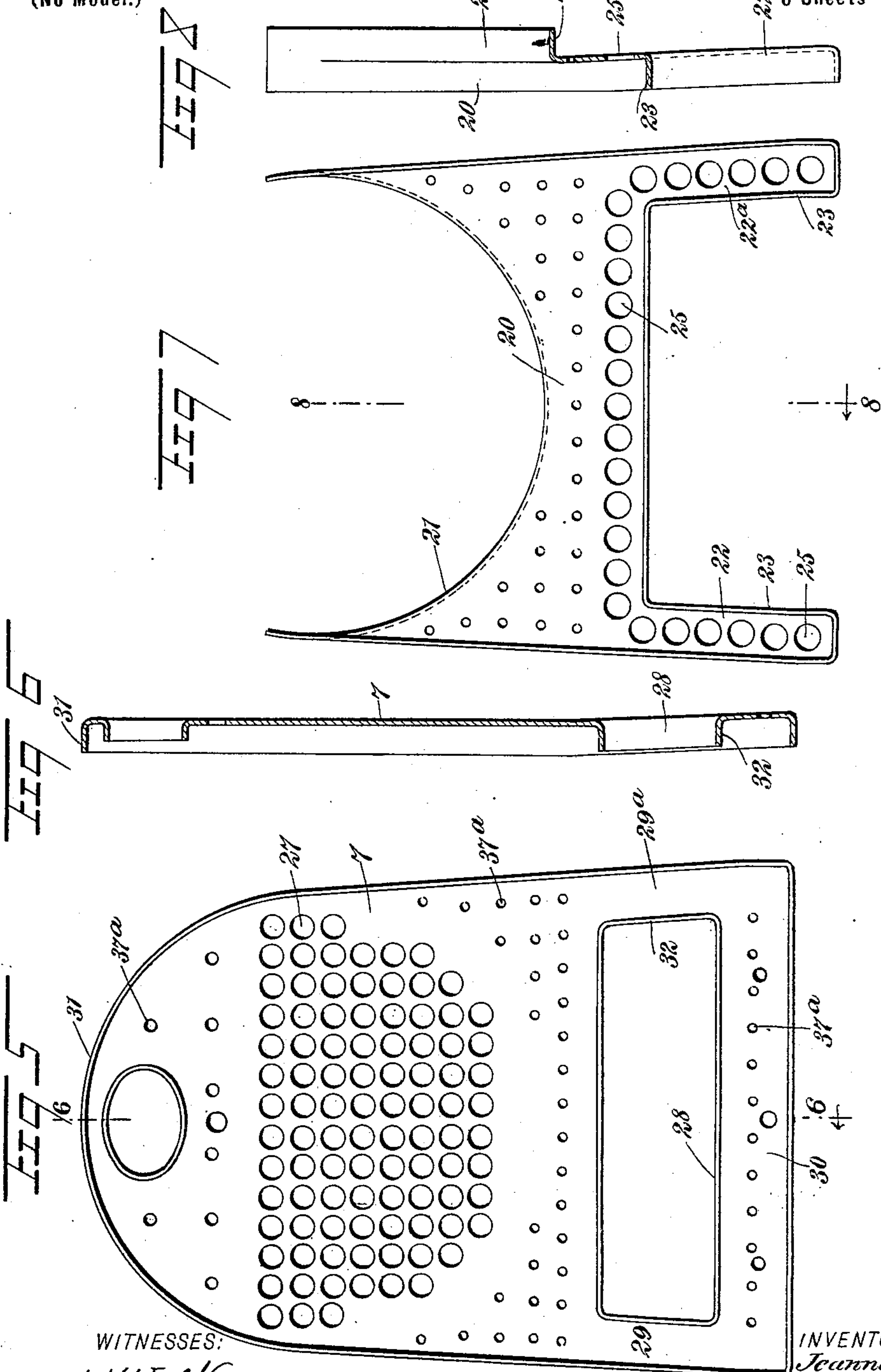
J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

6 Sheets—Sheet 3.

(No Model.)



WITNESSES:

H. Walker

H. J. Bouchard

INVENTOR

Jeanne Hopkins
Executrix of the Estate of William Hopkins
Deceased.

BY

Munn
ATTORNEYS.

No. 711,860.

Patented Oct. 21, 1902.

W. HOPKINS, Dec'd.

J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

(No Model.)

6 Sheets—Sheet 4.

Fig 9

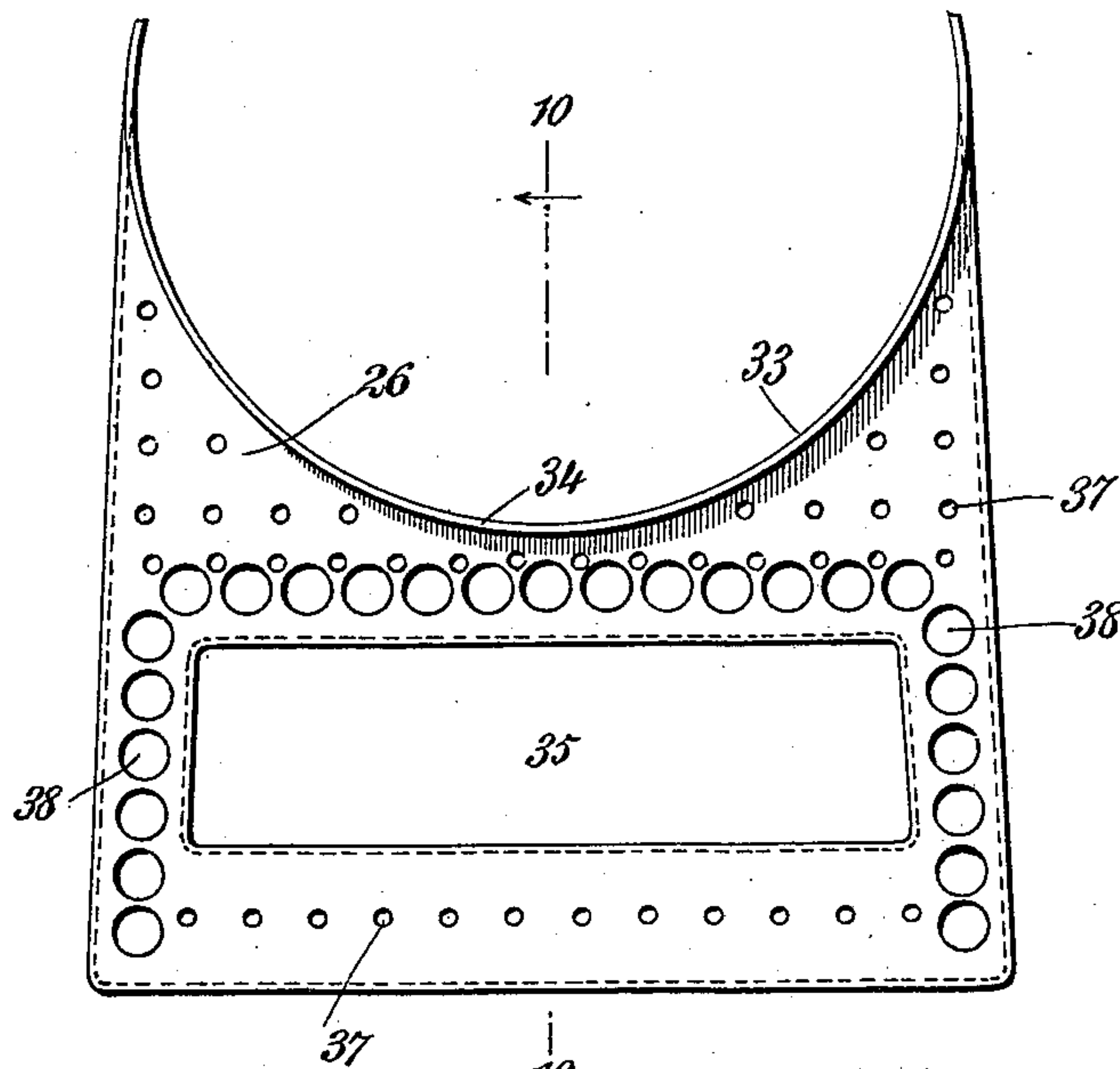
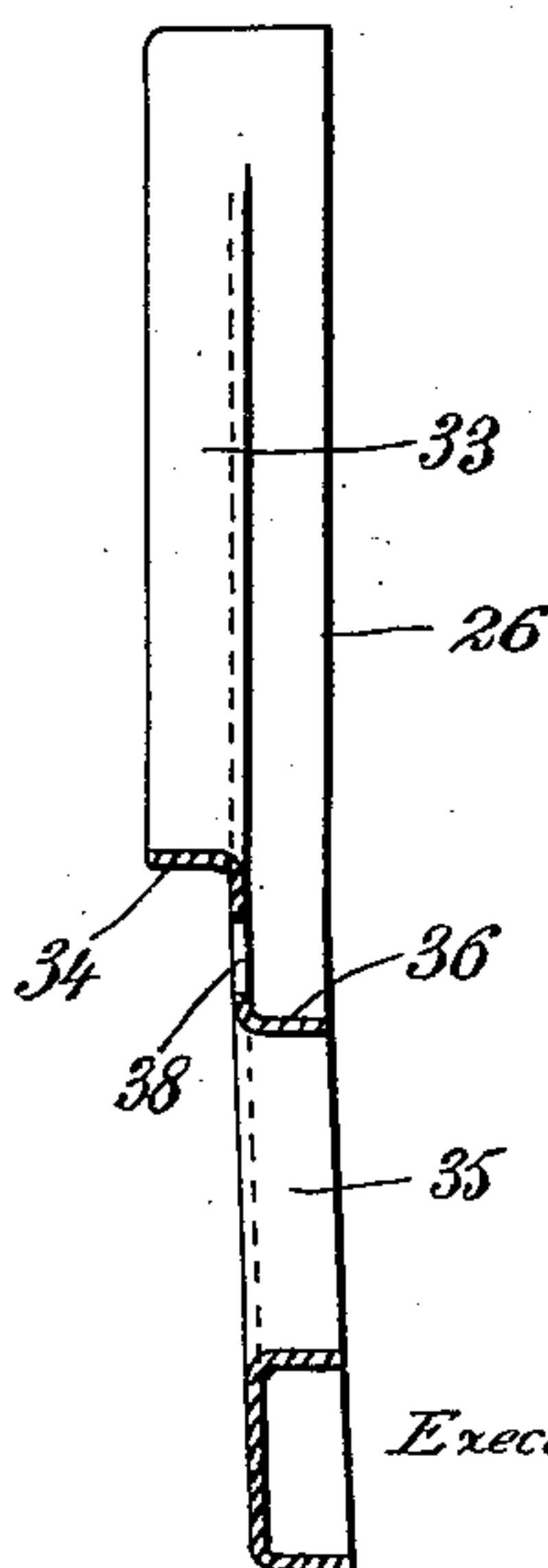


Fig 10



WITNESSES:

H. Walker

H. J. Benham

INVENTOR

Jeanne Hopkins

Executrix of the Estate of William Hopkins

BY

Murray
ATTORNEYS.

No. 711,860.

Patented Oct. 21, 1902.

W. HOPKINS, Dec'd.

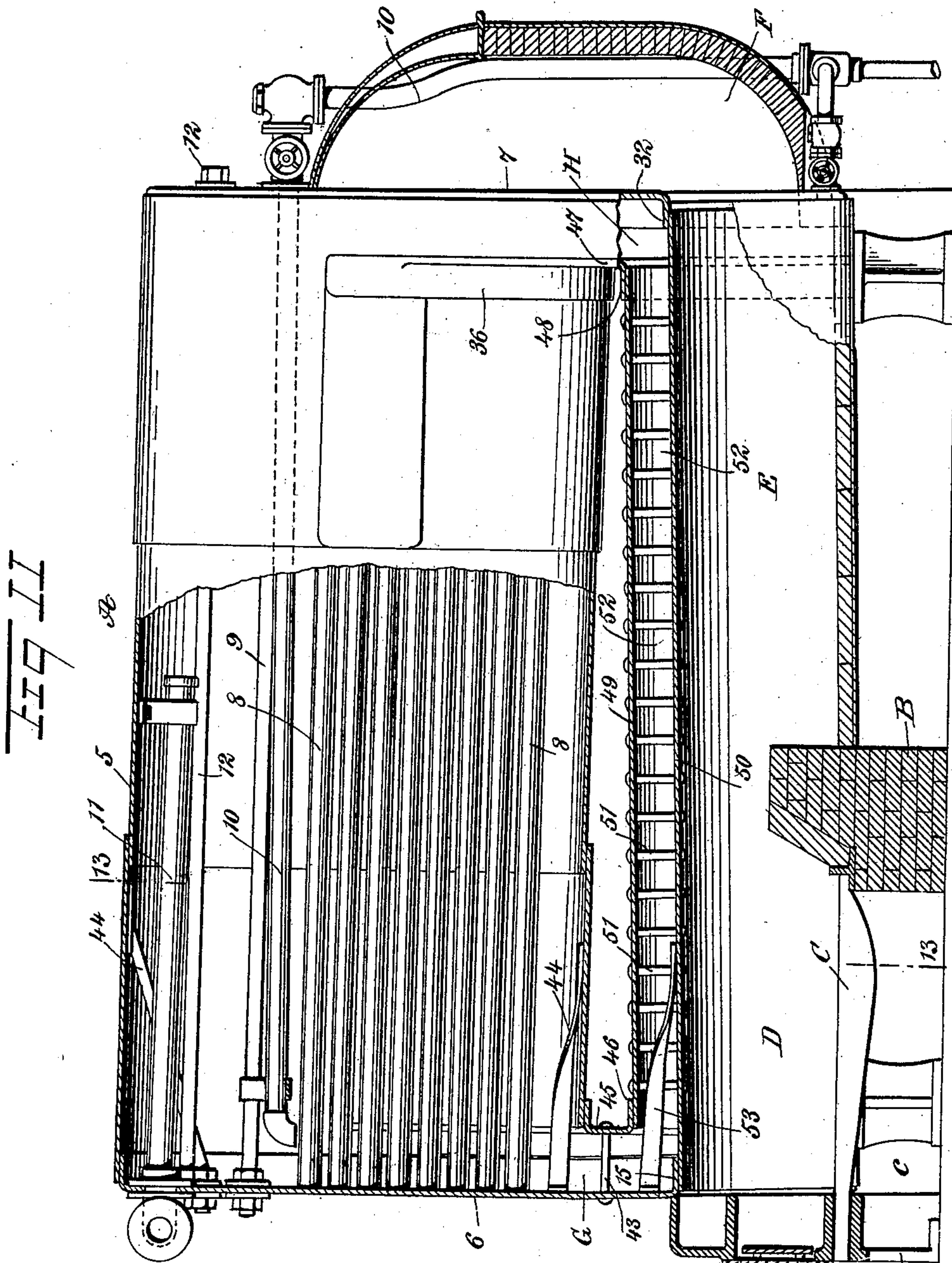
J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

(No Model.)

6 Sheets—Sheet 5.



WITNESSES:

H. W. Walker

N. J. Berchard

INVENTOR

Jeanne Hopkins

Executrix of the Estate of William Hopkins

BY

Thurs

ATTORNEYS

No. 711,860.

Patented Oct. 21, 1902.

W. HOPKINS, Dec'd.

J. HOPKINS, Executrix.

STEAM BOILER.

(Application filed May 3, 1902.)

(No Model.)

6 Sheets—Sheet 6.

Fig 13

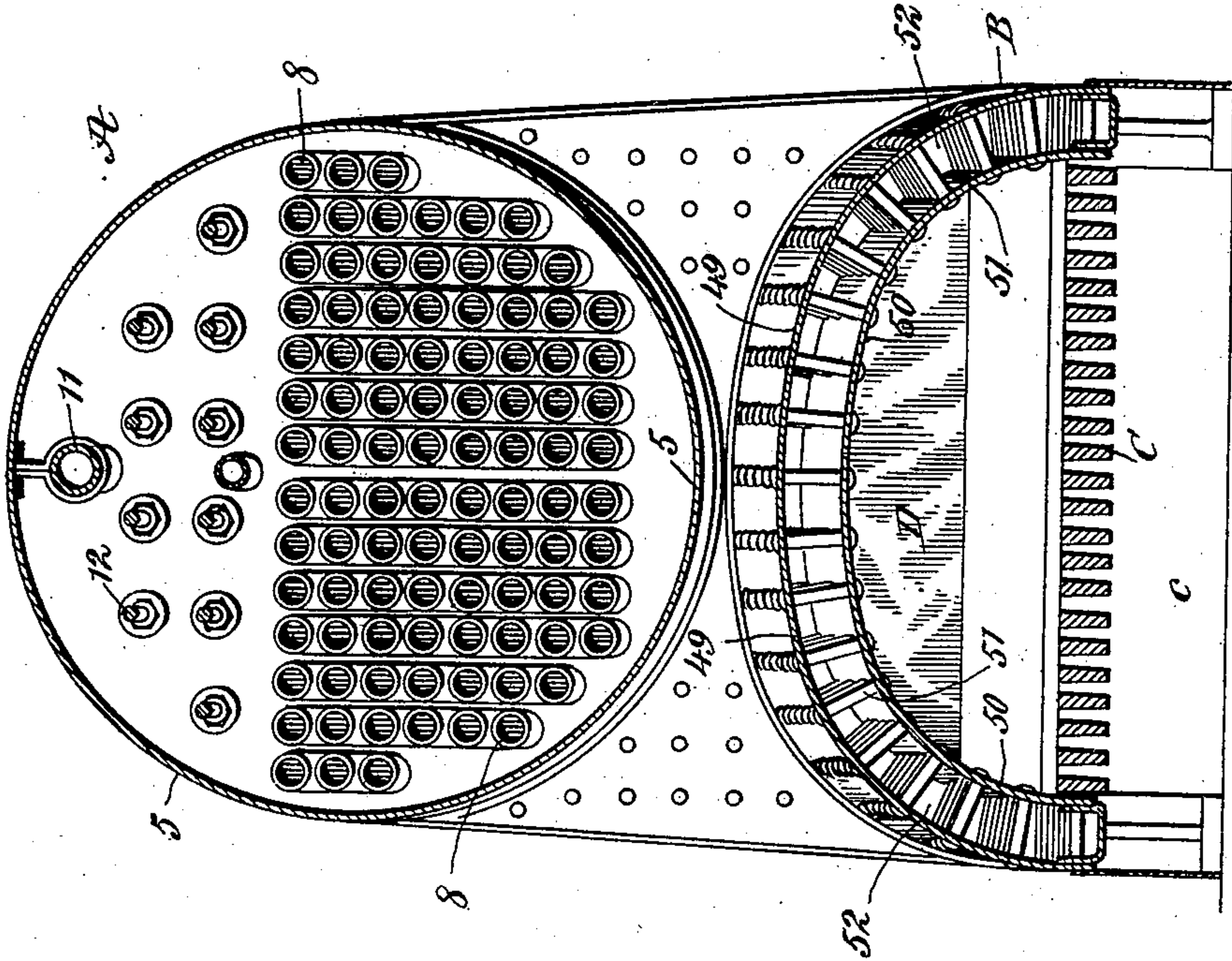
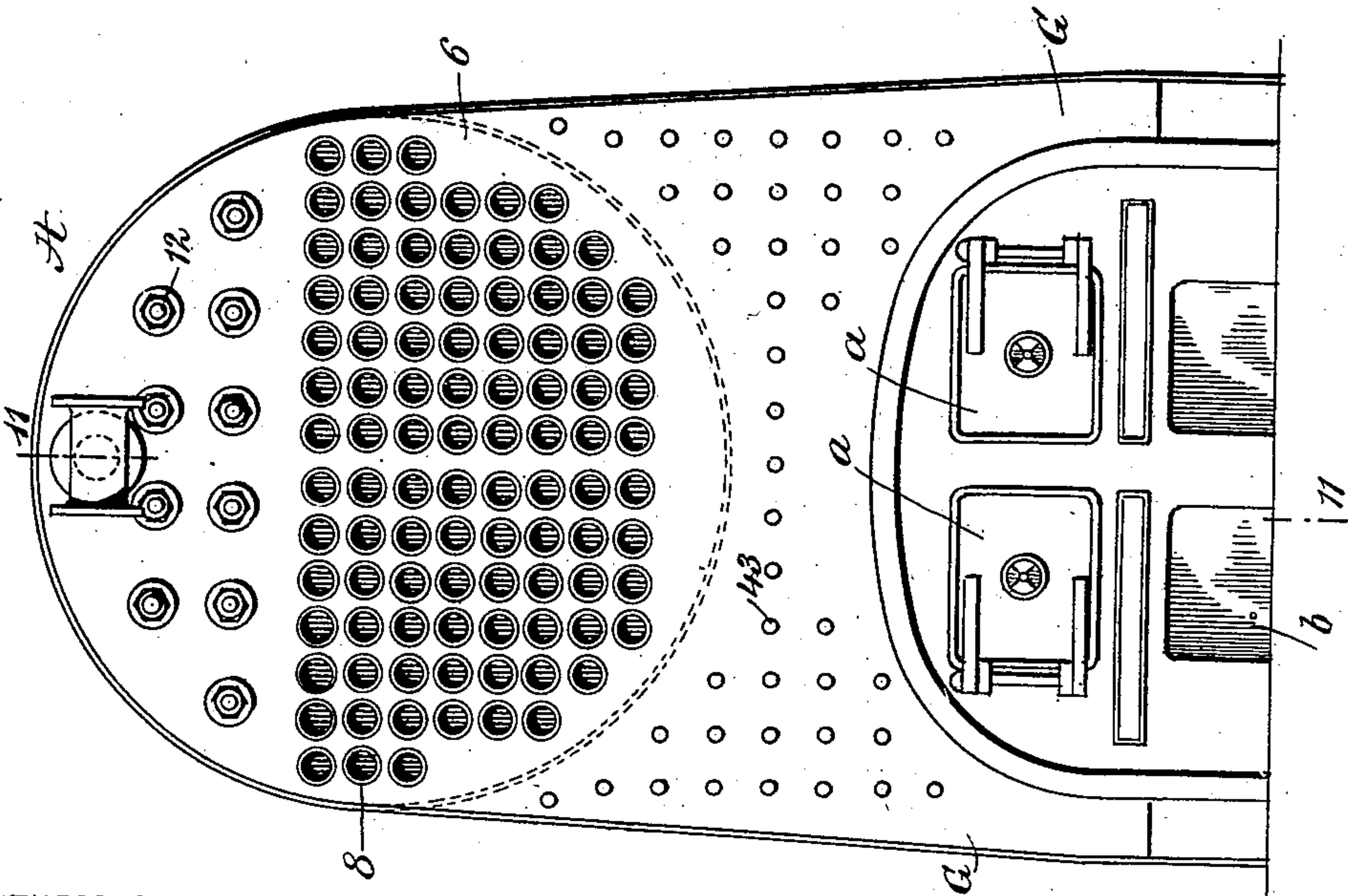


Fig 12



WITNESSES:

W. Walker

H. J. Berchard

INVENTOR

Jeanne Hopkins

Executrix of the Estate of William Hopkins

BY

Deceased

Munn

ATTORNEYS.

UNITED STATES PATENT OFFICE.

JEANNE HOPKINS, OF DUBUQUE, IOWA, EXECUTRIX OF WILLIAM HOPKINS,
DECEASED, ASSIGNOR TO IOWA IRON WORKS COMPANY, OF DUBUQUE,
IOWA.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 711,860, dated October 21, 1902.

Application filed May 3, 1902. Serial No. 105,784. (No model.)

To all whom it may concern:

Be it known that I, JEANNE HOPKINS, a citizen of the United States, and a resident of Dubuque, in the county of Dubuque and State of Iowa, executrix of the estate of WILLIAM HOPKINS, deceased, (late a citizen of the United States, and a resident of Dubuque, in the county of Dubuque and State of Iowa, as by reference to the duly-certified copy of letters testamentary hereto annexed will more fully appear,) who did in his lifetime invent certain new and useful Improvements in Steam-Boilers, do hereby declare the following to be a full, clear, and exact description of said invention.

This invention relates to improvements in steam-boilers which may be embodied in that type commonly known as "marine" boilers; but it is to be understood that the improvements can also be used in many other kinds of boilers.

The object of the present invention is to combine water-circulating devices with a tubular boiler in such a manner as to attain rapid circulation of the water through practically all parts of the structure, an almost perfect combustion of the fuel and the resulting gaseous products of combustion, and rapid generation of steam.

In devising the present construction the natural laws of the upward tendency of heat and the downward movement of cold were borne in mind, and the improved boiler about to be described makes provision for directing the heat and products of combustion in an upward direction and in a path longitudinally of the structure, so as to utilize the heat to the best advantage, and at the same time the cold or partially-heated water is allowed to circulate in a downward direction at one part of the boiler, then to move lengthwise of the boiler and in the path of the hottest part of the heat and flame, and then in an upward and backward direction, thus bringing thin layers or strata of water in the path of the circulating products of combustion, so as to quickly heat the water and generate steam.

The tubular element or member of the boiler is equipped with fire-tubes, and it is arranged in such relation to the grate-chamber and the

longitudinal boiler-flue that the shell of said tubular member is protected or isolated from the direct application or influence of the heat. This tubular member is operatively connected with water legs or boxes, which are disposed at the opposite ends of the grate-chamber and the boiler-flue, and these water legs or boxes are joined by an intermediate water connection which arches the grate-chamber and the longitudinal flue, so as to afford the desired protection to the shell of the tubular member and to allow the desired circulation of the water in a thin layer or stratum and lengthwise of the flue, the circulation of the water through this part of the boiler being facilitated by its rapid heating and the water serving to carry with it any sediment. The sediment cannot become deposited in the circulating-water channels of the boiler adjacent to the longitudinal flue, because the water carries the sediment with it; but as the water contained in the tubular member is heated to the proper point and does not circulate so rapidly as in the parts adjacent to the flue the sediment will accumulate in the tubular member, from whence it can be easily removed.

Another advantage of the improved construction is that the distribution of heat and circulation of water is uniformly secured, so as to overcome any undue contraction or expansion of the several parts.

It is well known that the parts of a boiler exposed both to accumulation of sediment and the direct application of heat are liable to deteriorate or burn out quite early in the service of the structure; but in the present invention these conditions do not obtain, because the sediment cannot collect in the parts exposed to the direct application of heat.

The invention further consists of a steam-boiler embodying novel features of 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 steam-boiler embodying the present invention, the plane of the section being indicated by the dotted line 1 1 of Fig. 2. Fig. 2 is an end elevation of the improved boiler looking at the front portion thereof. Fig. 3 is a detached detail view of the front flue-sheet removed from the boiler. Fig. 4 is a transverse section in the plane of the dotted line 4 4 of Fig. 3. Fig. 5 is a detached front view of the rear flue-sheet removed from the boiler. Fig. 6 is a vertical section through said rear flue-sheet in the plane of the dotted line 6 6 of Fig. 5. Fig. 7 is a detached view in front elevation of the front throat-sheet. Fig. 8 is a transverse section in the plane of the dotted line 8 8 of Fig. 7. Figs. 9 and 10 are views in front elevation and in transverse section, respectively, of the rear throat-sheet, the plane of the section in Fig. 10 being indicated by the dotted line 10 10 of Fig. 9. Fig. 11 is a vertical longitudinal section through another embodiment of the invention, the plane of the section being indicated by the dotted line 11 11 of Fig. 12. Fig. 12 is a front elevation of the boiler shown by Fig. 11, and Fig. 13 is a transverse section in the plane of the dotted line 13 13 of Fig. 11.

A designates the tubular member or element of the improved steam-boiler.

B is the bridge-wall.

C is the grate; D, the grate-chamber; E, the longitudinal flue, and F the return or back connection chamber.

The tubular member A of the boiler consists, primarily, of the cylindrical shell 5, the front and rear flue-sheets 6 7, and a plurality of fire-tubes 8, the latter being disposed in any suitable order within the shell 5 and united by approved means to the front and rear flue-sheets 6 7, respectively. The nests or groups of fire-tubes 8 are arranged within the cylindrical shell so as to form or leave therein a steam-space 9, and the upper part of this shell is adapted to receive the horizontal length of the feed-water pipe 10, the off-bearing steam-pipe 11, and a number of longitudinal stay bolts or rods 12; but as these last-described features are ordinary in the art it is not considered necessary to more particularly describe them.

In the improved boiler the flue-sheets 6 7 are constructed in a peculiar manner to form in part the water-legs at the front and rear ends of the boiler, and in Figs. 3, 4, 5, and 6 the improved flue-sheets are shown in detail. Referring to Figs. 3 and 4, the front flue-sheet 6 is provided at its lower part with the extensions 13 13^a, which are disposed at the sides of the sheet, the latter being cut out, as represented more clearly by Fig. 3, in order to produce these extensions. The marginal or boundary edge of the flue-sheet is bent to provide a rearwardly-extending flange 14, and the inner edge of the extensions 13 13^a and the bottom edge of the sheet are also bent in

order to form another rearwardly-extending flange 15. Said flue-sheet 6 is constructed with a plurality of tube-openings 16 in addition to the small openings 17 for the stay-bolts. This front flue-sheet is formed with a continuous series of comparatively large openings 18, the latter being arranged in the extensions 13 13^a and in the major portion of the flue-sheet just above the lower rearwardly-extending flange 15. These holes 18 in the complete boiler are adapted to serve as hand-holes for cleaning out the sediment which may accumulate in the front leg or water-box, and said holes are normally closed by means of suitable heads or caps, (indicated at 19 in Fig. 2.) The marginal flange 14 of the front flue-sheet is united to the front end of the shell 5, forming a part of the tubular member, and the rearwardly-extending flange 15 of this flue-sheet is disposed below said tubular-member shell 5, so that it will occupy a coincident relation to a forwardly-extending flange on a front throat-sheet 20.

The throat-sheet 20 is disposed within the boiler so as to occupy an intermediate position between the grate-chamber D and the lower part of the front flue-sheet 6, and this front throat-sheet is provided in its upper edge with a curved recess or cut-out portion 21, while at its lower part the throat-sheet is formed with the extensions 22 22^a. (See Fig. 7.) The recess or cut-out portion 21 of the front throat-sheet is curved on a radius corresponding to the external form of the shell 5, and this curved recess is provided with a rearwardly-extending flange 21^a. (See Fig. 8.) The upper part of the front throat-sheet 20 is thus fashioned to form a saddle adapted to receive the front part of the boiler-shell 5, and this throat-sheet is united firmly to said shell 5 by riveting the parts together in a well-known way. The lower part of the throat-sheet 20 is cut out so as to produce the extensions 22 22^a, which are provided with the forwardly-extending flange 23, and this flange 23 of the throat-sheet 20 occupies a coincident or abutting relation to the rearwardly-extending flange 15 of the front flue-sheet 6, such coincident relation of the two flanges being represented more clearly by Fig. 1. The front throat-sheet and the front flue-sheet are joined together in a substantial way by means of an embracing-strap 24, which occupies a lapping relation to the flanges 15 23, as shown by Fig. 1, and which strap is united firmly to the parts by rivets or any other suitable means.

The union of the front flue-sheet 6 and the front throat-sheet 20 provides a water leg or box G at the front part of the boiler, and this water-leg is in direct communication with the front part of the tubular member A, thus making provision for the downward circulation of the cold water, which is adapted to be supplied by the feed-pipe 10 to the front end of the boiler, as shown by Fig. 1. The front throat-sheet 20 is provided with a continuous

series of tube-openings 25, the same extending along the extensions 22 22^a and across the forwardly-extending flange 23, as shown more clearly by Figs. 7 and 8. The utility of these openings 25 will presently appear.

The front of the boiler is equipped with the usual fire-doors *a* and the ash-pit doors *b*, and these fire-doors have suitable fittings *a'*, which extend through the water leg or box *G*, so as to allow access to be obtained to the grate-chamber *D*. The ash-pit doors *b* provide access to the ash-pit *c*, as usual. The grate *C* is properly supported at one end in front of the boiler and at the other end by the bridge-wall *B*, the latter being built of fire-brick or other suitable material.

A back water leg or box *H* is provided at the rear part of the boiler by a construction analogous to the parts forming the front water leg or box *G*, and in Figs. 5, 6, 9, and 10 are shown the detail construction of the rear flue-sheet 7 and the rear throat-sheet 26. The rear flue-sheet 7 is provided with a plurality of tube-openings 27, in which are expanded the rear ends of the fire-tubes 8, and this flue-sheet is formed at its lower part with the large opening or slot 28, the latter providing the extensions 29 29^a at the sides of said sheet, these extensions in this instance being joined together by the integral bridge portion 30 at the lower part of the sheet. The flue-sheet 7 is formed with a marginal flange 31, and this flue-sheet is riveted to the shell 5, and the edges surrounding the opening or slot 28 are bent so as to form the forwardly-extending flange 32.

The rear throat-sheet 26 is formed with a recess 33, which conforms to the radius of the shell 5, and this recessed edge is bent to provide a forwardly-extending flange 34, the latter adapted to serve as a seat or saddle for the rear part of the boiler. The throat-sheet 26 is provided with a slot or opening 35, the edges of which are bent to produce a rearwardly-extending flange 36, and, furthermore, the throat-sheet is formed or provided with the stay-bolt openings 37 and with the tube-openings 38, the latter extending around three sides of the slot 35. The rear throat-sheet 26 is placed in the boiler-setting so as to lie near the rear extremity of the longitudinal flue *E*, and this throat-sheet receives in its flanged recess 33 34 the rear part of the shell. The throat-sheet is placed in such relation to the flue-sheet 7 that the slot 35 of the throat-sheet will occupy coincident relation to the slot or opening 28 of said rear flue-sheet. This disposition of the throat and flue sheets 26 7 will bring the flanges 36 and 23 into coincident or abutting relation, and the union between these flanged portions of the flue-sheet and the throat-sheet is made water-tight by the employment of the strap (not shown) and which is similar to the strap 24. The water leg or box *H* thus formed at the rear part of the boiler is in direct communication with the water-space of the tubular member

A, so as to allow of the heated water and the steam passing in an upward direction from this water-leg *H* into the tubular member *A*. Furthermore, the water leg or box *H* provides the outlet for the heat and escaping products of combustion from the flue *E* into the back connection chamber *F*, because the passage provided by the openings 28 35 in the flue-sheet and the throat-sheet, respectively, establish the communication between the flue *E* and the chamber *F*, such heat-flue being surrounded by the water-box *H*.

One of the important features of the present invention is a water connection extending longitudinally of the flue *E* and the grate-chamber *D*, said water connection serving to unite the front and rear water legs or boxes *G* *H* and affording means for the maintenance of water in thin strata, layers, or columns adjacent to or in the direct path of the escaping products of combustion. In one embodiment of the invention this water connection is attained by a plurality of tubes or pipes 39, which are necessarily disposed in an inclined direction longitudinally of the boiler. The front ends of these tubes 39 are united to the front throat-sheet 20 by any approved means, preferably by expanding said tubes in the tube-openings 25, while the rear ends of said tubes 39 are united in an approved way to the rear throat-sheet 26, preferably by expanding said tubes 39 in the tube-openings 38 thereof. These tubes 39 have direct communication at their front ends with the front water box or leg *G*, while the rear ends of the tubes have like communication with the rear water box or leg *H*. These water-tubes are disposed in series at the sides and over the top of the grate-chamber and the longitudinal flue, and the flues are therefore exposed to the direct action of heat and the escaping products of combustion, because they practically surround the said grate-chamber and the flue.

The arrangement of the circulating-tubes 39 in positions exposed to the direct action of the escaping products of combustion and the inclination of these tubes longitudinally of the boiler facilitates the circulation of the water through the tubes and from the front water-leg *G* toward the rear water-leg *H*, whereby the circulating water is adapted to carry with it any sediment which may be present in the water, thus overcoming all tendency of the sediment to accumulate in the circulating-tubes. The water circulating through the tubes 39 and the legs is adapted to carry with it the sediment which is caused to lodge or accumulate in the shell 5 of the tubular member, from whence the sediment can be removed more easily than from any other part of the boiler. It therefore becomes necessary to protect the shell 5 from the direct action of the escaping products of combustion, and this end is secured in the construction shown by Fig. 1 by the provision of an arched flue-crown *I*, the same extending over the group of tubes 39

and outside of the vertically-disposed tubes at the sides of the boiler. This flue-crown extends over the grate-chamber and the longitudinal flue, and said flue-crown preferably consists of the series of fire-tiles 40, a protection layer 41 of asbestos or other non-heat-conducting material, and a metallic sheet 42, the whole being compactly disposed across the lower part of the shell 5 and over the group of circulating water-tubes 39. It is evident that the heat will not radiate freely through this rounded flue-crown, and thus the under side of the boiler-shell 5 will not be exposed to the direct action of the heat.

The back connection-chamber F lies at the rear of the boiler, so as to have communication with the flue E through the slots and openings 28 35 in the sheets 7 26, respectively, and the upper part of this chamber F is disposed in a manner to deliver the heat and products of combustion in the fire-tubes 8, the latter serving to conduct the heat and gases through the water contained in the chamber of the shell 5, whereby the waste heat and gases will be discharged at the front end of the boiler and into the stack or up-take.

The flue-sheet 6 and the throat-sheet 20 are reinforced by the employment of suitable stay-bolts 43, and the flue-sheet 6 and the shell 5 are also strengthened by the employment of the stays 44. (See Fig. 1.) The rear flue-sheet 7 and the rear throat-sheet 26 should be similarly reinforced by stay-bolts adapted to be secured in the openings 37 of the throat-sheet and similar openings 37^a, which are provided in the rear flue-sheet 7.

In the boiler shown by Figs. 11 to 13, inclusive, the tubular member A is constructed as hereinbefore described and is equipped with the tubes or stays and the ordinary pipes. The front and rear flue-sheets are substantially the same as in the boiler shown by Fig. 1, while the front and rear throat-sheets are modified somewhat in order to receive the parts forming the modified type of longitudinal water connection between the front and rear water legs or boxes G H. The throat-sheet 45 at the front is provided with a rearwardly-extending flange 46, while the rear throat-sheet 47 has a forwardly-extending flange 48. To these flanges of the front and rear throat-sheets are united the end portions of an arched shell 49, within which arched shell is disposed the crown-sheet 50, the latter occupying a parallel or concentric relation throughout its length to the arched shell 49. The end portions of the crown-sheet 50 have overlapping relation to the inwardly-extending flanges 15 and 32 of the front and rear flue-sheets 6 7, respectively, and this crown-sheet is bolted or riveted firmly to said flanges of the flue-sheets. The crown-sheet thus extends from end to end of the boiler, so as to occupy an arching and inclosing relation at the sides of the grate-chamber D and the longitudinal flue E, whereby the crown-sheet is exposed throughout its

length and width to the direct action of heat and products of combustion. The crown-sheet 50 and the arched shell 49 are united together by the stay-bolts 51, any desired number of which may be employed in any desired order or relation, and said parts 49 50 provide a water jacket or chamber 52, which has direct communication at its end portions with the legs G H, such chamber serving to maintain a thin stratum or layer of water adjacent to the path of the escaping products of combustion. The crown-sheet 50 and the surrounding water-chamber 52, formed by said crown-sheet and the shell 49, occupy a rearwardly and upwardly inclined position from the front water-leg to the rear water-leg, and this arrangement of the parts facilitates the circulation of the products of combustion and of the hot water and steam contained in the chamber. The products of combustion in this type of boiler pass from the flue E through the rear water-leg H into the back connection-chamber F, from whence they pass in an upward direction into the fire-tubes 8 of the boiler member A. It is preferred to employ the stays 53 between the crown-sheet 50 and the front flue-sheet 6, as shown by Fig. 11. The surrounding water-chamber 52, which forms the circulating connection between the front and rear water-legs, affords the desired protection to the under side of the shell 5, so as to prevent the escaping heat and products of combustion from having direct access to this shell, and in this respect the chamber 52 is the equivalent for the group of circulating-pipes 39 and the arched flue-crown I.

In the service of the boiler the gases and products of combustion pass from the grate-chamber D into and through the flue E, and thence the products of combustion pass through the back water-leg H into and through the back connection-chamber F, from whence they pass through the fire-tubes 8 of the tubular member A. The gases and smoke which traverse the flue E pass in an upward and rearward direction, because the flue is inclined to facilitate the escape of the products of combustion, and the parts surrounding this flue, as well as the combustion-chamber F, are adapted to be heated, so that proper combustion of the smoke and gases will be obtained after the boiler shall have been started. The comparatively cool feed-water is supplied by the pipe 10 at the front end of the boiler, so that it will pass into the water-leg G and from thence flow in a backward and upward direction through the tubes 39 or the chamber 52. The cold water being supplied by the front water-leg to the tubes or chamber, it is evident that the water in passing through the tubes will be heated quickly by the gases and products of combustion, and as this heated water has a natural tendency to rise the inclination of the tubes 39 or the chamber 52 facilitates the circulation of the water. After passing through the tubes or the chamber the water flows into the back

leg H and from thence in an upward direction into the tubular member A, through which the water flows toward the front, whereby the water is adapted to circulate continuously from the front toward the rear in the lower part of the structure and from the rear toward the front in the upper part of the structure. This circulation of the water and the inclination of the tubes or the chamber prevents the lodgment of the sediment in the circulating connections at the lower part of the boiler, and the sediment is thus carried into the tubular member A, in which the sediment is free to accumulate, as hereinbefore described.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. A steam-boiler substantially such as described, comprising a tubular member having smoke-flues, a grate-chamber, a flue in communication with said tubular member and the grate-chamber, front and rear water-legs in communication with the tubular member, and a water connection arching the grate-chamber and the flue and in communication with the front and rear water-legs.

2. A steam-boiler substantially such as described, comprising a tubular member provided with smoke-flues, front and rear water-legs having direct communication with the water-space of said tubular member, a grate-chamber, a longitudinal flue, a back connection between said flue and the smoke-flues, and a water connection in communication with said legs and extending longitudinally of the grate-chamber and said longitudinal flue, said water connection lying between the tubular member and the longitudinal flue.

3. A steam-boiler substantially such as described, comprising an upper member having smoke-flues, a grate-chamber, a longitudinal flue in communication with said grate-chamber, a back connection between the longitudinal flue and the smoke-flues of the upper member, a water-leg connected to the water-space of the upper member at the front end thereof, another water-leg connected to the water-space at the rear end of said upper member and disposed in the path of the products of combustion as they pass from said flue into the upper member, and a water connection in communication with the front and rear legs and extending along the grate-chamber and said flue, said water connection being interposed between the upper member and the connected grate-chamber and flue.

4. A steam-boiler substantially such as described, comprising a tubular member having smoke-flues, a grate-chamber, a connecting-flue between the grate-chamber and the tubular member, front and rear water-legs in communication with end portions of said tubular member, and an inclined water connection extending below the tubular member and arching the grate-chamber and the flue and communicating with said water-legs.

5. A steam-boiler substantially such as described, comprising a tubular member having smoke-flues, a grate-chamber, a back connection in communication with the smoke-flues, a flue between said grate-chamber and the back connection, front and rear water-legs in communication with the water-space at end portions of said tubular member, and an intermediate water connection in communication with said water-legs, said intermediate connection being inclined between said water-legs and arching the grate-chamber and said flue.

6. A steam-boiler substantially such as described, comprising a tubular member having smoke-flues, a grate-chamber, a back connection in communication with said smoke-flues, a longitudinal flue connecting the grate-chamber and the back connection, front and rear water-legs in direct communication with the water-space of said tubular member, and an intermediate water connection in communication with said water-legs and disposed between the tubular member and said grate-chamber to afford protection to the tubular member against direct action of escaping products of combustion.

7. In a steam-boiler substantially such as described, a tubular member having a front flue-sheet provided with integral depending extensions, a front throat-sheet having similar downwardly-extending portions and united to the front flue-sheet to form an intermediate water leg or chamber, and a series of smoke-flues within the tubular member and attached to the front flue-sheet, combined with a rear water-leg, and an intermediate water connection between the two water-legs.

8. In a steam-boiler substantially such as described, a tubular member having a front flue-sheet which is extended below the shell of said member and is cut away to form the integral depending extensions, a front throat-sheet disposed in parallel relation to the tube-sheet and united therewith to form an intermediate water leg or box at the front of the boiler, and a series of smoke-flues disposed in the tubular member and attached to the front flue-sheet, combined with a rear water-box, and an intermediate connection between the two water boxes or legs.

9. In a steam-boiler substantially such as described, a tubular member provided with a front flue-sheet having integral depending extensions, said flue-sheet having a series of hand-holes in the lower part thereof and in said extensions, a front throat-sheet disposed in coöperative relation and united to said flue-sheet to form an intermediate water leg or box at the front of the boiler, and a series of smoke-flues disposed in the tubular member and attached to the front flue-sheet, combined with a rear water leg or box, and an intermediate connection between the front and rear water-legs.

10. In a steam-boiler substantially such as described, a tubular member having its front

flue-sheet extended below the shell of said member, a front throat-sheet formed with a recess which constitutes a saddle for the reception of said tubular member, said front throat-sheet being united to the front flue-sheet and forming therewith a water leg or box at the front of the boiler, and smoke-flues disposed in the tubular member and attached to said front flue-sheet, combined with a rear water leg or box, and an intermediate water connection between the two water-legs.

11. In a steam-boiler substantially such as described, a tubular member provided with a rear flue-sheet having integral depending extensions, a rear throat-sheet provided with like extensions and disposed in coöperative relation to said rear sheet to form a water leg or box at the rear of the boiler, and smoke-flues disposed in the tubular member and attached to said flue-sheet, in combination with a front leg or box, and a water connection intermediate of said water-legs.

12. In a steam-boiler substantially such as described, a tubular member having a rear flue-sheet provided with integral depending portions and with a flanged slot or opening, a rear throat-sheet in coöperative relation to said flue-sheet to form an intermediate water-leg, and likewise having a flanged slot or opening which forms with the slot of the flue-sheet a passage for escaping products of combustion, and smoke-flues attached to the rear flue-sheet, combined with a front water-box, and an intermediate water connection.

13. In a steam-boiler substantially such as described, a tubular member having its rear flue-sheet provided with integral depending portions, a throat-sheet disposed in coöperative relation to the flue-sheet to form there-with a water leg or box, said throat-sheet having a saddle which receives said tubular member, and smoke-flues in the tubular member and attached to the rear flue-sheet, combined with a front water-leg and an intermediate water connection.

14. In a steam-boiler substantially such as described, the combination of a tubular member having smoke-flues and provided with depending water-legs at its front and rear por-

tions, the rear water-leg being provided with a transverse slot for the passage of products of combustion, a grate-chamber, a flue communicating with said slot of the rear water-leg, and a series of water-tubes in communication with said water-legs and arching the grate-chamber and the flue.

15. In a steam-boiler substantially such as described, the combination of a tubular member having smoke-flues and provided with water-legs at its front and rear portions, said rear water-leg having a transverse smoke-passage, a grate-chamber, a flue communicating with said smoke-passage of the rear water-leg, a water connection between said water-legs, and an arched flue-crown between the water connection and said tubular member.

16. In a steam-boiler substantially such as described, the combination of a tubular member having smoke-flues and provided with water-legs at its front and rear portions, a grate-chamber, a flue, a back connection between said flue and the smoke-flues of the tubular member, a water connection between said water-legs, and an arched flue-crown interposed between the connection and the tubular member, said flue-crown having a facing composed of fire-tile and a heat-resisting lining forming a backing for said fire-tile.

17. In a steam-boiler substantially such as described, the combination of a tubular member having smoke-flues and provided with water-legs at its end portions, a grate-chamber, a flue, a back connection between the flue and said smoke-flues of the tubular member, a series of inclined water-tubes connecting said water-legs, and a flue-crown disposed below the tubular member and over said water-tubes.

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

JEANNE HOPKINS,
Executrix of the estate of William Hopkins,
deceased.

Witnesses:

ROBT. BONSON,
HENRY SCHROEDER.