

No. 674,939.

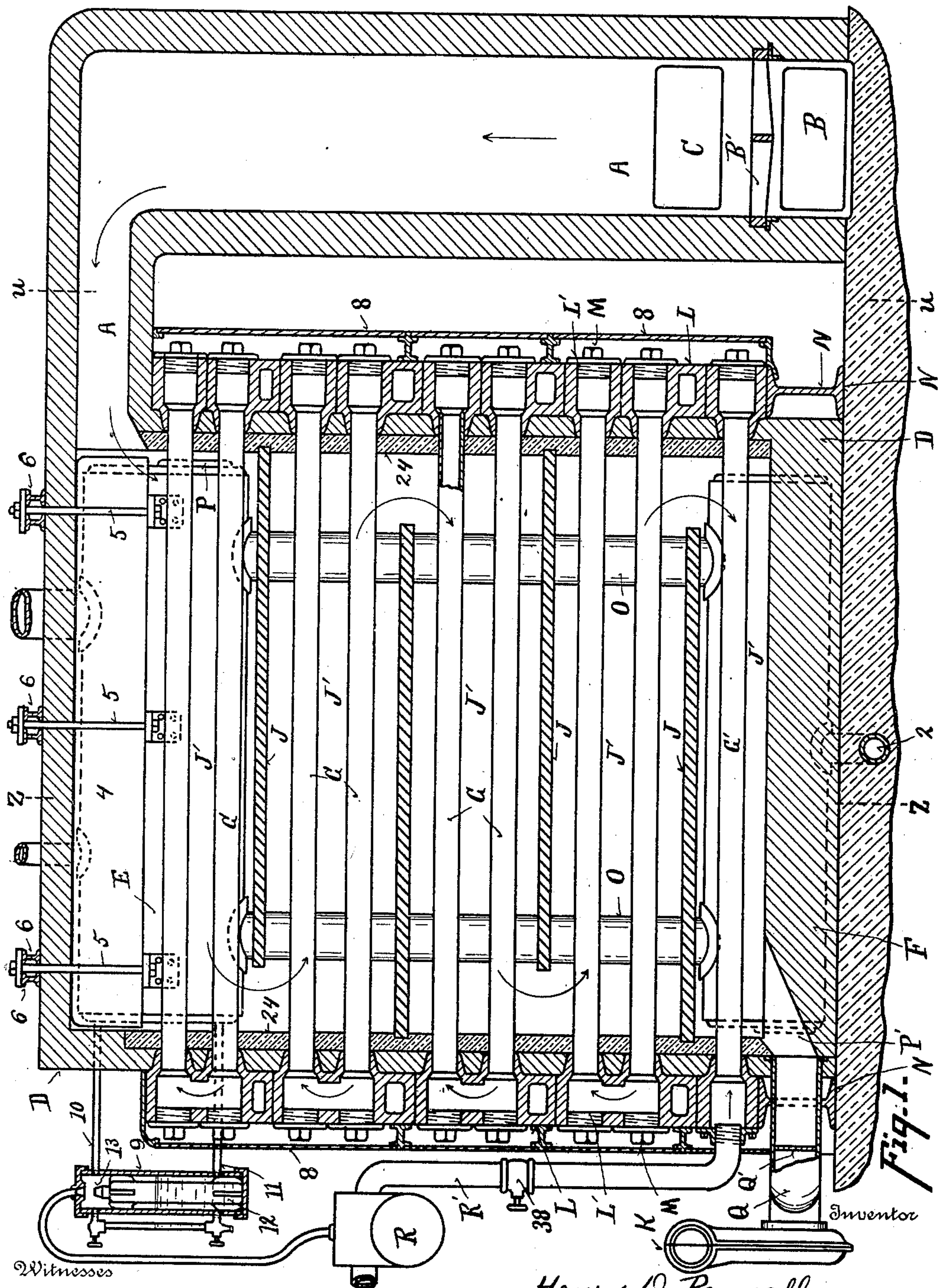
Patented May 28, 1901.

H. D. POWNALL.
STEAM GENERATING APPARATUS.

(Application filed Feb. 4, 1901.)

(No Model.)

4 Sheets—Sheet 1.



Witnesses
Harry Anderson
Joe Peterson

— *Henry D. Pownall* —
By *C. W. Miles* — Attorney

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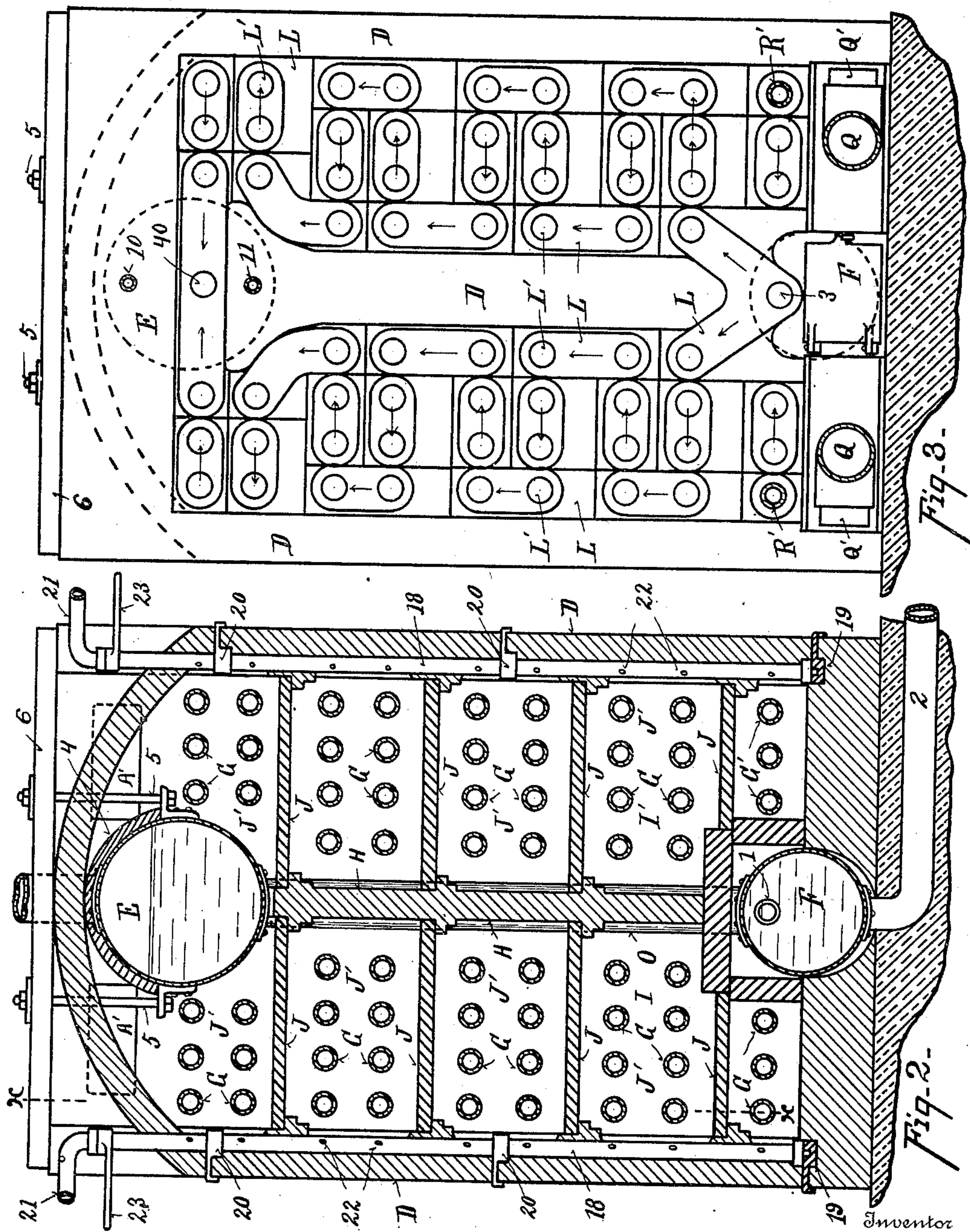
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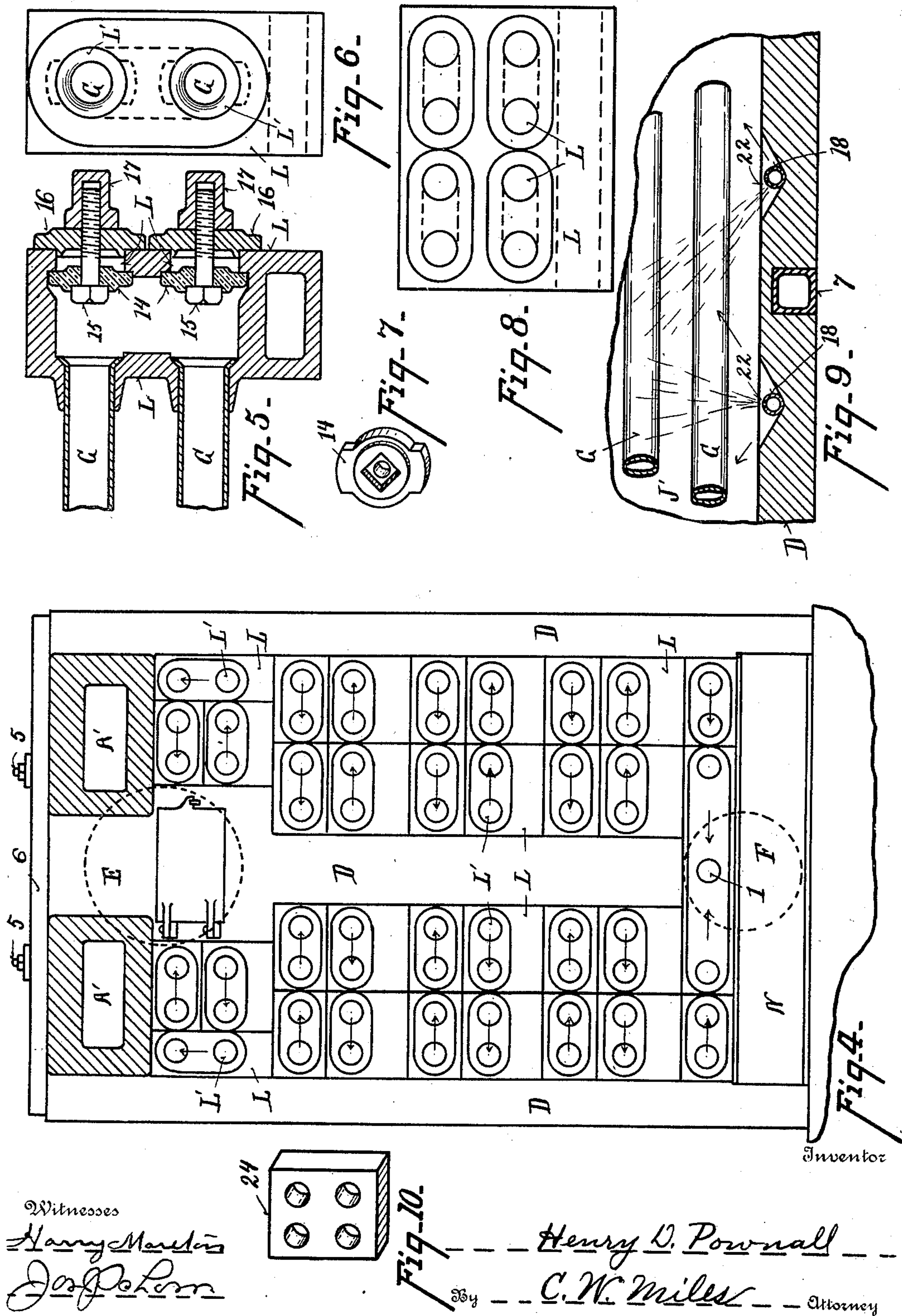
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Fig. 10.

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Patented May 28, 1901.

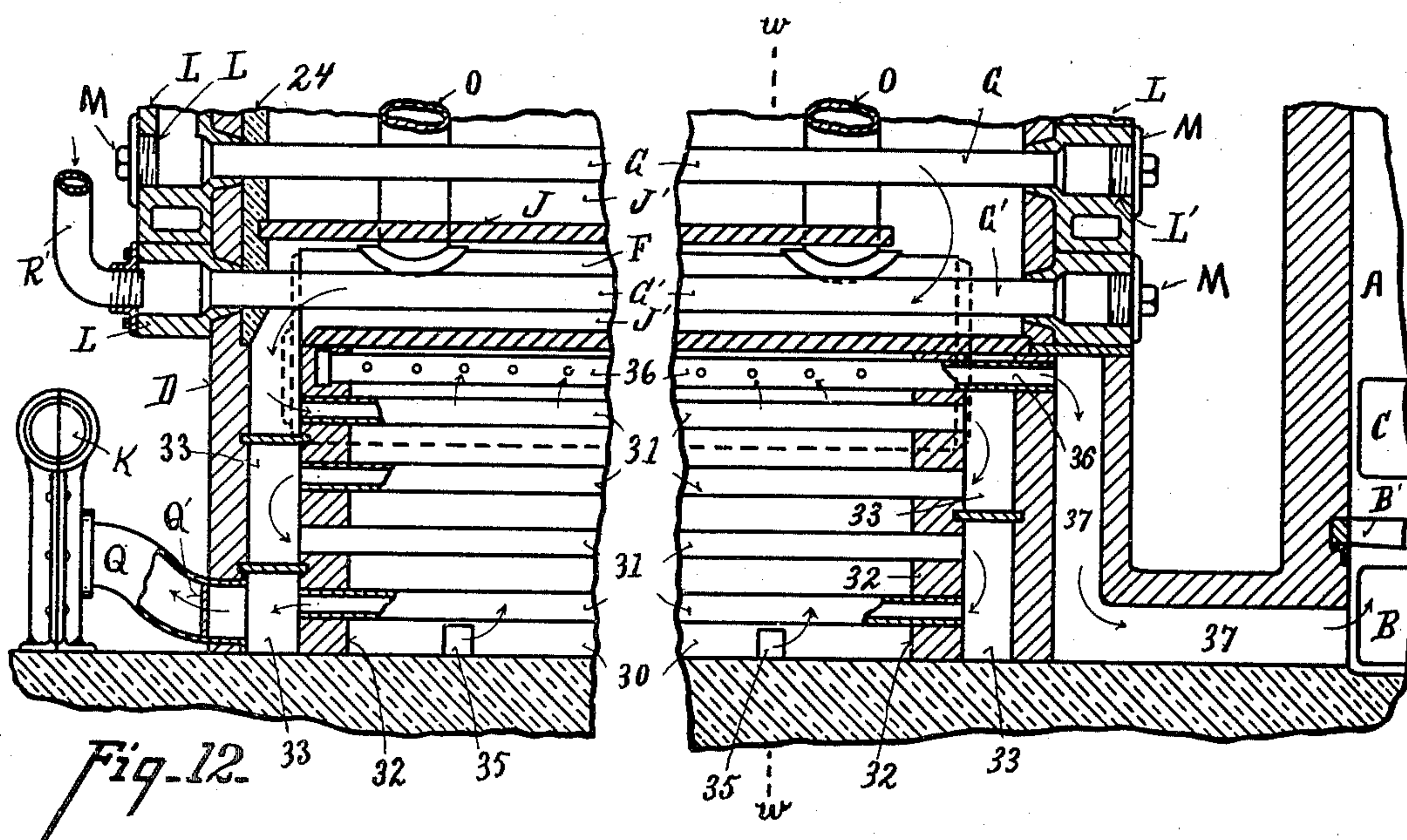
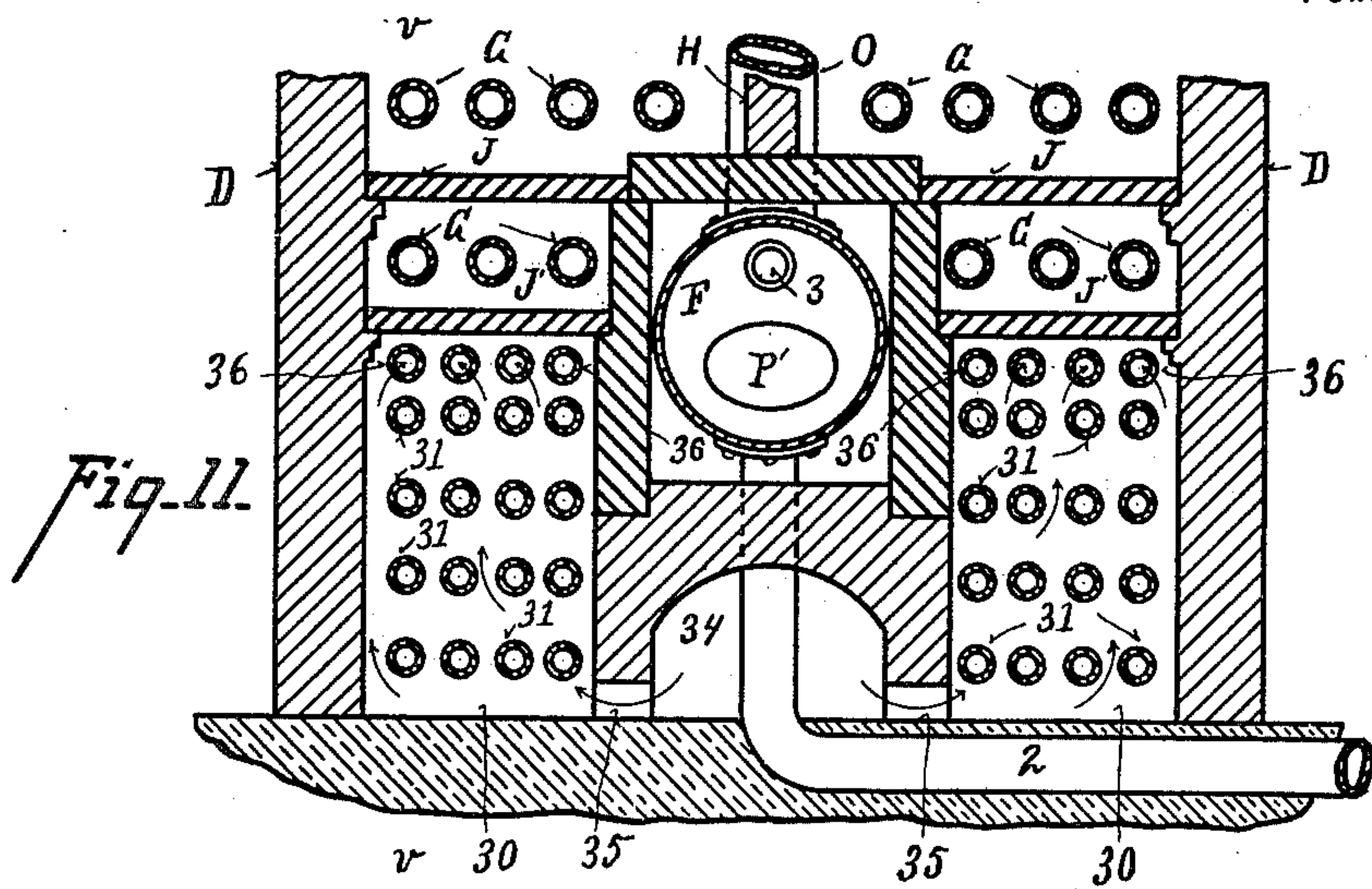
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(No Model.)

4 Sheets—Sheet 4.



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UNITED STATES PATENT OFFICE.

HENRY D. POWNALL, OF CINCINNATI, OHIO.

STEAM-GENERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 674,939, dated May 28, 1901.

Application filed February 4, 1901. Serial No. 45,913. (No model.)

To all whom it may concern:

Be it known that I, HENRY D. POWNALL, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Steam-Generating Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improved apparatus for generating steam.

One of the objects is to provide an apparatus which is readily and conveniently accessible for the purpose of cleaning.

Another object is to provide an apparatus more economical of fuel.

Another object is to provide an apparatus in which the pipe-joints are not in contact with the fire and which is therefore more durable.

Another object is to provide an apparatus in which the scale-forming impurities in the water are precipitated in a finely-divided state and pass through the tubes to the mud-drum instead of depositing on the walls of the tubes.

Another object is to provide an apparatus in which the cool water is first introduced into the cooler part of the furnace and from thence passes to the hotter part of the furnace and finally to the steam-dome, thereby producing a more economical apparatus and one which more thoroughly utilizes the heat of the fuel.

Another object is to provide an improved form of furnace and draft apparatus for efficiently carrying on the operation.

It also consists in certain details of form, combination, and arrangement, all of which will be more fully set forth in the description of the accompanying drawings, in which—

Figure 1 is a longitudinal section through my apparatus on line *xx* of Fig. 2. Fig. 2 is a section through the same on line *zz* of Fig. 1. Fig. 3 is a rear end view of the generator. Fig. 4 is a front elevation of the generator, taken on line *uu* of Fig. 1. Fig. 5 is a detail sectional view of one of the tube-couplings. Fig. 6 is a plan view of the same with the caps removed. Fig. 7 is a perspective view

of one of the clamping-plates. Fig. 8 shows a modification of the tube-coupling, Fig. 6. Fig. 9 is a detail section through the side wall and tube-cleaners. Fig. 10 is a perspective view of one of the lining-tiles. Fig. 11 is a section similar to Fig. 2, taken on line *ww* of Fig. 12 and showing the preferred form of constructing the lower portion of the generator. Fig. 12 is a longitudinal section through the same on line *vv* of Fig. 11.

As shown in Fig. 1, the furnace fire-box A is constructed separate from the steam-generating apparatus, with flues A' leading thereto. The fire-box may, if desired, be constructed above the steam-generator, with the flues leading down therefrom. B represents the ash-pit, B' the grate, and C the furnace-door.

The steam-generator consists of a brick structure D, in which are mounted a steam drum or dome E, a mud-drum F, and a series of water-tubes G. The furnace-flue is preferably divided by a central vertical wall H into two sections I I', which are divided by horizontal partitions J, so as to form extended zigzag flues J', which receive the products of combustion from the fire-box, near the top of the furnace, from whence they circulate downwardly and are preferably drawn off and discharged by means of a blower K. The tubes G are arranged so as to traverse the several sections of the flue, with their ends projecting through the walls of the furnace. The ends of the tubes enter coupling boxes or heads L, in which the ends of the tubes are flanged to form steam and water tight joints.

L' represents exterior openings opposite the ends of each tube, which are closed by means of caps M. These boxes are preferably formed to receive the ends of two tubes only, as shown in Figs. 5 and 6, but may be formed to receive and connect the ends of a number of tubes, as shown in Fig. 8. These heads are also preferably arranged so as to rest one upon another, as shown in Figs. 1, 2, and 3, the whole being supported by means of I-beams N, resting upon the foundation. When so constructed, any expansion or contraction of the tubes is accommodated by the sliding of the boxes one upon another.

O represents water legs or pipes, of which

there may be one or more, connecting the steam-drum with the mud-drum or lower water-tubes, so as to permit an equalization or return circulation of the water from the steam-drum to the mud-drum and lower tubes when water is not being supplied through the pump.

P represents a manhole for cleaning the steam-drum, and P' a manhole into the mud-drum.

Q represents tubes leading from the lower end of the furnace-flues to the blower, and Q' dampers for regulating the openings therein to control the draft.

The circulation of the water through the generator is preferably as follows: R represents a pump supplying water under pressure through pipes R' to one or more of the lower section of tubes G'. The water circulates first through the tubes of the lower section G', where it is heated by the partially-cooled products of combustion, and as the water is in rapid circulation causes the precipitation of the scale-forming impurities in a finely-divided state, in which form it is carried by the current of water into the mud-drum, entering at 1, where the precipitate settles to the bottom of the drum and is blown off through the blow-off pipe 2. The water traverses the mud-drum and passing out at 3 circulates successively through the upper series of tubes, preferably as indicated by arrows, being progressively exposed to hotter portions of the products of combustion, and is finally discharged, together with the steam generated, into the steam-drum. The generation of steam in the tubes assists to create an upward current of the water in the tubes, and any excess of water discharged from the tubes into the steam-drum after being freed from steam returns to the mud-drum through the water-legs, thereby always maintaining a full supply and an upward current of water through the upper tubes, the water-line in the steam-drum being maintained above the top of the upper series of tubes.

4 represents a jacket of tiles or other non-conducting material protecting the steam-drum above the water-line from the direct action of the products of combustion.

The steam-drum and mud-drum are preferably suspended from above by means of bolts 5 and I-beams 6, which rest upon the top of the vertical walls or preferably upon vertical columns 7, (see Fig. 9,) about which the walls are built. This construction enables the walls to be repaired or taken down and rebuilt without disturbing the steam and mud drums.

In the modification, Figs. 11 and 12, the products of combustion after heating the feed-water circulating through tubes G' is further utilized to heat the air supplied to the furnace for combustion, which is preferably effected in the following manner: Below the tubes G' and partitioned off therefrom I provide air-heating chambers 30, through which pass a series of tubes 31. The

ends of these tubes are preferably built into the walls 32, so that the tubes communicate with chambers 33 at opposite ends thereof. The products of combustion pass downward successively through the several series of tubes 31, as indicated by arrows in Fig. 12, and thence through the pipes Q, as before described, to the blower. The air-supply for the furnace enters a passage 34, and from thence through side passages 35 enters the bottom of chambers 30, in which the air rises as it becomes heated by contact with the tubes 31, and is finally drawn off, by means of perforated tubes 36, into the passage 37, from whence it enters the ash-pit to support combustion, the draft being regulated by the damper Q', near the blower.

It will be noted that by employing the heads L, located on the exterior of the furnace-wall, with openings opposite the several tubes, the tubes are easily accessible and may be readily and conveniently cleaned; also, that by employing an internal pipe-cutter any one of the tubes may, if defective, be severed at a point between the heads L and the severed sections withdrawn and a new tube inserted and its ends flanged into the heads.

8 represents light sheet-metal doors inclosing the heads to protect them from undue loss of heat. As the products of combustion are utilized until their temperature is reduced to the boiling-point of water or lower, it is preferable or necessary to employ a forced draft or blower of some kind to create a steady and reliable circulation through the furnace.

In order to automatically maintain the proper supply of water in the boiler, I preferably employ a stand-pipe 9, connected by pipes 10 and 11 at top and bottom with the steam-drum, and provided at its upper end with a pipe supplying steam to the feed-pump R.

12 represents a float supported within the stand-pipe and provided at its upper end with a valve 13, which rises and shuts off the supply of steam to the pump as soon as the water has reached the desired height in the steam-drum and stand-pipe and automatically opens again to start the pump as soon as the water falls below the desired level.

In Fig. 1 I have shown the outer openings in the heads L closed by means of screw-threaded caps; but I preferably employ the caps shown in Figs. 5, 6, and 7, in which the cross-bar 14 seats on the inside of the opening and carries a bolt 15, the outer end of which passes through the cap-plate 16 and is screw-threaded into the cap-nut 17, which is turned up with a wrench to draw the parts together and form a steam-tight joint. The joint may be either ground joints or provided with gaskets, as desired.

In order to free the exterior of the tubes G from any accumulation of soot or dust, I provide a series of upright tubes 18, set vertically in the side walls, being stepped upon footpieces 19 and journaled in brackets 20,

built into the walls. 21 represents hose-pipes supplying steam thereto, which when in use issues in a series of jets through the openings 22 and sweeps the dust and soot from the outside of the tubes.

23 represents hand-levers with which to turn the tubes to different angles, so that each tube is enabled to sweep a considerable section of the tubes, as shown in Fig. 9. The end walls of the generator are preferably lined with tiles 24, provided with perforations through which the tubes G pass.

Valves 38 are provided in each of the pipes leading from the pump to the generator, by means of which the amount of water supplied to the sections of tubes on opposite sides of the generator can be regulated, while the dampers Q' permit a like control of the products of combustion, which are both of considerable importance in regulating the operation of the generator under varying circumstances.

I claim—

1. In a steam-generator, a furnace having a circuitous flue leading from the top to the bottom thereof; means for maintaining a downdraft therein; a series of water-tubes spanning said flue with their ends projecting through the furnace-walls; couplings on the outside of the walls connecting said tubes in series; openings in said couplings opposite the mouth of the tubes, and caps adapted to close said openings; a steam-drum located near the top of the furnace; a water connection for a return circulation from the steam-drum to the lower tubes; and means for maintaining the water-supply in said tubes and drum.

2. In a generator, a furnace having a circuitous flue; means for creating a downdraft through said flue; a steam-drum located in the upper part of the furnace; a mud-drum located in the lower part of the furnace; a series of water-tubes spanning said flue and connected with said drums so that the water can be circulated first through the lower section of tubes to heat it, then through the mud-drum, and from thence through the upper section of water-tubes to the steam-drum; a return connection from the steam-drum to the lower portion of the tubes; and means for forcing water into the tubes.

3. In a steam-generator, a furnace having a circuitous flue leading from the top to the bottom of the furnace; means for creating a downdraft in said flue; a steam-drum located in the upper portion of the furnace; water-tubes spanning said flue and connected in series; means for forcing water from the lower tubes to the steam-drum; a connection from the steam-drum for a return circulation of water to the lower tubes; an air-heating chamber in contact with said flues; and a passage leading from the air-heating chamber to the fire-box.

4. In a steam-generator, a furnace having

an extended circuitous flue; means for creating a downdraft through the successive actions of said flue; a steam-drum located in the upper part of the furnace; a series of water-tubes spanning the flue and connected in series; means for forcing water from the lower section of tubes to the steam-drum; and a connection from the steam-drum to the lower tubes for a return circulation of water.

5. In a steam-generator, a furnace having a circuitous flue; means for creating a downdraft therein; a steam-drum located in the upper portion of the furnace; a mud-drum located in the lower portion of the furnace; water-tubes spanning said flue and connected so that the water can be circulated first through the lower section of tubes, then through the mud-drum, then through the upper section of tubes to the steam-drum; a water connection between the two drums for a return circulation; an air-heating chamber in contact with the flue; and a passage leading from the air-heating chamber to the fire-box.

6. In a steam-generator, a furnace; a divided circuitous flue; a steam-drum located near the top of the furnace; a mud-drum located near the bottom of the furnace; a water connection between said drums; a series of water-tubes spanning the flues and connected with the respective drums; means for creating a downdraft in the respective flues; and independent dampers controlling the draft therein.

7. In a steam-generator, a furnace having a circuitous flue; means for creating a downdraft therein; a steam-drum near the top of the furnace; a series of water-tubes spanning said flues; a pump adapted to force water into the lower water-tubes; a stand-pipe connected at top and bottom with the steam-drum; a pipe leading from the top thereof to the pump; and a float located in said stand-pipe and provided with a valve adapted to automatically start and stop the pump to maintain the water-supply in the tubes and steam-drum.

8. In a steam-generator, a furnace having an extended circuitous flue leading from the top to the bottom thereof; a steam-drum located near the top of the furnace; a series of water-tubes spanning the flue and connected in series; a connection from the steam-drum for a return circulation of water to the lower tubes; means for forcing water from the lower tubes to the steam-drum; and a blower connected to the lower end of the flue for creating a downdraft.

9. In a steam-generator, a furnace having a continuous circuitous flue leading from the top to the bottom of the furnace; a steam-drum located near the top of the furnace; a series of water-tubes spanning the flue and connected in series; a connection from the steam-drum to the lower tubes for a return circulation; means for creating a downdraft

in the flue; and means for creating a current of water in the tubes to flow in the opposite direction to that of the draft in the flue.

10. In a generator, a furnace having a continuous circuitous flue leading from the top to the bottom of the furnace; a steam-drum located near the top of the furnace; a series of water-tubes spanning the flue and connected in series; a connection from the steam-drum to the lower tubes for a return circulation; means for creating a downdraft in the

flue; an air-heating chamber in contact with the flue below the water-tubes; and a passage leading from the air-heating chamber to the fire-box.

In testimony whereof I have affixed my signature in presence of two witnesses.

HENRY D. POWNALL.

Witnesses:

J. V. SAYRE,
JOS. J. SCHORR.