

(No Model.)

2 Sheets—Sheet 1.

C. E. DAVIS.

SMOKE CONSUMING FURNACE.

No. 374,457.

Patented Dec. 6, 1887.

Fig. I.

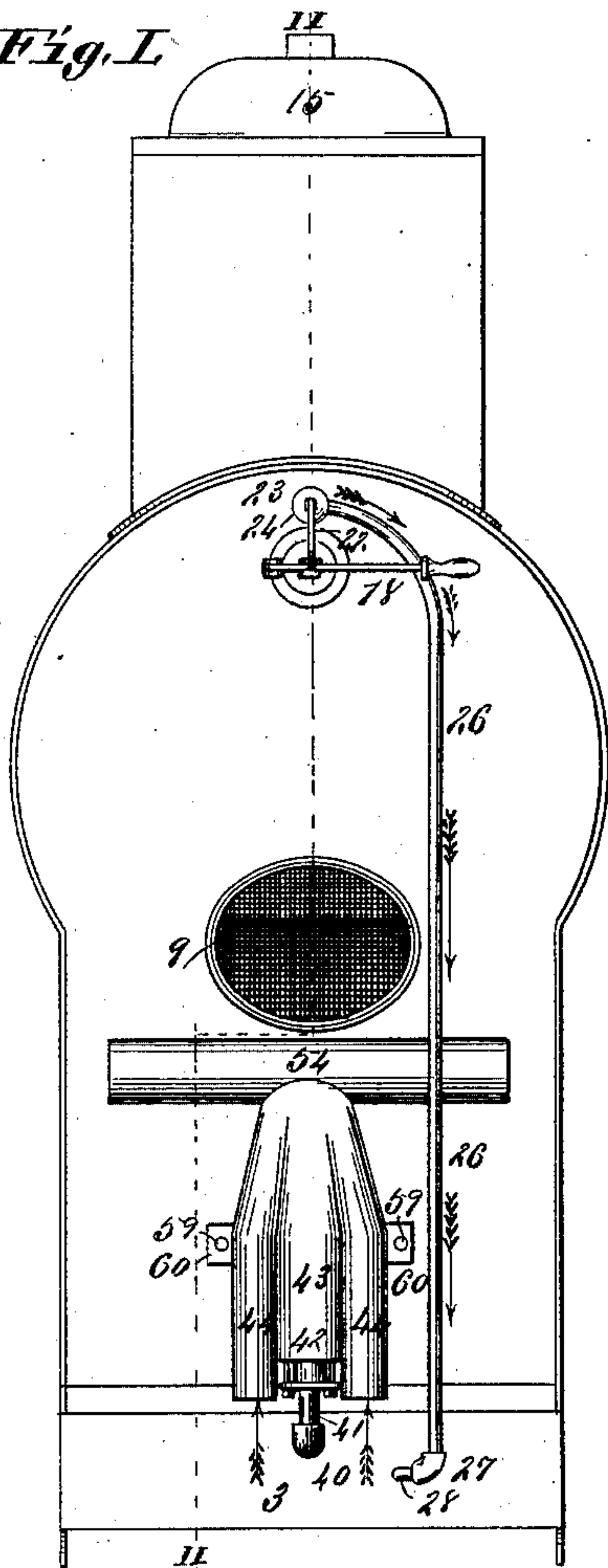


Fig. II.

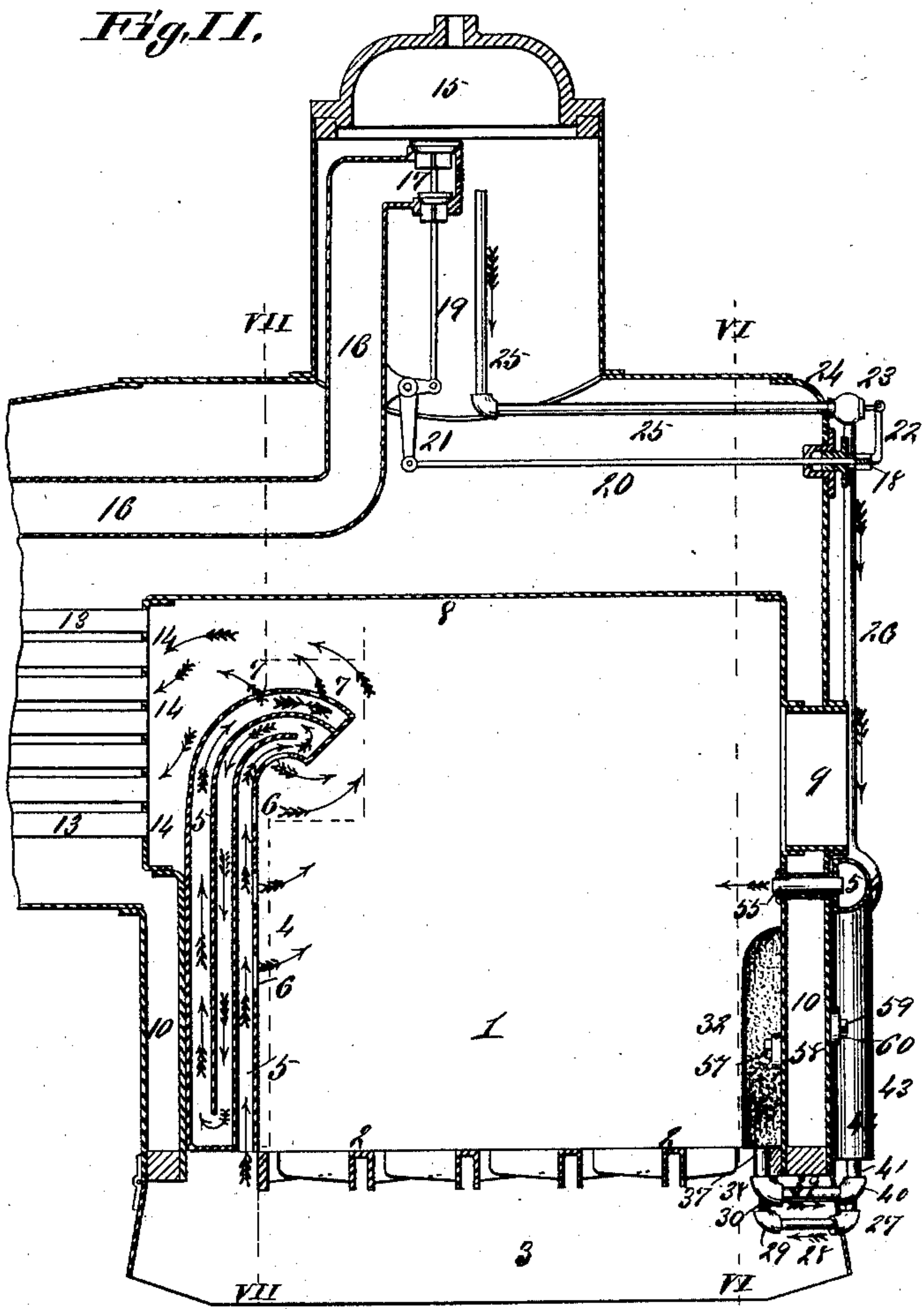


Fig. III.

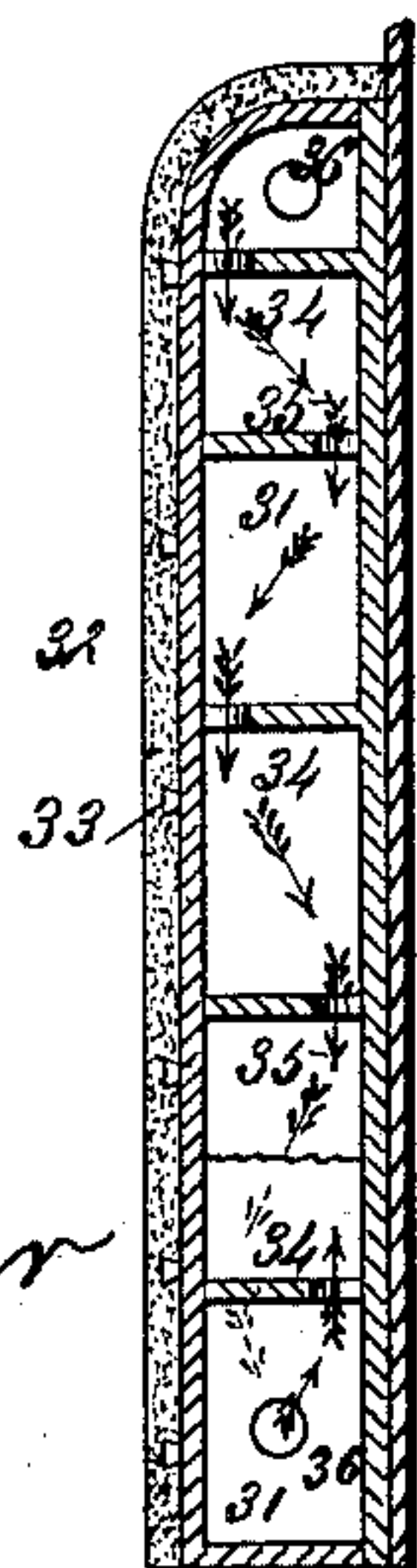


Fig. IV.

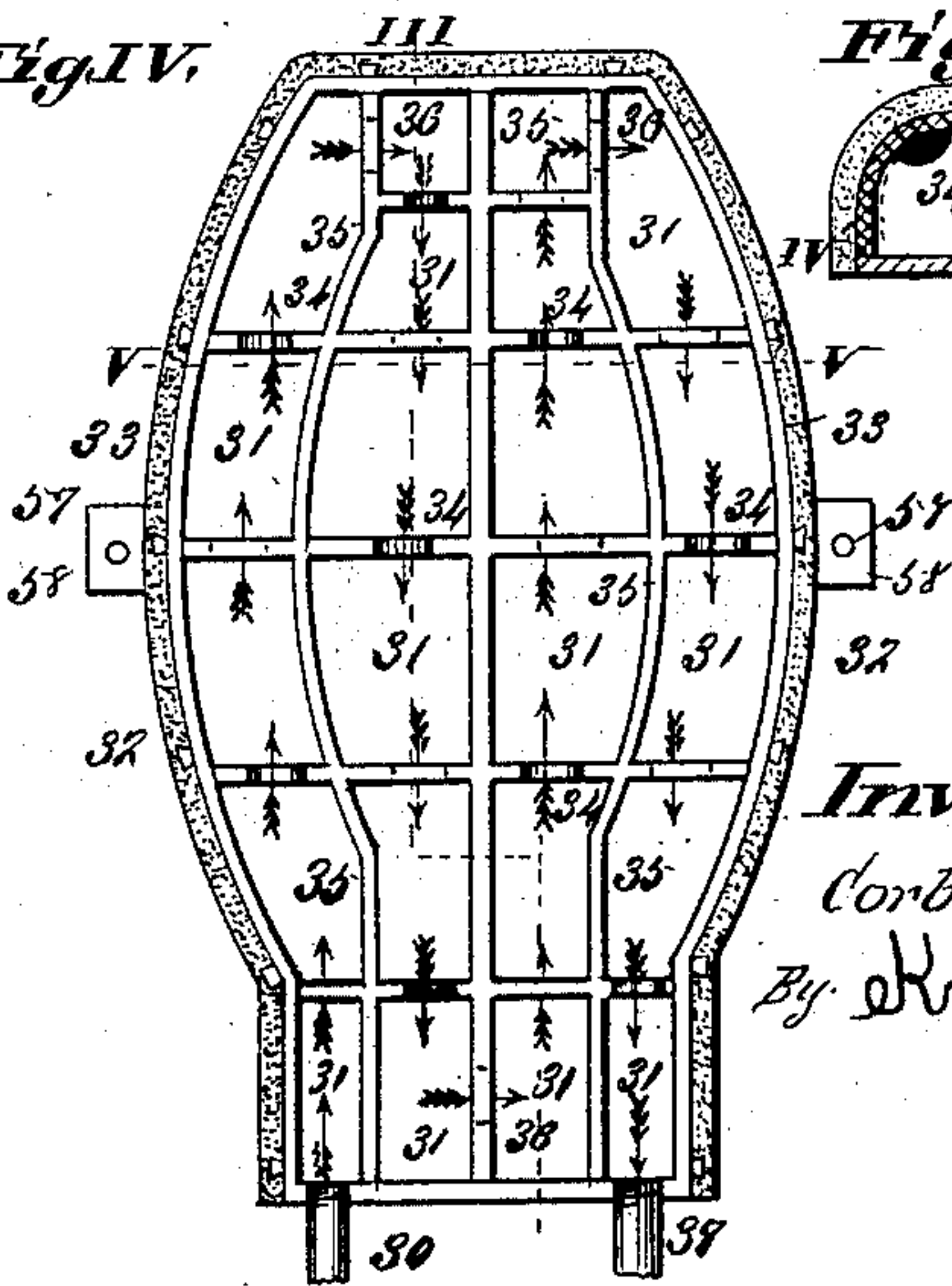
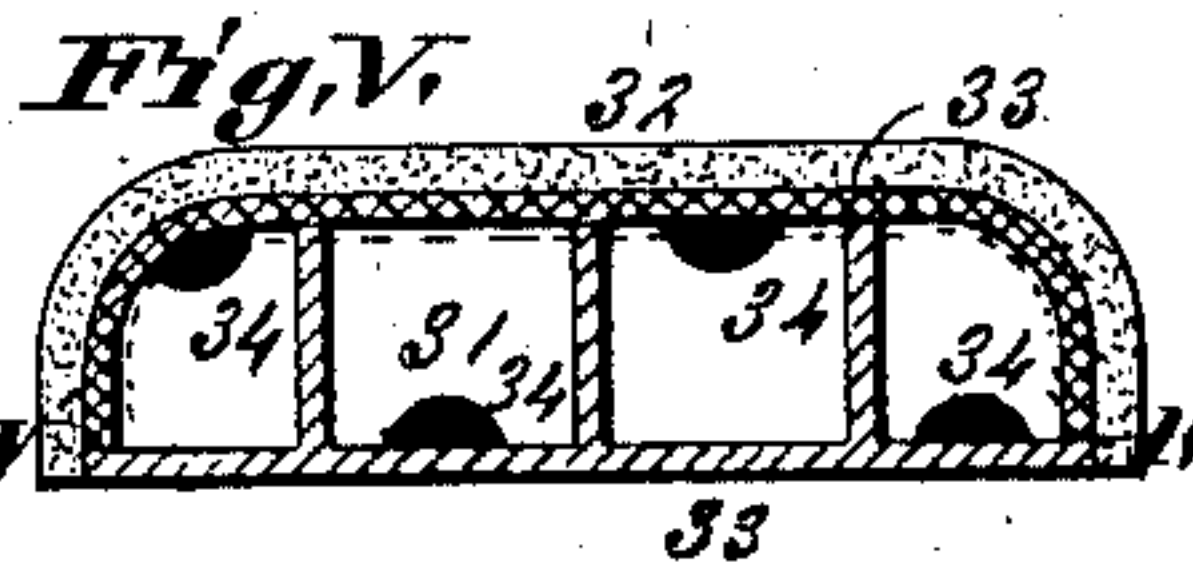


Fig. V.



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Fig. VI.

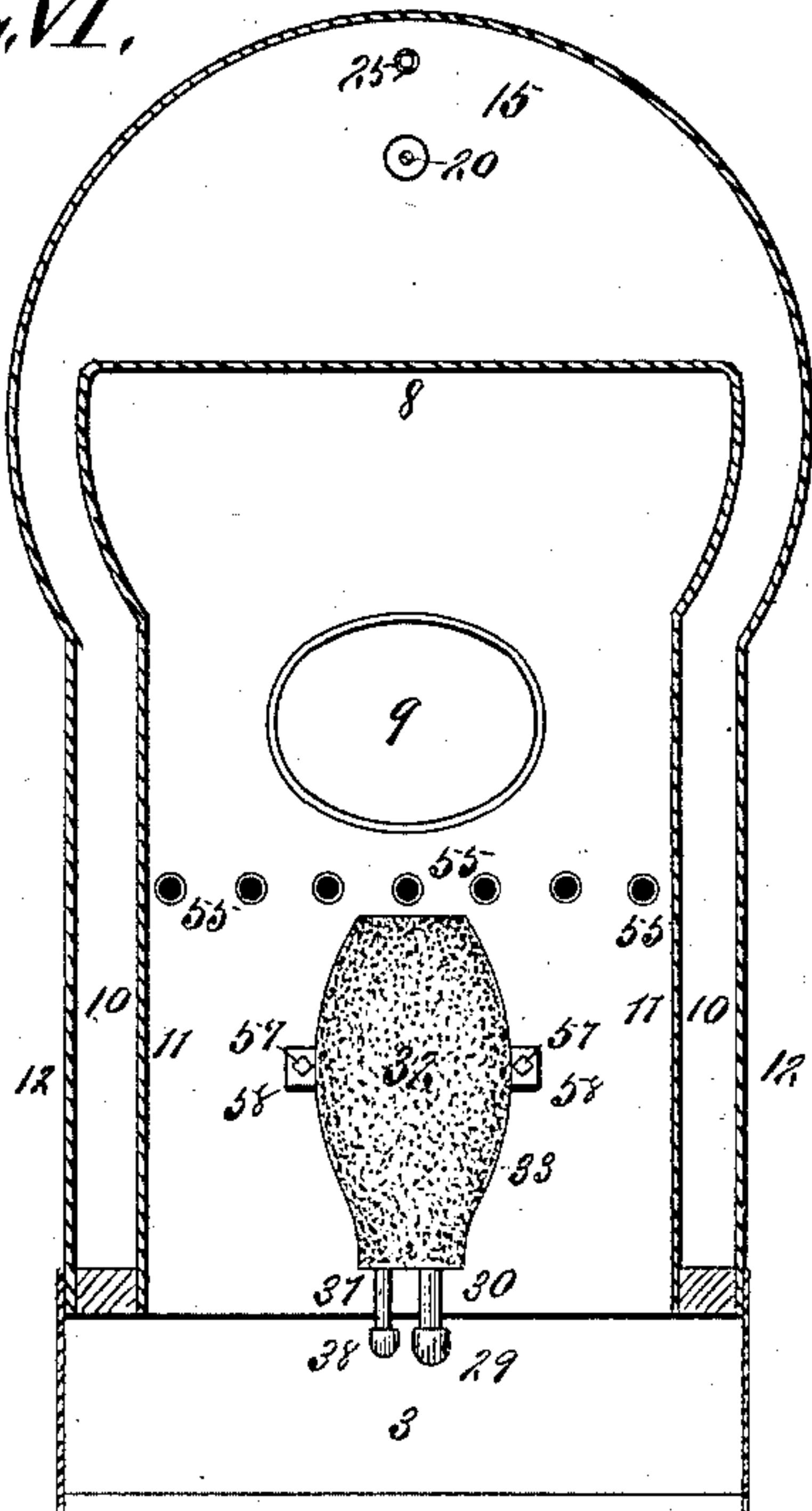


Fig. VII.

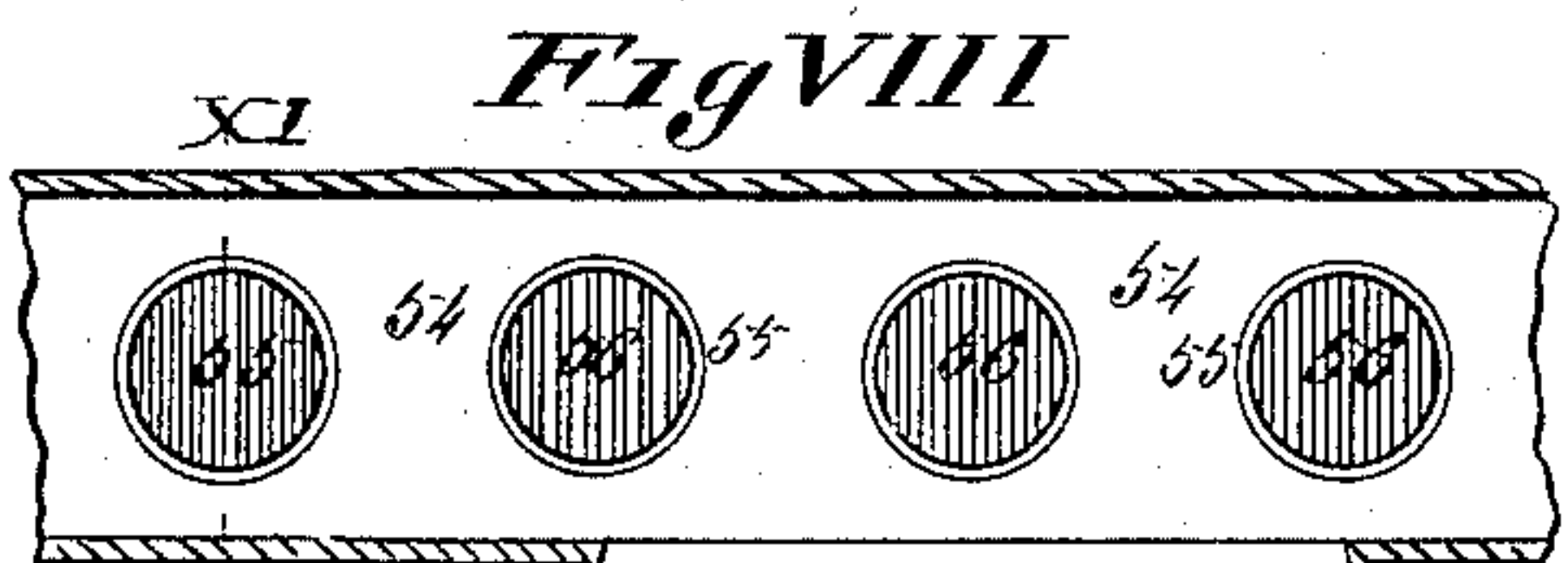
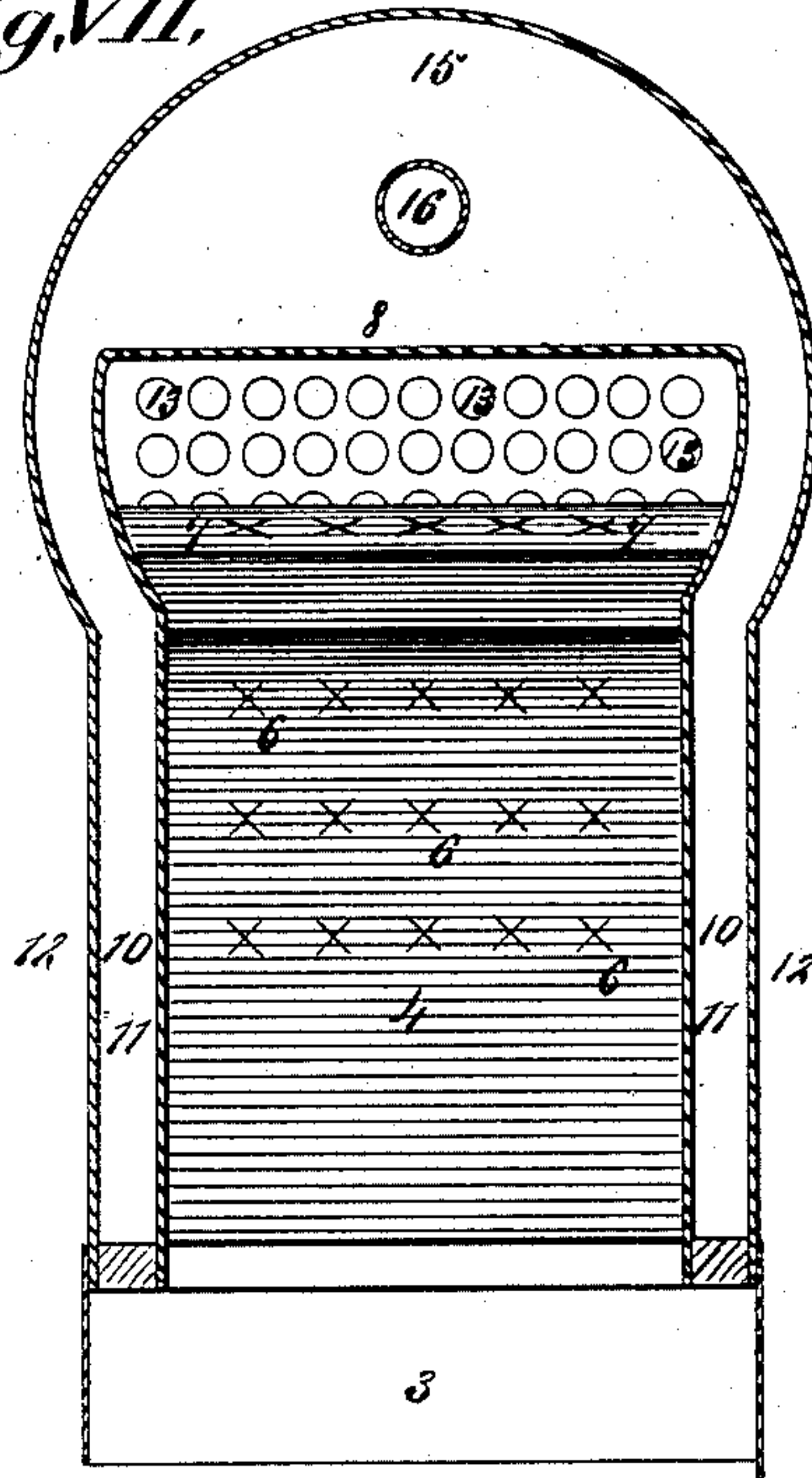


Fig. IX.

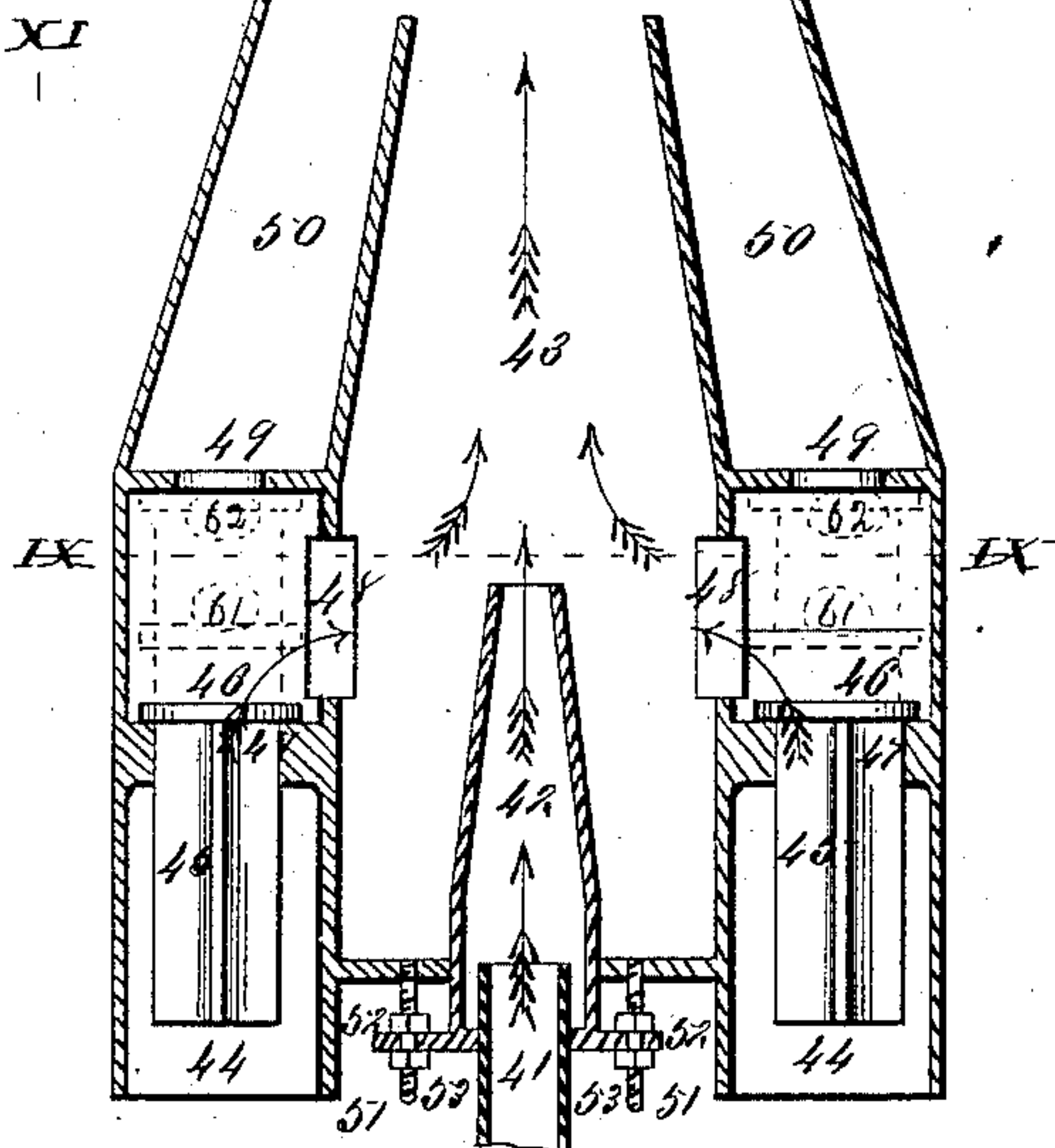
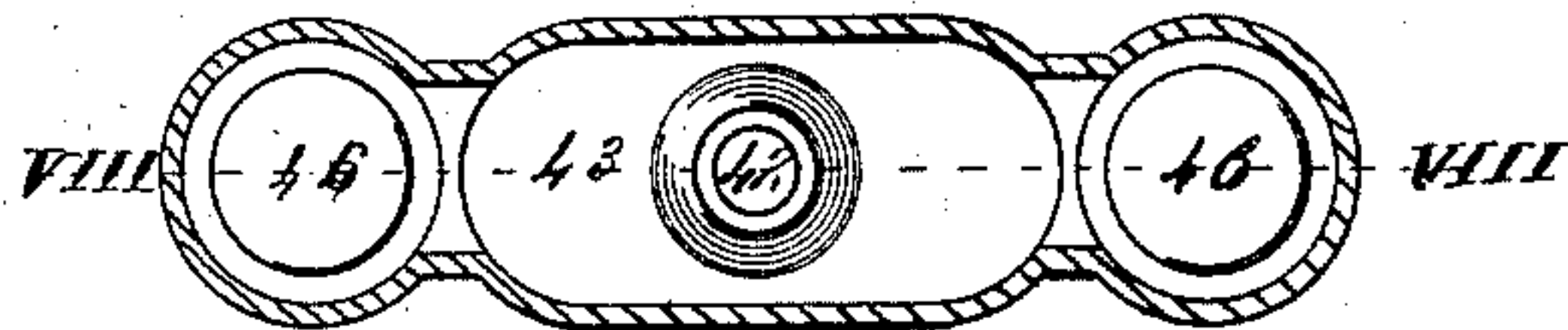


Fig. X.

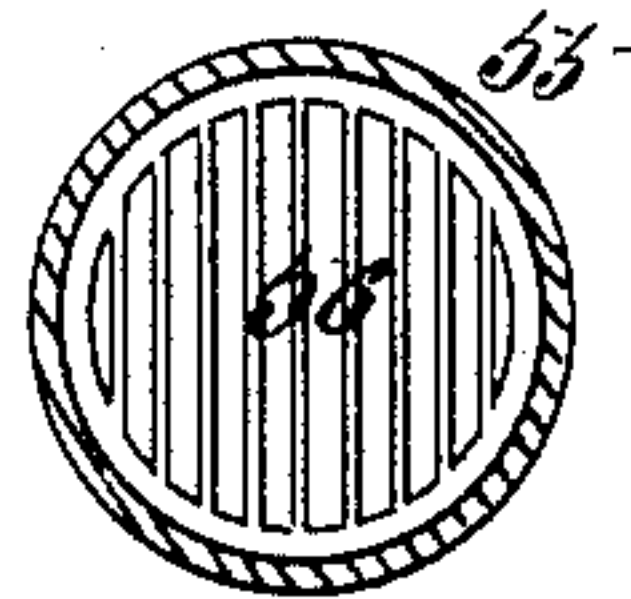
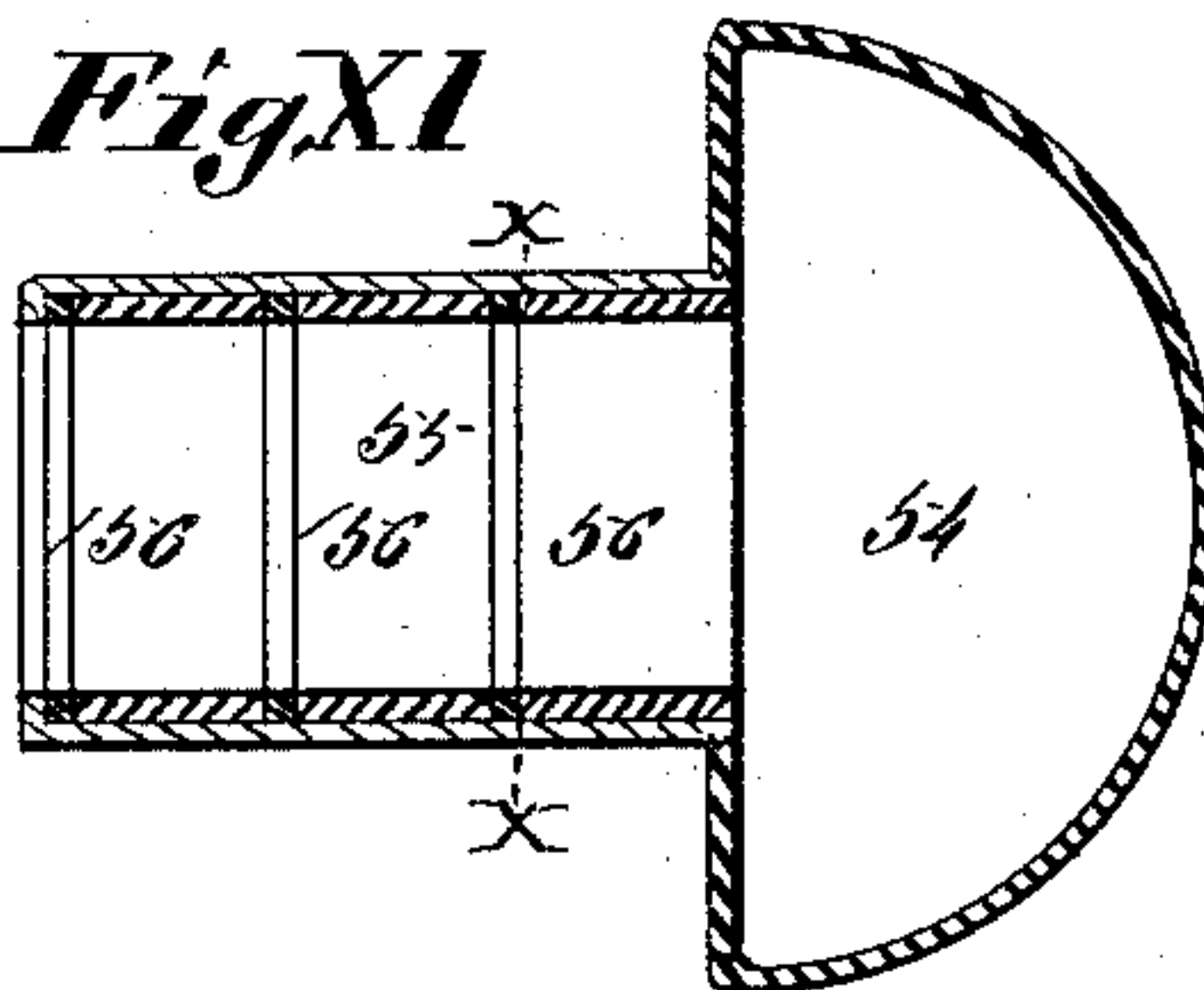


Fig. XI.



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UNITED STATES PATENT OFFICE.

CORBIN E. DAVIS, OF ST. LOUIS, MISSOURI, ASSIGNOR OF ONE-HALF TO
HENRY A. ISMOND, OF SAME PLACE.

SMOKE-CONSUMING FURNACE.

SPECIFICATION forming part of Letters Patent No. 374,457, dated December 6, 1887.

Application filed August 11, 1887. Serial No. 246,705. (No model.)

To all whom it may concern:

Be it known that I, CORBIN E. DAVIS, of the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Smoke-Consuming Furnaces, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, and in which—

10 Figure I is a rear end elevation showing the receiving-pipe that conducts steam through a secondary throttle-valve to be operated on in the superheating regenerator-cells. Fig. II is a vertical section taken on line II II, Fig. I, showing the action of the throttle-valves, the receiving steam-pipe leading to the superheating-cells and from thence to the combining-chamber, where the superheated dry steam or its gaseous constituents are mixed with atmospheric air, and from thence discharged into the fire-box. It also shows the back arch with its tortuous flues. Fig. III is a longitudinal section taken on line III III, Fig. IV, showing the tortuous passage of the steam through one series of the superheating-cells. Fig. IV is a section taken on line IV IV, Fig. V, showing the tortuous course of the steam through the four series of superheating regenerator-cells. Fig. V is a transverse section taken on line V V, Fig. IV, showing the apertures in the partitions between the cells alternately at front and back of said partitions, to enforce a tortuous course of the steam during the process of superheating, and regenerator-cells. Fig. VI is a vertical section taken on line VI VI, Fig. II, showing the ovate bulb-casing of the superheating-cells, the receiving steam-pipe entering the same, and the connecting-pipe leading to the combining-chamber. It also shows the mouths of the pipe from said chamber that discharge the smoke-consuming gases into the fire-box. Fig. VII is a vertical section taken on line VII VII, Fig. II, showing the arch in the back of the fire-box, the vents from its internal flues for the escape of the rarefied air that is drawn from the ash-pit, the crown-sheet above the fire-box, and the entrance to the boiler-flues. Fig. VIII is a vertical section taken on line VIII VIII, Fig. IX, showing the combining-chamber in which

the superheated steam or gas, coming through its central supply-pipe and funnel, mixes with the air that is drawn through the adjacent side pipes, and is discharged through a series of pipes above into the fire-box to provide the necessary gases to aid ignition of the carbon in the smoke. Fig. IX is a transverse section taken on line IX IX, Fig. VIII, showing the air-pipes and mouth of the funnel discharging into the combining-chamber. Fig. X is a vertical section taken on line X X, Fig. XI, showing the grated damper for insertion in the supply-pipes that discharge the requisite gases into the fire-box to aid ignition of the carbon; and Fig. XI is a vertical section taken on line XI XI, Fig. VIII, showing the transverse pipe that surmounts the combining-chamber and the supply-pipes from it to the fire-box. It also shows the position of the grated dampers therein.

This invention relates to devices for consuming smoke in the fire-boxes of locomotives and stationary engines; and the invention consists in features of novelty hereinafter fully described, and pointed out in the claims.

Referring to the drawings, in which similar figures of reference indicate like parts in all the views, 1 represents the furnace or fire-box; 2, the grates; 3, the ash-pit; 4, the back-arch; 5, the tortuous flues within the back-arch, through which rarefied air from the ash-pit beneath the furnace is carried in circumlocutory directions—first ascending through the front flue and giving off a part of its volume through the perforations 6 in front of the arch to add atmospheric oxygen to the superabounding carbon within the fire-box, then descending through the middle flue, and eventually ascending through the back flue and discharging through the perforations 7 in close proximity to the entrance of the boiler-flues. By this means the intense heat of the hollow back-wall arch is utilized by the suction of a draft from the ash-pit through its flues to superheat the air before its entrance to the boiler-flues, and at the same time the arch itself is preserved from rapidly burning out.

8 is the crown-sheet that surmounts the fire-box; 9, the furnace-door; 10, the water lining

or jacket between the inner walls, 11, of the fire-box and the outer walls, 12, of said fire-box or furnace.

13 is the boiler; 14, the boiler-flues; 15, the steam-dome; 16, the dry-pipe leading to the cylinder, and 17 the throttle-valve to the engine.

18 is the lever that operates the throttle through its pivoted connecting-rods 19 20 and bell-crank lever 21.

The lever 18 at the same time that it operates the engine-throttle also, by its connecting-link 22, works the throttle 23, which operates in the globe joint 24, that connects the angular jointed steam-pipe 25 (which descends from the dome of the boiler) with the vertical receiving-pipe 26, which pipe connects by an elbow-joint, 27, with a short horizontal pipe, 28, that runs beneath the fire-box. The last-mentioned pipe connects, by an elbow, 29, with a short vertical pipe, 30, that discharges into the first of a series of cells, 31, that form in the aggregate with the metal casing 33 in its shield 32 the complex ovate superheating-column. The said shield is preferably made of fire-clay to protect the metal case and cell partitions from the intense heat of the furnace. The column is secured to the fire-box by screw-nutted bolts 57, that engage in the perforated lugs 58 (that project from the column) and engage in the inner casing of the fire-box.

The steam passes upward from cell to cell through apertures 34, that pass through the partitions 35 alternately at the back and forward sides of said partitions, so as to give the course of the steam a serpentine movement and both retard its progress through the cells of the column and make it sweep with more persistence against its superheated sides and regenerate its product. After passing upward through the first series of cells longitudinally of the column, the steam, becoming more and more highly heated, passes through one of the apertures 36, that connect the vertical series of cells, and downward through the second series, up again through the third series, and down through the fourth or last series, from which it or its gaseous product passes in an intensely-heated condition by the short vertical pipe 37, that connects by the elbow-joint 38 to the horizontal pipe 39, the return-elbow 40, and pipe 41, which delivers it into the funnel 42, that discharges into the combining-chamber 43, which is secured to the outer casing by the bolts 59, that pass through the lugs 60 and engage in the outer casing of the fire-box or furnace.

44 are two side air-tubes that ascend parallel with the combining-chamber 43, and have ports opening into said chamber. Said tubes are provided with drop-valves 45, that are surmounted by disks or valve-seats 46, which, when the valves are at rest, close the ports 47, which they sit down on; but when a draft is formed by rapid ascension of the superheated

dry steam or its constituents (the disunited aqueous gases) through pipe 41, funnel 42, and the combining-chamber 43, and a strong suction thereby engendered through the open ports 48, said drop-valves are elevated thereby; also, the rarefied external air heated by the high temperature of the superheated steam passing through the adjacent pipes and funnel has suction through the open mouths of the pipes 44, (being driven forward by the cooler denser air at its back.) Thus this drive force from beneath the valves uniting with the suction force exerted by the rapidly-ascending aqueous gases in the combining-chamber elevates the valves at first to the intermediate position shown at 61, when the air will begin to pass through the lower part of the open ports 48 and be mixed with the dry steam or aqueous gases in the combining-chamber; but the combined suction from above and drive force from beneath, if the engineer has let on a full head of steam, soon elevates the valves until their disk-heads close the open ports 49, as seen at 62, that communicate with the flues 50, said flues discharging at the summit of the combining-chamber. The ports 48 are thus fully disclosed, allowing the air that ascends through the open drop-valves to rush through into the combining-chamber and intimately mix with the highly-heated dry steam or aqueous gases.

Screw-bolts 51, that hang pendent from the bottom of the combining-chamber, pass through foot-flanges 52 of the funnel 42, and said parts are thus coupled together and secured by nuts 53, that engage on the bolts.

The gas products of the superheated dry steam, combined with the air introduced through the open ports 48, rapidly ascend to the horizontal distributing-chamber 54, and from that through the discharge-pipes 55 into the fire-box, where the highly-superheated combination provides the essential gases, that the carbon (with which the smoke is densely saturated) lacks, to cause ignition and utilize the same in its consumption.

56 are damper-grates that are seated in the discharge-pipes 55 to dampen the force of delivery of the gaseous combination, the number of such grates being regulated to relatively adjust the force of the draft and keep it within bounds that will not overcome the natural draft of the furnace. There may be two or three of these damper-grates in each pipe, as shown; but I do not confine myself to that number, for it may be advantageously increased or diminished, as circumstances may demand. I also provide an automatic device to equalize the supply of the gaseous draft to the limit that the distributor is able to discharge. When the supply in the combining-chamber exceeds said limit, a back-draft is engendered down the flues 50 through ports 49, which forces back the drop-valves 45 to the position shown in full lines in Fig. VIII. While in that position the supply of air is entirely shut off from the chamber until the

distributor is no longer choked, when the valves again automatically rise into their open position.

The combining-chamber and its attached flues are secured to the outer wall of the furnace by bolts 59, which pass through lugs 60, that project from the casing of said chamber and secure it in said position.

The operation of my smoke-consuming device is as follows: The pipe 25 is charged with steam from the dome of the boiler, where said steam is the driest, and when the throttle is thrown open to supply the cylinder, simultaneously, by the action of the same lever, a throttle-valve in the globe-joint that connects the steam-pipe 25 with the vertical receiving-pipe 26 is also thrown open, letting the steam for my smoke-consuming device through the connecting-pipes, heretofore described, to the series of cells (I show twenty-two in four vertical flues, but do not confine myself to that number) in the complex ovate superheating or regenerator column. The steam is made to take a zigzag course by alternating the openings through which it passes from front to back, and vice versa, and passing it upward and downward in the four series of flues, (see Figs. III, IV, and V,) the column being itself intensely heated from its position in the furnace, so that the steam in its long and tortuous course becomes sufficiently superheated to divorce the union of the oxygen and hydrogen, (the constituent elements of water, from which the steam is generated,) and thus separate the aqueous gases into their constituent parts. In this form it is commonly called "dry" steam, and is a great feeder of combustion when united with other elements that favor ignition, especially at high degrees of temperature. The steam then passes from the superheating regenerator column through connecting-pipes and the discharge-funnel into the combining-chamber 43, where it is mixed with a supply of atmospheric air that is drawn up into said chamber, as before described.

If the head of superheated steam is not very great, the drop-valves may be only lifted to the lowest position shown in dotted lines; but it is generally preferred to provide a sufficient head of steam that will also insure corresponding action in the air-tubes to raise the valves to their under seat beneath the ports 49, which they then close until, if the supply overcharges the distributor, as before described, the said valves are forced back and close the ports 47, shutting off the supply of atmospheric air. When the atmospheric current passes into the combining-chamber it is mixed, as described, with the aqueous gases generated from the superheated dry steam, both heating it and bringing it into intimate affinity with said gases preparatory to their united discharge into the fire-box to unite with the carbon, with which the smoke is densely saturated. Thus the dis-

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heated almost to a degree of spontaneous ignition are in a condition for mutual affinity with the highly-heated carbon that, lacking the essential elements for ignition, has been heretofore in a condition to smother the fire.

Care is required in the relative provision of the right proportion of aqueous and atmospheric gases, so that the latter may not preponderate over the former, causing too great a supremacy of oxygen over hydrogen, producing carbonic oxide, or, when in still greater excess, carbonic acid, either of them, especially the last, repugnant to combustion. At the same time sufficient oxygen is required, especially as in possession of its strong chemical affinities, when in rapid affiliation with the carbon, it is very combustible. In the meantime there is carbon enough in the densely-charged smoke also to produce a rapid affinity with the other gaseous element, (hydrogen,) making one of the forms of carbureted hydrogens, which is our common illuminating-gas.

To sum up, the smoke from the furnace, as usual, before the introduction of my smoke-consuming device, is densely saturated with carbon, which lacks the affinities necessary to generate combustion and in consequence smothers instead of aids the same. The required affinities, as above described, unite with the carbon, when, from their superheated condition, the union is still more rapidly and perfectly effected, the act of union also, especially between the oxygen and carbon, forming a prolific source of combustion, so that the smoke with its carbon is entirely consumed and utilized, to the great saving in the cost of fuel, the increase in the capacity of the engine, and the abatement of the smoke nuisance in the surrounding neighborhood.

I have described the shield that covers the ovate superheating-column as preferably of fire-clay; but I do not confine myself to fire-clay, for it may be of cement or any other suitable material.

I claim as my invention—

1. In a smoke-consuming device for locomotives and stationary engines, the combination of two throttle-valves simultaneously regulating the supply of steam to the engine and to the smoke-consuming devices of the furnace, a lever, 18, that simultaneously operates both throttles, receiving-pipes that convey steam to a series of cells, in which it is superheated and regenerated, to disunite its constituent elements to produce aqueous gases, the combining-chamber 43, in which said gases are mixed with air received through tubes 44 and regulated by drop-valves 45, the distributing-chamber 54, and pipes 55, that discharge said gaseous elements into the fire-box to combine with the carbon in the smoke and cause its ignition, substantially as and for the purpose set forth.

2. In a smoke-consuming device for locomotives and stationary engines, the combination of the steam-receiving pipes, the second-

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ary throttle 23, operated by the lever 18 to furnish steam to the series of superheating regenerator-cells 31, the air-tubes 44, combining-chamber 43, and the drop-valves 45 and their disk-tops 46, all arranged to disunite the aqueous gases and combine them with atmospheric air, and through connecting-pipes discharge them into the fire-box to unite with carbon in the smoke and aid its ignition, substantially as and for the purpose set forth.

3. In a smoke-consuming device for locomotives and stationary engines, the combination of the throttle-lever adapted to simultaneously operate the engine-throttle and secondary throttle for supplying steam to the superheating regenerator-cells provided with a shield of fire-clay, said series of cells having a tortuous passage for the steam where its constituent parts are disunited to provide dry steam or aqueous gases, with the combining-chamber where said products are aerated, the distributing-chamber, and damper-grates 56 in discharge-pipes that deliver into the fire-box to aid the ignition of the carbon in the smoke, substantially as described, and for the purpose set forth.

4. In a smoke-consuming device for locomotives and stationary engines, the combination of the superheating regenerating-cells for decomposition of the steam into its constituent aqueous gases, the air-flues 44, drop-valves 45, ports 47, 48, and 49, and pipes connecting column of superheating regenerator-cells with the funnel 42, that discharges into the chamber 43, into which atmospheric air is admitted from said air-flues, mixed with the aqueous gases, discharged into the distributor 54, and *via* pipes 56 into the fire-box, to aid the ignition of the carbon in the smoke, substantially as described, and for the purpose set forth.

5. In a smoke-consuming device for locomotives and stationary engines, the combination of the series of superheating and regenerator cells for decomposing the steam into its constituent parts, and the aqueous gases, and their mixture in the combining-chamber with atmospheric air and discharge into the fire-box to add the necessary affinities to the carbon in the smoke to insure its ignition and consumption, substantially as and for the purpose set forth.

6. In a smoke-consuming device for locomotives and stationary engines, the combination of the fire-box, the back-wall arch 4, with tortuous flues 5 and vents 6 7, the superheating regenerator-cells, and aerating supply-flues 44, with valves 45, the combining-chamber 43, distributor 54, and damper-grates 56 in pipes 55, said pipes discharging the aerated aqueous gases into the fire-box to affiliate with the carbon in the smoke and cause its ignition, substantially as described, and for the purpose set forth.

7. In a smoke-consuming device for locomotives and stationary engines, the combination of the receiving steam-pipe 26, supplied from the top pipe, 25, through the secondary throttle 23, that connects them, the pipes connecting said receiving-pipe and the superheating regenerator-cells, said cells placed in series, with connecting vents arranged to lead the steam through a tortuous passage, delay its exit from the cells, and cause it to sweep laterally with force against the superheated walls of said cells to decompose the steam, the combining-chamber, into which it is discharged, air-flues discharging into said chamber to aerate the aqueous gaseous product, and distributing-chamber and discharge-pipes that carry it to the fire-box to affiliate with, ignite, and aid the consumption of the carbon in the smoke, substantially as and for the purpose set forth.

8. In a smoke-consuming device for locomotives and stationary engines, the combination of the superheating regenerator-column filled with a series of cells, through which the steam passes in a tortuous direction to delay its exit while disuniting its aqueous gases, the combining-chamber 43, into which said product is discharged, the air-flues 44, drop-valves 45, and ports 47 and 48, for the regulated admission of air to aerate the gaseous product, the distributor 54, and discharge-pipes from distributor to fire-box to deliver the product to affiliate with the carbon in the smoke and aid its ignition and consumption, and the return draft-pipes 50, that, when the distributor is overcharged, carry back the overdraft, which then passes through the port 49 and drives back the drop-valve 45, shuts off the air-supply, and so relieves the overcharged distributor, substantially as and for the purpose set forth.

9. In a smoke-consuming device for locomotives and stationary engines, the combination of the fire-box, the back-wall arch provided with flues, through which passes air from the ash-pit, arranged to heat the air before delivery to the boiler-flues and protect the arch from burning out, the superheating series of cells within the regenerator-column within the furnace for the regeneration of steam into its aqueous gases, the combining-chamber, in which said product is aerated by atmospheric air ascending through the air-tubes 44, and the distributing-chamber and discharge-pipes provided with damper-grates 56, said pipes discharging into the fire-box to add the necessary affinities to the carbon in the smoke to insure its ignition and consumption, substantially as described, and for the purpose set forth.

CORBIN E. DAVIS.

In presence of—

BENJN. A. KNIGHT,
EDW. S. KNIGHT.