

**No. 711,044.**

**Patented Oct. 14, 1902.**

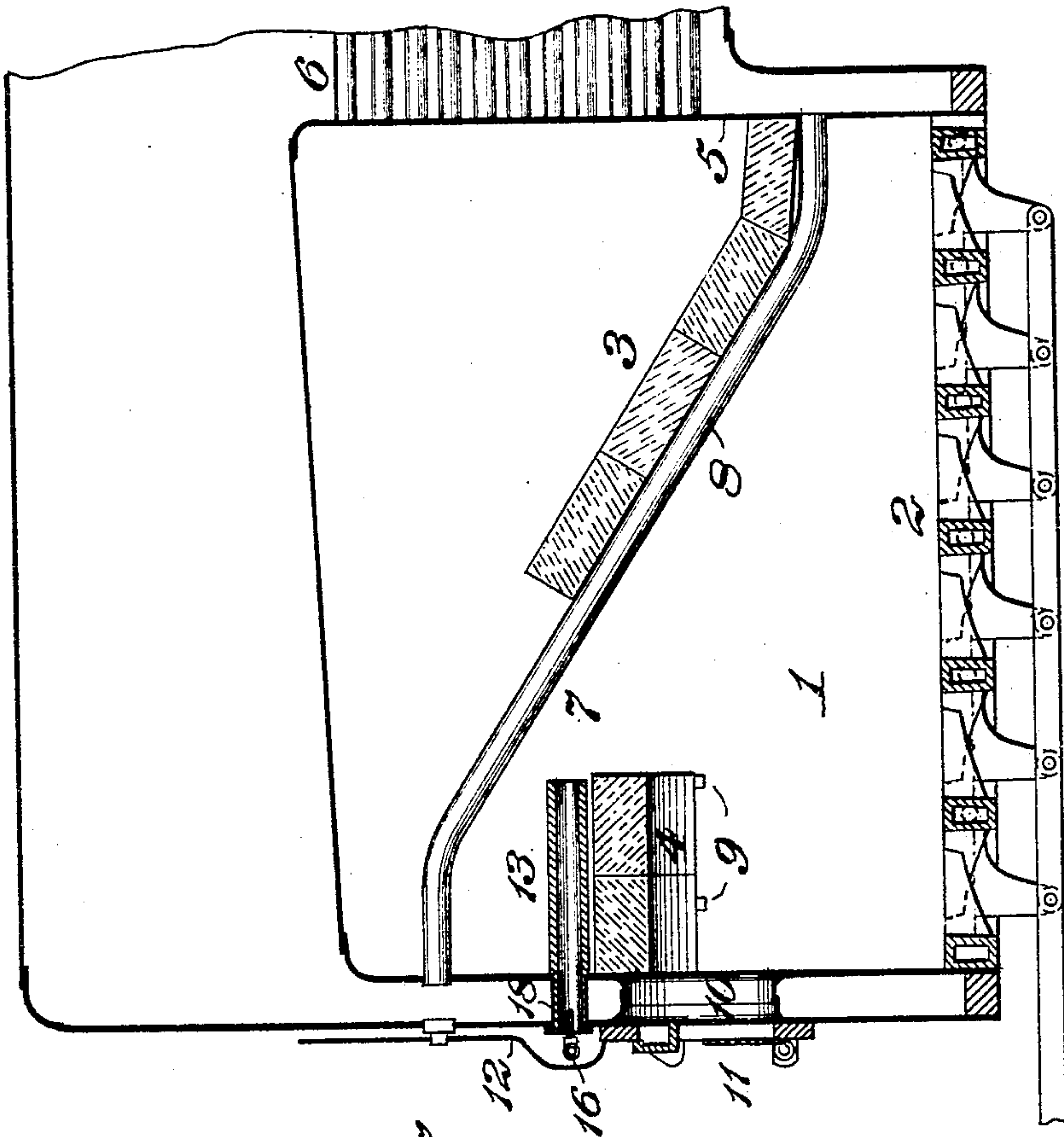
**J. S. S. FULTON.**  
**LOCOMOTIVE BOILER.**

(Application filed July 9, 1902.)

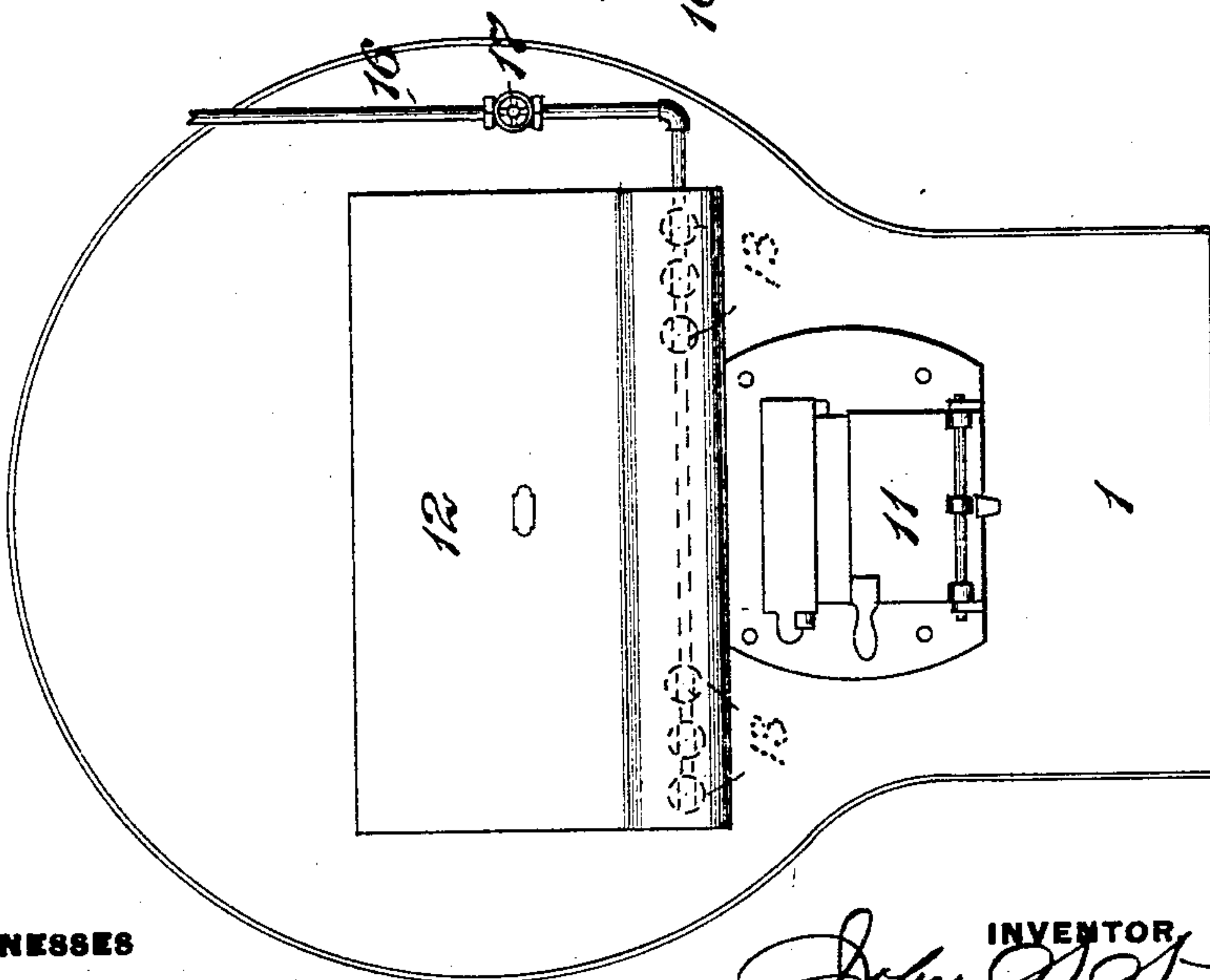
(No Model.)

**3 Sheets—Sheet 1.**

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**WITNESSES**

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**INVENTOR**

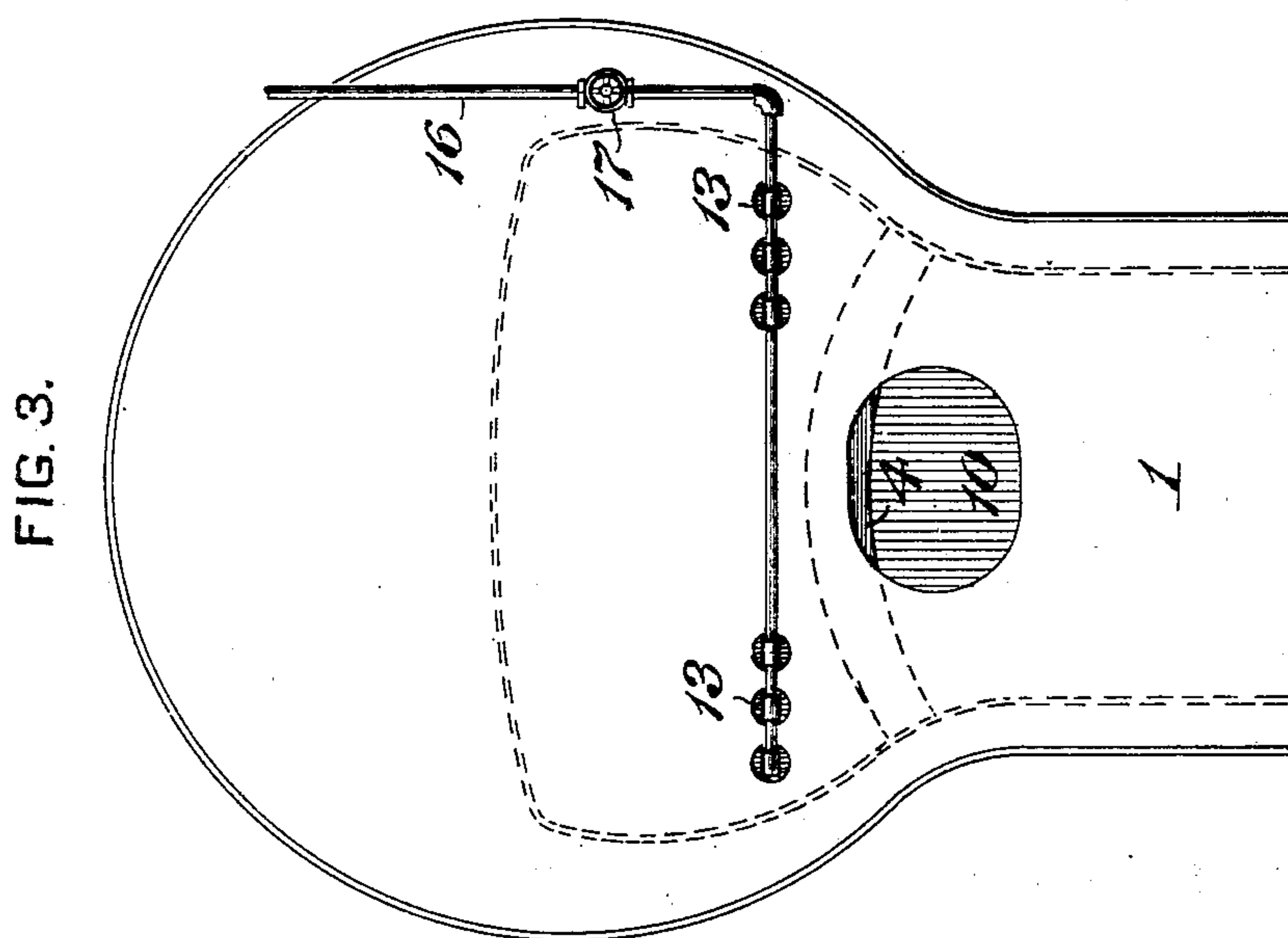
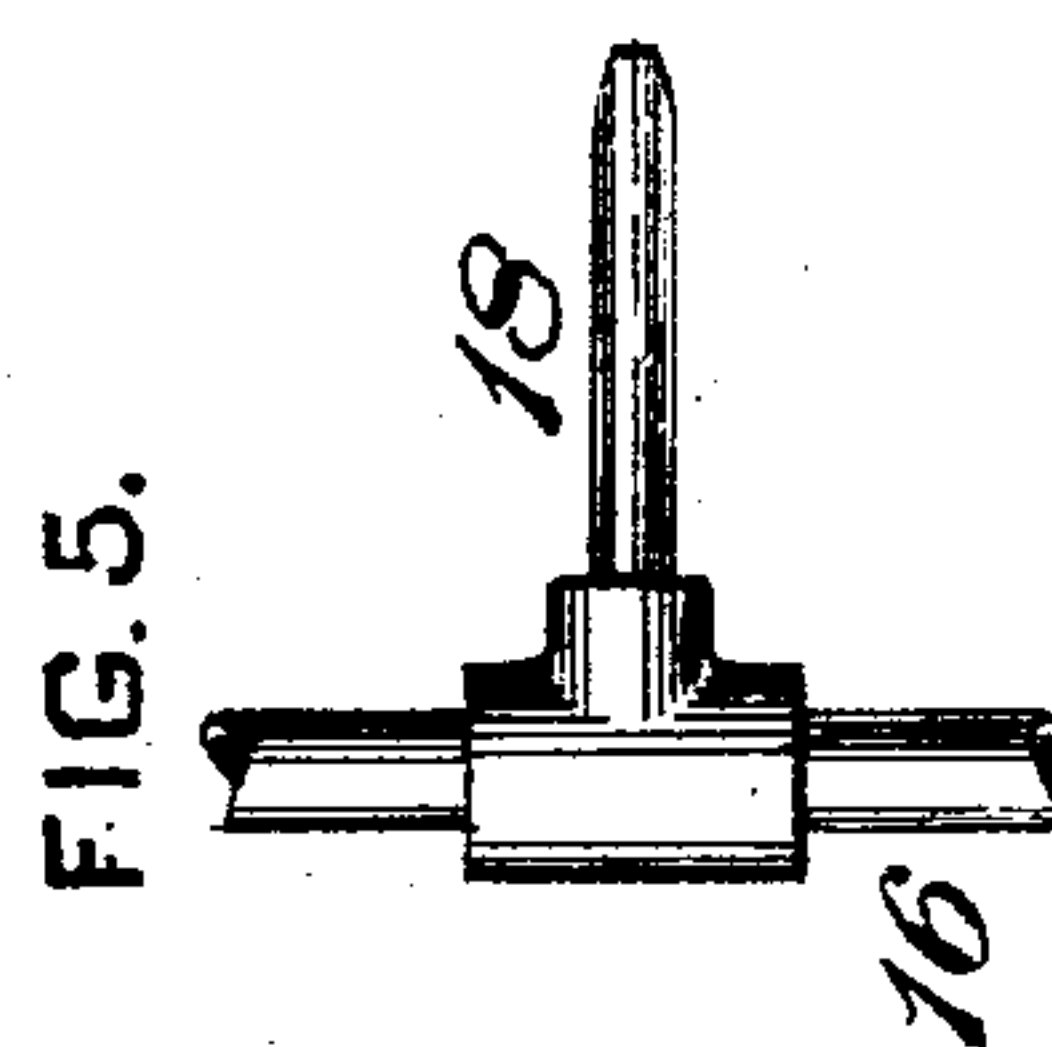
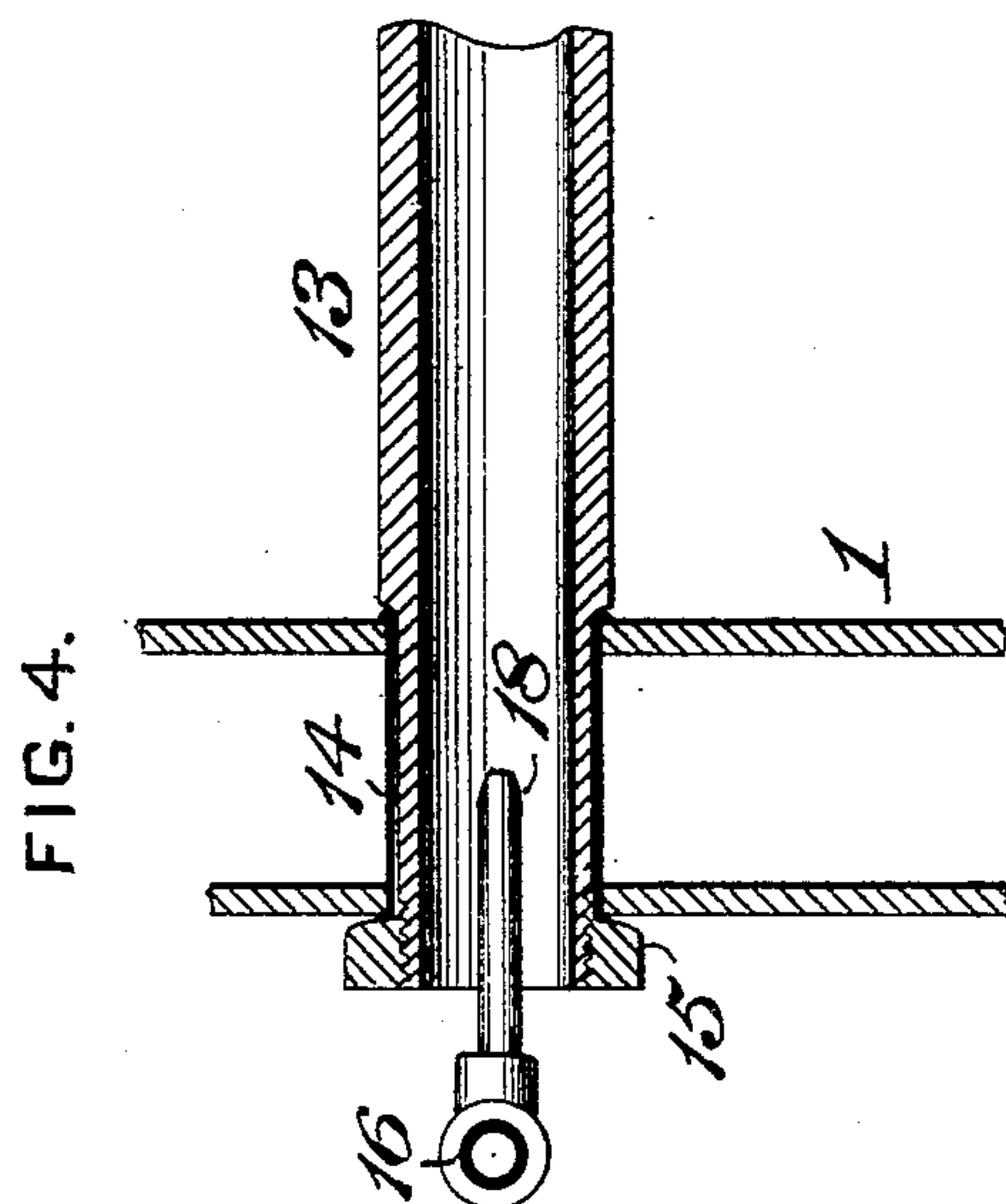
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LOCOMOTIVE BOILER.

(Application filed July 9, 1902.)

(No Model.)

3 Sheets—Sheet 2.



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3 Sheets—Sheet 3.

(No Model.)

FIG. 7.

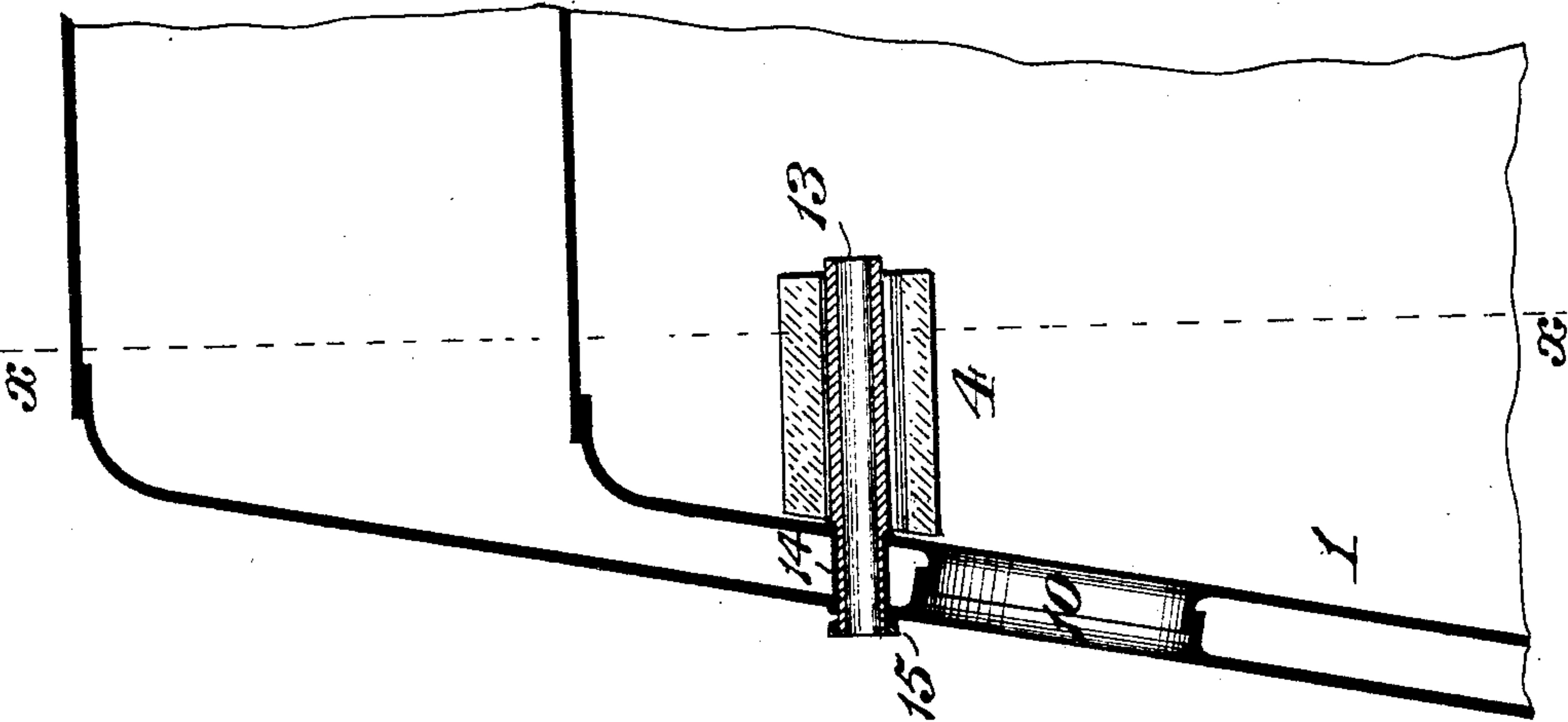
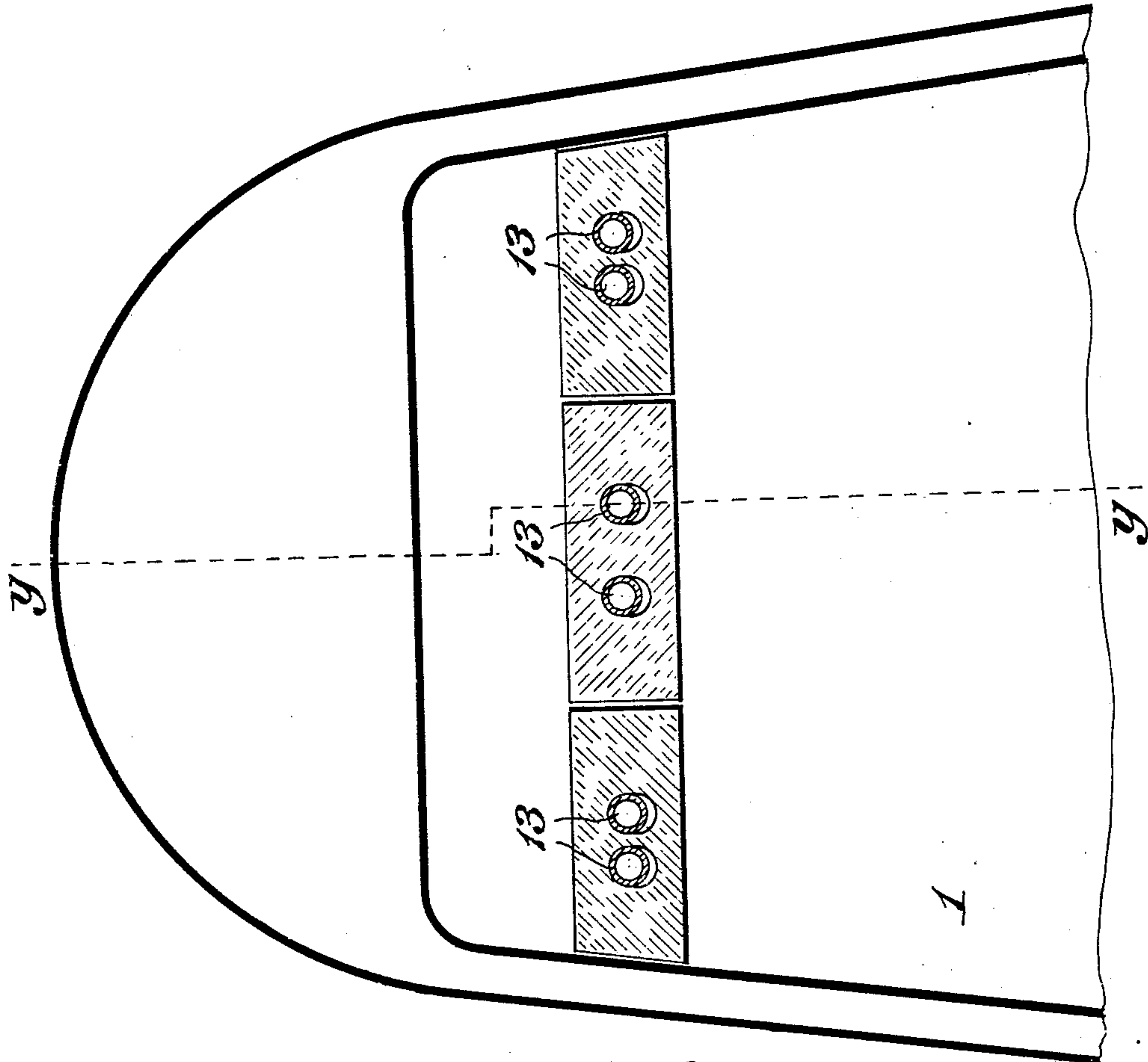


FIG. 6.



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# UNITED STATES PATENT OFFICE.

JOHN S. S. FULTON, OF FRANKLIN, PENNSYLVANIA.

## LOCOMOTIVE-BOILER.

SPECIFICATION forming part of Letters Patent No. 711,044, dated October 14, 1902.

Application filed July 9, 1902. Serial No. 114,852. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN S. S. FULTON, of Franklin, in the county of Venango and State of Pennsylvania, have invented a certain new and useful Improvement in Locomotive-Boilers, of which improvement the following is a specification.

My invention relates to appliances for promoting combustion in the fire-boxes of locomotive-boilers or other boilers which are normally operated under forced draft and for preventing the evolution of smoke and unconsumed or partially-consumed particles of fuel therefrom, thereby economizing fuel consumption and avoiding the annoyance and damage which are occasioned by the discharge of smoke and cinders from the stack.

The object of my invention is to provide an appliance of the above type which shall be simple and inexpensive in construction, of ready applicability in locomotive-boilers of the present standard constructions, and which shall be effective in operation, whether the engine is running under steam, is standing, or is "drifting" with steam shut off.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings, Figure 1 is a view in elevation of the back head of a narrow-fire-box locomotive-boiler with my improvement applied; Fig. 2, a vertical longitudinal central section through the fire-box; Fig. 3, a view similar to Fig. 1, but with the fire-door and its frame and the air-heater casing removed; Fig. 4, a vertical section, on an enlarged scale, through the rear water-wall of the fire-box and one of the air-heater tubes; Fig. 5, a plan view of a jet-pipe for an air-heater tube; Fig. 6, a transverse section on the line  $x x$  of Fig. 7 through the upper portion of the fire-box of a locomotive-boiler of the wide-fire-box type, showing a structural modification of the disposition of the air-heater tubes and rear fire-box division-wall; and Fig. 7, a partial vertical longitudinal section through the same on the line  $y y$  of Fig. 6.

Investigations and experiments have evidenced that in order that the smoke and gases evolved in the combustion of bituminous coal and fuels of analogous character shall be effectively and thoroughly consumed the fol-

lowing at least, among other conditions, are essential, and that the combustion will be more or less successful proportionately as they are complied with, viz: First, the fuel and the evolved products of combustion must be sufficiently heated before the latter are permitted to escape from the fire-box into the tubes; second, air must be supplied to the products of combustion in such manner and to such extent that these products cannot escape before being mingled with sufficient oxygen to effect perfect combustion, and, third, the air supplied must be as highly heated as practicable before being brought into contact with the gaseous products of combustion in order that the temperature of the latter may not be lowered below the igniting-point.

My invention is designed to provide means by the application of which the conditions above stated may be performed in practical service without necessitating any departure from the ruling and essential features of the various forms of locomotive-boilers now in approved use or involving the employment of structural details which are complicated, expensive, or liable by their failure or derangement in operation to impair to any substantial degree the effectiveness of the boiler.

In the practice of my invention the interior of the fire-box 1, which is, as usual, fitted with a lower grate 2 of any suitable and preferred form, is separated by transverse division-walls 3 4, formed of fire-brick or other suitable refractory material, into two spaces, the lower of which contains the fuel in combustion on the grate and through the upper of which the products of combustion evolved from the fuel pass to the tubes 6 and thence to the stack. The front division-wall 3 adjoins and extends rearwardly from the tube-sheet 5, and the rear division-wall 4 adjoins and extends forwardly from the opposite sheet of the fire-box casing. The adjacent ends of the walls 3 and 4 are separated by a comparatively narrow opening or throat 7, extending across the fire-box, through which only communication between the lower and upper fire-box spaces is afforded. As shown in Figs. 2 and 3, the division-walls 3 4 are arched transversely, the front wall 3 being



supported on arch-tubes 8 in the manner of the ordinary fire-box brick arch and the rear wall 4 being supported on studs 9, fixed in the side sheets of the fire-box. The specific form of the division-walls is not, however, an essential of my invention, and they may be made flat instead of being curved or arched transversely, as in the construction shown in Figs. 6 and 7. The rear wall 4 is preferably substantially horizontal in longitudinal section and located at such a height in the fire-box as to clear or nearly clear the fire-door opening 10, and the front wall 3 is upwardly and rearwardly inclined in the manner of the fire-box brick arches in ordinary use, its rear end being about the same height above the grate as the front of the wall 4, this, however, being a matter of structural convenience mainly and not being important.

The division-walls, separated longitudinally by an intervening throat or opening, as above described, perform the function of diverting the products of combustion which are evolved from the entire surface of the body of ignited fuel on the grate to the transverse throat 7 and causing them to meet and thoroughly commingle thereat, thereby effecting the result of causing deficiency or surplus, as the case may be, of a combustible element in currents passing in one direction from the fuel to the throat to be compensated and harmonized by contrary conditions in currents passing to the throat in the opposite direction. Highly-heated air is supplied to the commingled products of combustion as they pass from the throat 7 to the upper portion of the fire-box by air supply and heating appliances, the construction of which is substantially as follows: An air-heater casing 12, which is preferably formed of sheet metal and which is open at its top for the free admission of air and closed at its sides and bottom, is secured to the back head of the fire-box 1 above the frame of the fire-door 11, and a plurality of air-heater tubes 13 extend from the lower portion of the air-heater casing into the fire-box, said tubes being of such length that their inner ends will be located at or near the rear line of the throat 7. The heater-tubes 13 pass through thimbles or sockets 14 in the rear water-casing of the fire-box and are held in position with the capacity of ready removal and renewal, as required, by nuts 15, engaging screw-threads at their outer ends. They may either be located above the rear division-wall 4, as shown in Figs. 1, 2, and 3, or may pass through said wall, as shown in Figs. 6 and 7, and in the latter case may perform the additional function of supports for said wall.

When the engine is running under steam, the draft induced by the action of the exhaust steam from the cylinders maintains a constant inflow of atmospheric air into the air-heater casing 12 and thence through the air-heater tubes 13 to the fire-box, into which the air is delivered at points closely adjoining

the throat 7, which separates the division-walls 3 and 4. The incoming air is preliminarily heated in its traverse through the air-heater casing and is further and highly heated in passing through the tubes 13, which are continuously exposed to the high temperature existing in the fire-box. The heated air thus delivered at the throat 7 meets and mingles with the products of combustion which pass out through the throat, and the supply of oxygen heated to the igniting-point which is thereby effected enables practically complete combustion to be obtained.

In some cases, as when the engine is standing or is drifting down a grade with steam shut off and when, consequently, only a comparatively small amount of air is drawn into the fire-box, it may be desirable to employ from time to time, as desired, means independent of the exhaust-blast, which is not at these times in action, for inducing draft through the air-heater casing and heater-tubes. To this end a steam-supply pipe 16, controlled by a cock or valve 17, is led from the steam-space of the boiler into the lower portion of the air-heater casing 12 and is provided with jet-pipes 18, each having a contracted nozzle, which projects into one of the air-heater tubes 13. By suitable manual regulation of the valve 17 a greater or less draft may be maintained through the air-heater tubes and heated air be thereby supplied in such degree as the condition of the fire may render necessary or desirable.

My improvement has been found in practical railroad service upon locomotives of large capacity to materially improve the steaming qualities of the engines and to effect a substantial economy of fuel, as well as to practically eliminate the emission of smoke and sparks or cinders from the stack with ordinary good firing. A collateral feature of advantage is the protection which the construction affords to the flues against the access of cold air and leakage of flues occasioned thereby, which is a familiar objection in locomotive service. The readiness and inexpensiveness of the application of the improvement to engines of the constructions now in service will be apparent to those familiar therewith, and it contains no parts liable to derangement or which by failure in service would disable the engine or interfere to any substantial extent with its operation.

I am aware that a construction has been heretofore proposed and essayed to some extent in practice in which it was sought to apply the general and long-known principle of supplying heated air to the gases evolved from fuel in combustion on a grate by the provision of tubes leading into a hollow ring of cast-iron located above an opening in an inclined water-wall which extended across a locomotive fire-box, said ring being provided with nozzles from which currents of air induced in the tubes by a steam-jet were dis-



charged into the fire-box around the opening in the water-wall.

So far as my knowledge and information extend the construction above referred to was not found in practice to afford sufficiently satisfactory results to warrant its adoption in continued service, and my invention is designed to utilize the same general principle in such novel structural application as will render it practically and usefully adaptable to the conditions of actual service and will avoid the employment of features or members which are of such character as to be rapidly destroyed by the heat to which they are necessarily subjected, or which, if deteriorated thereby, would involve any substantial interruption of the operation of the boiler or be incapable of ready and inexpensive removal and replacement. The objections which were indicated in practice to be inherent in the prior construction above referred to were the increase in cost of the fire-box, due to the addition thereto of the transverse water-wall or water-space, the rapid deterioration of the water-wall, the superposed ring, and the connected air-tubes by the action of the high heat of the fire-box, and the material expense and delay involved in the renewal of said parts.

My invention embodies a novel combination which presents the following features of advantage not existing in any prior design as to which I have knowledge or information, viz: The division-walls of the fire-box are less expensive and more durable than a water-wall, are not subject to leakage or other detriment which would disable or impair the boiler, and may be readily and inexpensively removed and renewed whenever required. The air-heating tubes are not connected to any interior device, but open freely and directly into the fire-box and being directly accessible from a transverse throat and attached at their outer ends only can be quickly removed and replaced by new ones whenever required. Finally, the discharge of the products of combustion is not restricted to a central opening, but is effected through a transverse throat extending entirely across the fire-box, and the heated air is delivered to the products of combustion passing out of the throat at a plurality of points in a plane parallel therewith, so as to be mingled with the escaping products of combustion at their exit from the throat as thoroughly and effectively as possible.

I claim as my invention and desire to secure by Letters Patent—

1. In a locomotive-boiler, the combination, substantially as set forth, of two transverse division-walls of refractory material, extending rearwardly and forwardly from the front and rear ends of the fire-box, respectively, between the grate and the ends of the tubes, and separated by a transverse opening or throat, and a plurality of removable air-

heater tubes extending through the rear casing of the fire-box into the interior thereof, above the bottom of the adjacent division-wall, and having free inner ends which open directly to the fire-box adjoining, and in a plane parallel with, the transverse throat.

2. In a locomotive-boiler, the combination, substantially as set forth, of two transverse division-walls, extending rearwardly and forwardly from the front and rear ends of the fire-box, respectively, between the grates and the ends of the tubes, and separated by a transverse opening or throat, an air-heater casing fixed to the outer sheet of the rear casing of the fire-box and open at its top to the atmosphere, and a plurality of air-heater tubes, extending from the lower portion of the air-heater casing, through the rear casing of the fire-box, into the interior thereof, above the bottom of the adjacent division-wall, and having their inner ends open to the fire-box adjoining the transverse throat thereof.

3. In a locomotive-boiler, the combination, substantially as set forth, of two transverse division-walls of refractory material, extending rearwardly and forwardly from the front and rear ends of the fire-box respectively, between the grate and the ends of the tubes, and separated by a transverse opening or throat, a plurality of removable air-heater tubes extending through the rear casing of the fire-box into the interior thereof, above the bottom of the adjacent division-wall, and having free inner ends which open directly to the fire-box adjoining, and in a plane parallel with, the transverse throat, and a manually-regulated steam-jet appliance for inducing draft through the air-heater tubes.

4. In a locomotive-boiler, the combination, substantially as set forth, of a transverse division-wall, of refractory material, extending forwardly from the rear casing of the fire-box, thimbles or sockets connecting the inner and outer sheets of said casing above the bottom of the division-wall, removable air-heater tubes fitting freely in said thimbles and extending into the fire-box, with free inner ends which open directly thereto, adjacent to, and in a plane parallel with, the front of the division-wall, and fastening appliances on the outer ends of the air-heater tubes.

5. In a locomotive fire-box, an arch extended from the rear wall of the fire-box, a boxing arranged at the rear of the fire-box and extended along the rear of the boiler, and tubes extended through the wall of the fire-box and over the arch, providing communication between said boxing and the interior of the fire-box, the said tubes being exposed to the products of combustion substantially as specified.

6. In a locomotive, a boxing or plate secured to the rear of the boiler and open at its top, tubes extended from the lower portion



of said boxing into the fire-box, and steam-jet nipples discharging into said tubes, substantially as specified.

5 7. In a locomotive, a fire-box, brick arches extended from the opposite ends of said box, there being a comparatively narrow throat-space between them, a boxing arranged on the rear of the boiler and open at its top,

tubes leading from the lower portion of said boxing into the fire-box above the forward arch, and steam-injecting devices forward of the tubes, substantially as specified.

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Witnesses:

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