

(No Model.)

4 Sheets—Sheet 1.

A. O. SMITH.  
GAS GENERATOR.

No. 412,678.

Patented Oct. 8, 1889.

Fig. 2.

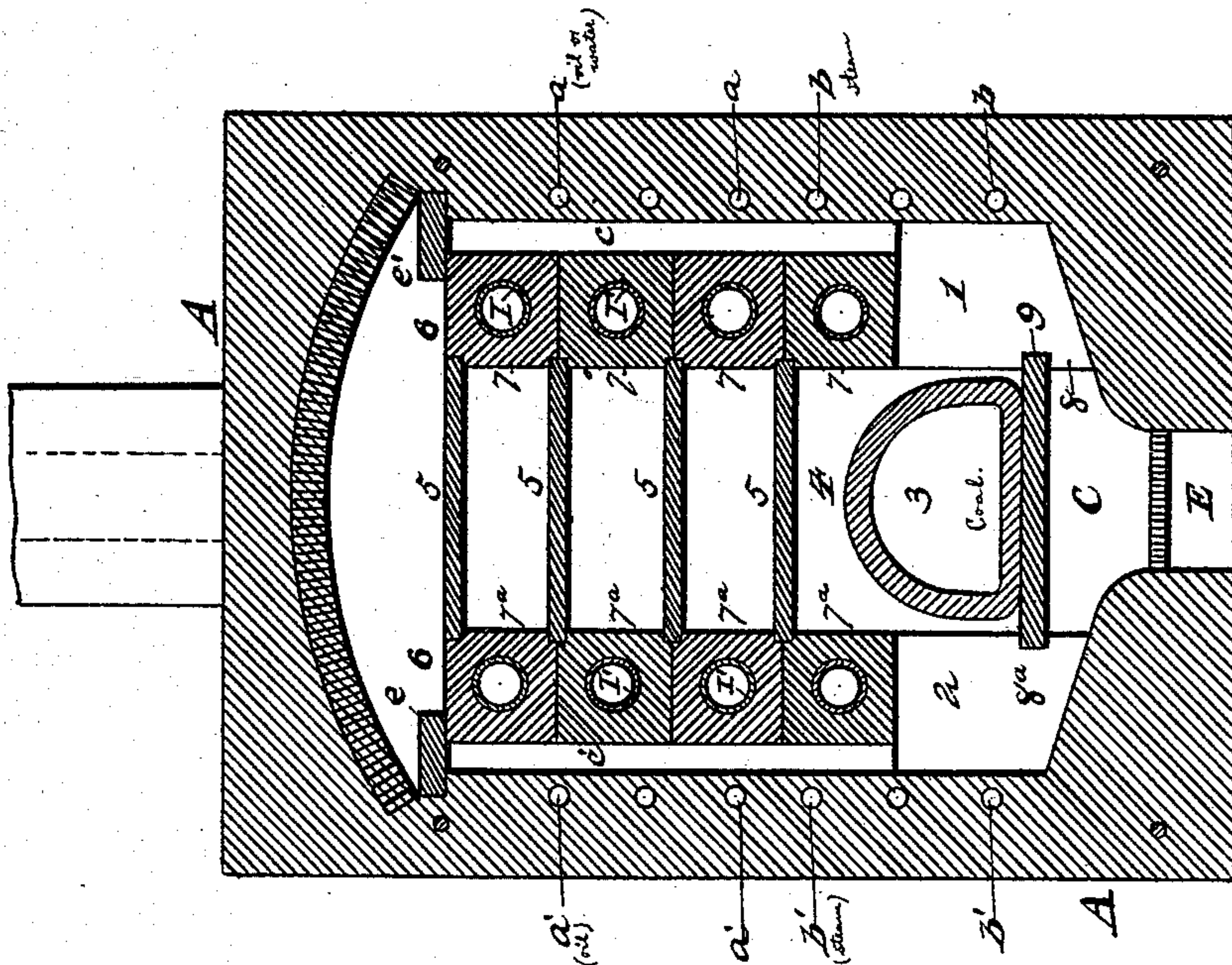
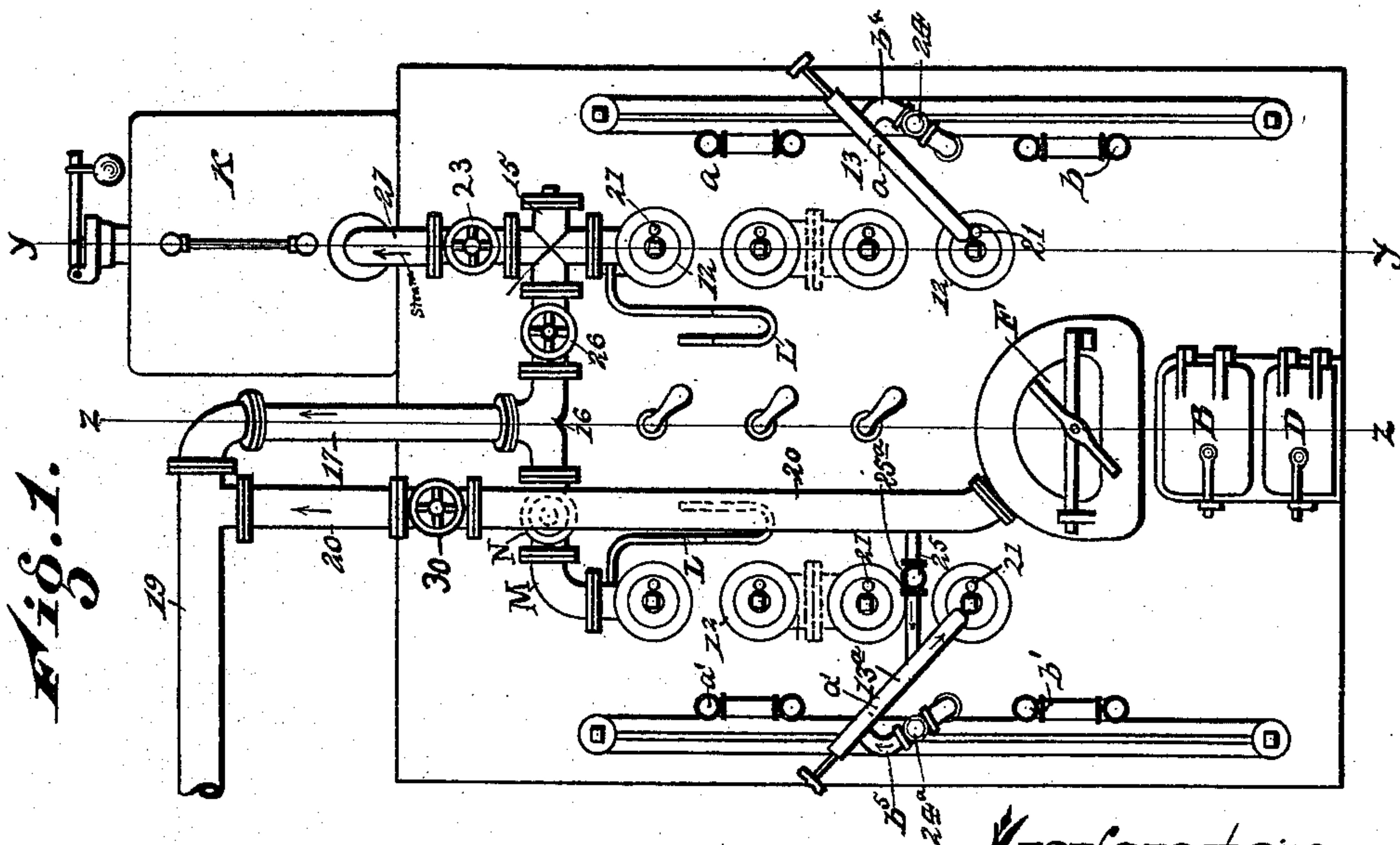


Fig. 1.



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by Wood & Bond  
His Attorneys &c.



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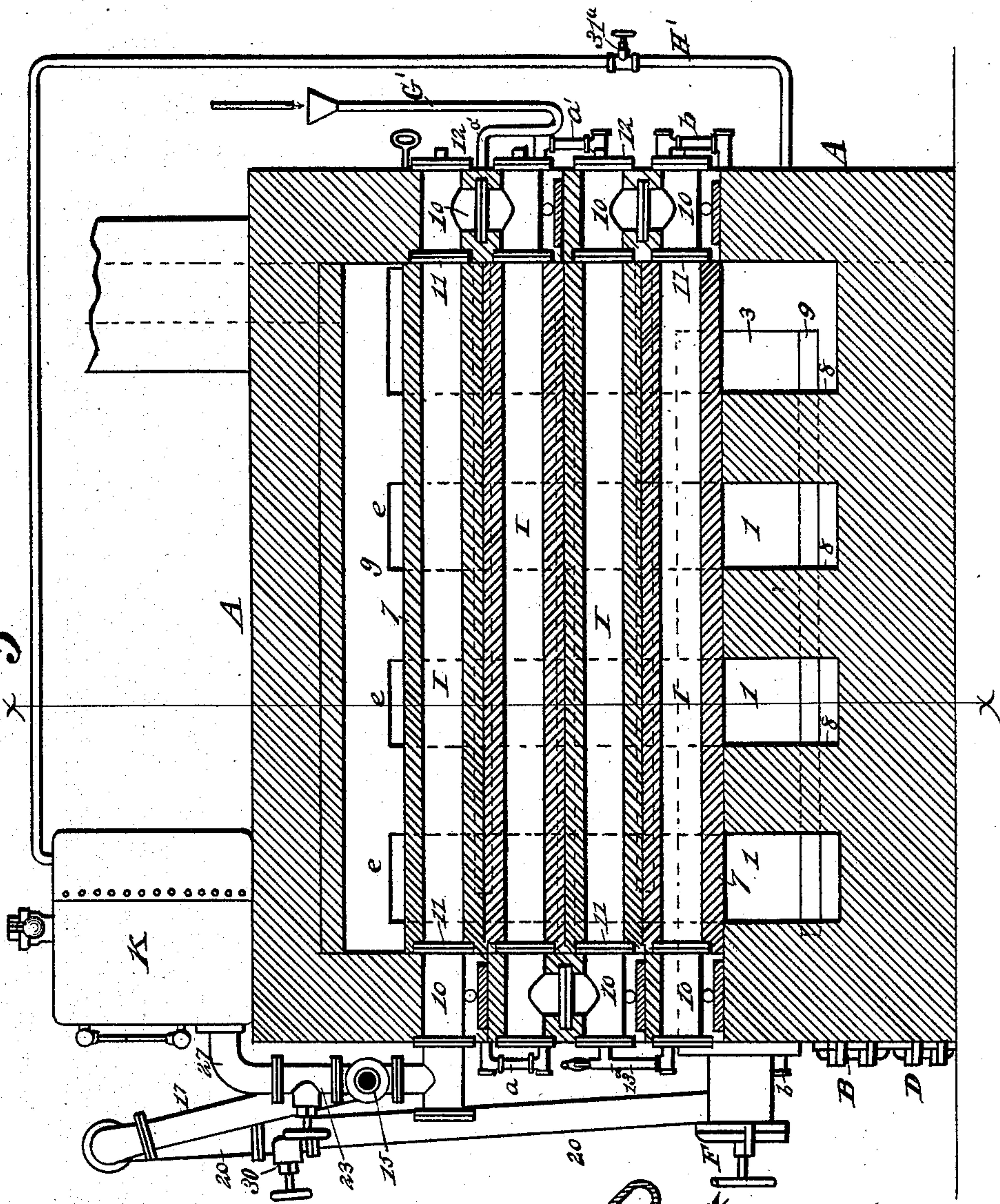
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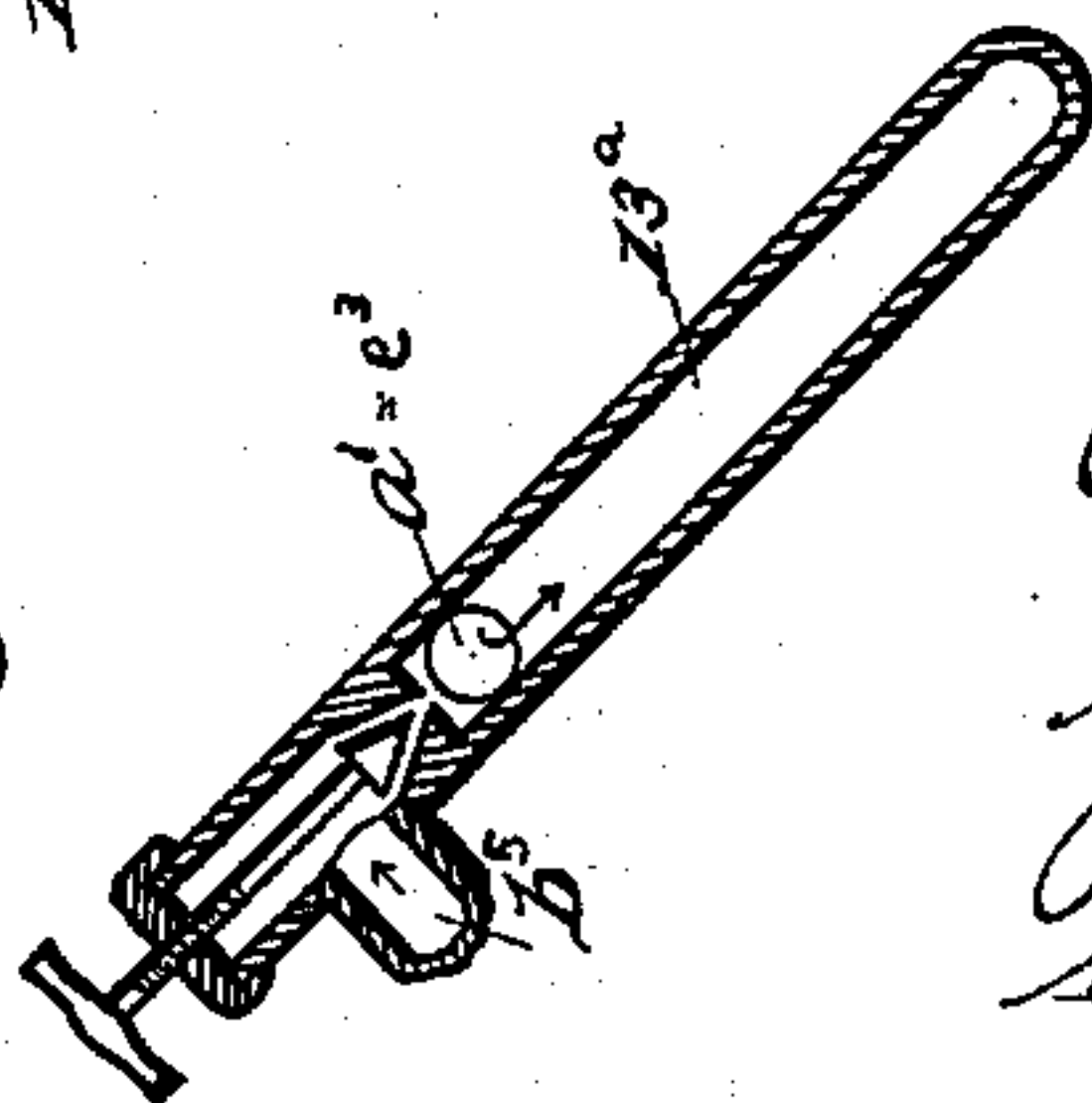
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Fig. 3.



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Fig. 5.



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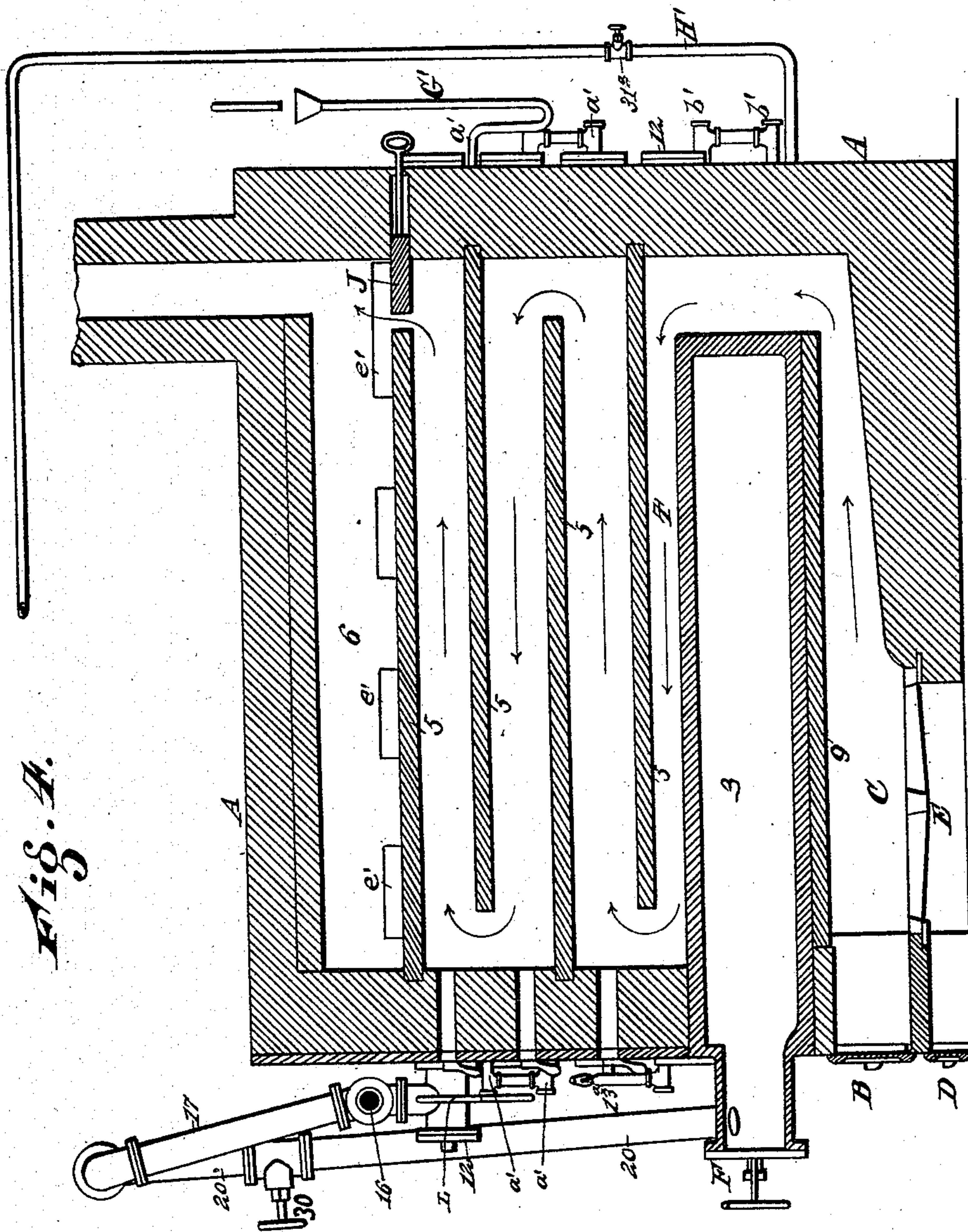


Fig. 4.

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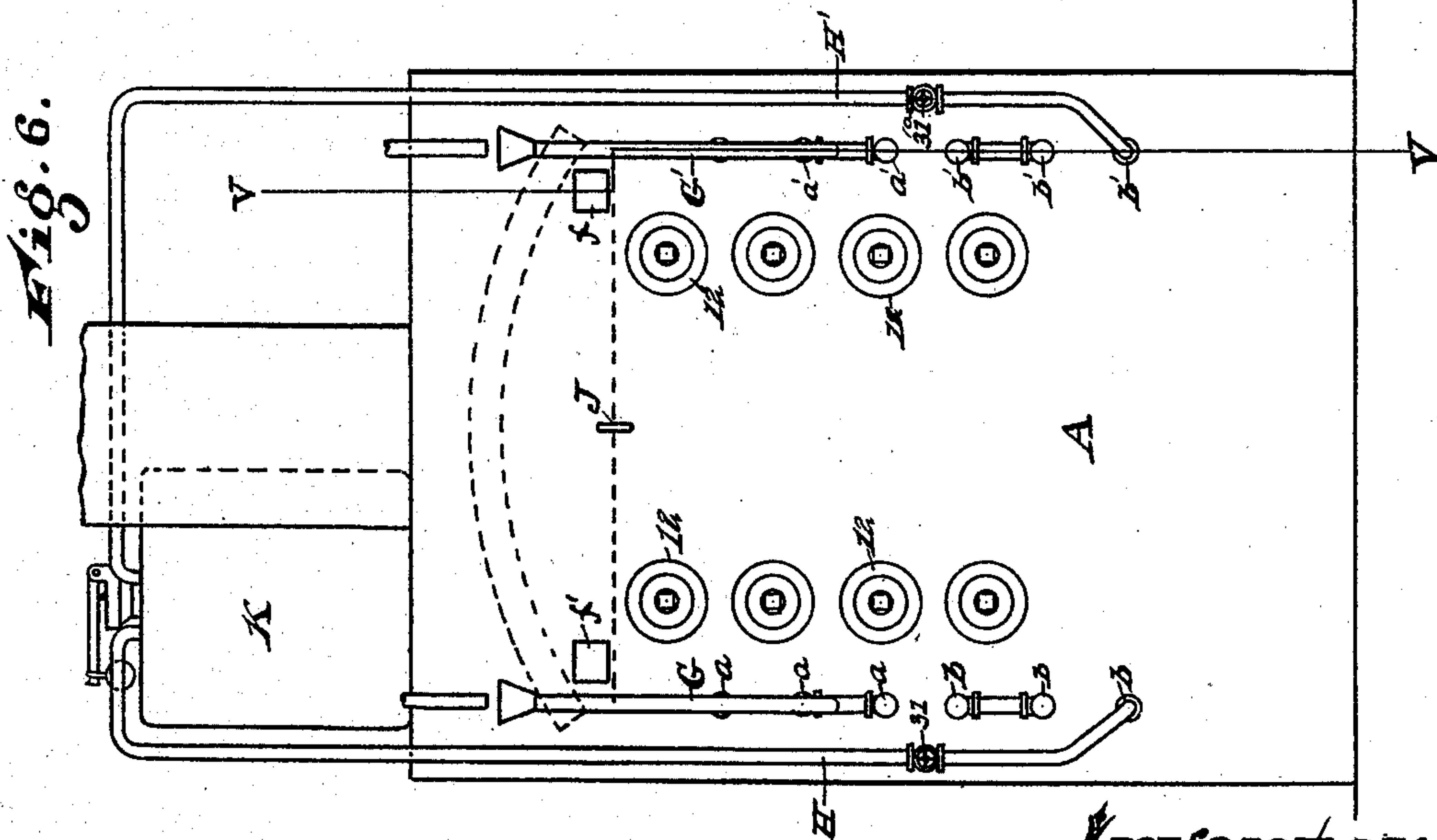
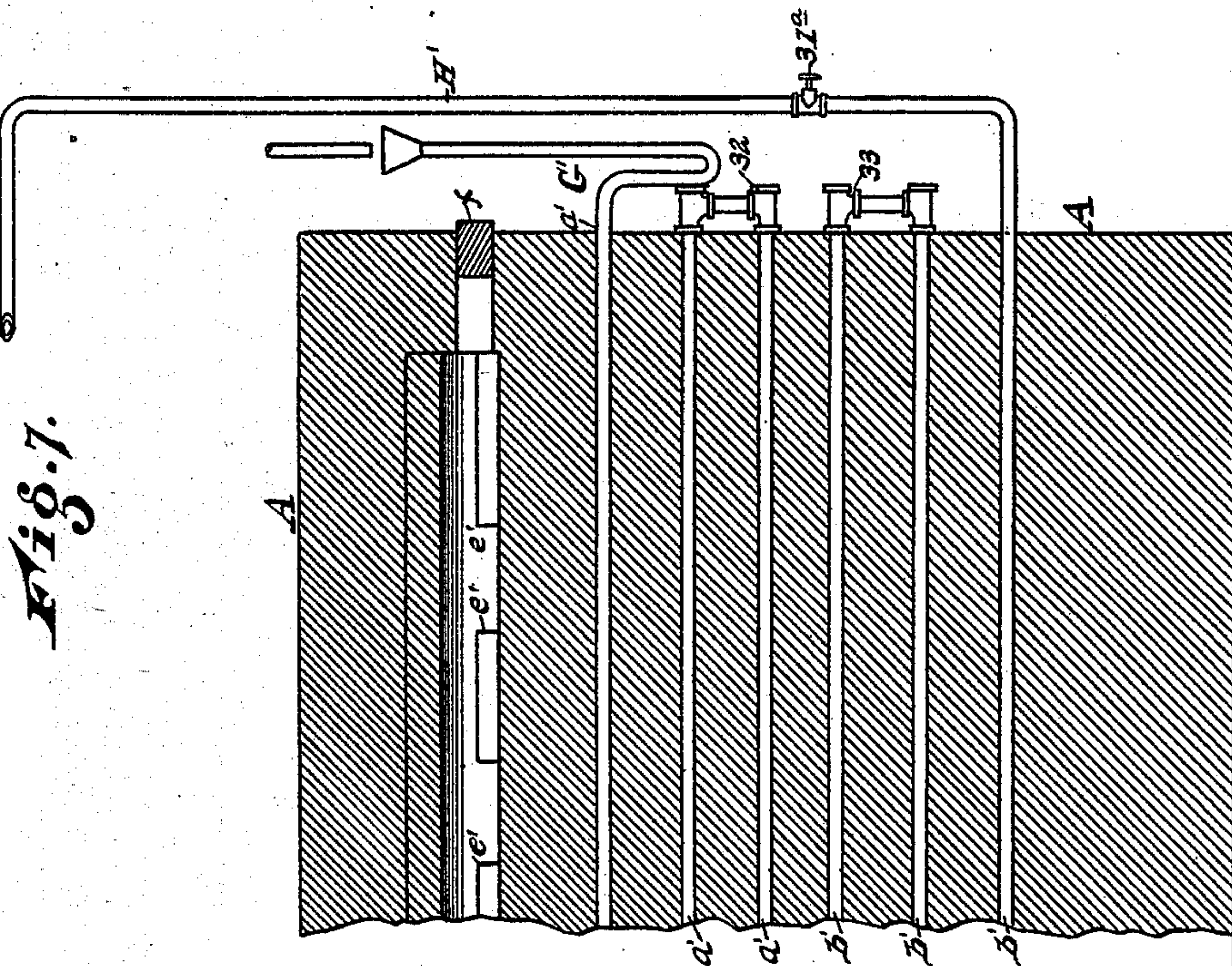
(No Model.)

4 Sheets—Sheet 4.

A. O. SMITH.  
GAS GENERATOR.

No. 412,678.

Patented Oct. 8, 1889.



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# UNITED STATES PATENT OFFICE.

AMBROSE O. SMITH, OF SHEBOYGAN, WISCONSIN, ASSIGNOR OF ONE-HALF TO  
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## GAS-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 412,678, dated October 8, 1889.

Application filed May 8, 1888. Serial No. 273,203. (No model.)

*To all whom it may concern:*

Be it known that I, AMBROSE O. SMITH, of Sheboygan, in the county of Sheboygan and State of Wisconsin, have invented certain new and useful Improvements in Gas-Generators, of which the following is a specification.

The object of my invention is to provide a novel gas-generator for the manufacture of illuminating and heating gas from coal, water, and crude oil, (or other product of petroleum,) or for the manufacture of gas from any two of such materials. This object I accomplish in the manner and by the means hereinafter described and claimed, reference being made to the accompanying drawings, in which—

Figure 1 is a front end elevation of a gas-generator embodying my invention; Fig. 2, a transverse sectional view taken on the line  $x x$ , Fig. 3; Fig. 3, a longitudinal sectional view taken on the line  $y y$ , Fig. 1; Fig. 4, a longitudinal sectional view taken on the line  $z z$ , Fig. 1; Fig. 5, a detail sectional view of one of the steam and oil injectors; Fig. 6, a rear end elevation; and Fig. 7, a broken sectional view taken on the line  $v v$ , Fig. 6.

In order to enable those skilled in the art to make and use my invention, I will now describe the same in detail, referring to the drawings, wherein—

The letter A indicates a furnace structure, preferably made of brick-work, having in its base a fire-chamber C and ash-pit E, provided, respectively, with suitable doors B and D. A series of separated refractory blocks or supports 8 and 8<sup>a</sup> are located, respectively, at intervals along the opposite inner sides of the furnace structure to provide side passages 1 and 2, and between and supported by the blocks or supports is arranged a refractory bed-plate 9, that supports the main retort 3, which is furnished with a suitable door F, and in which the charge of coal is placed to produce the coal-gas. A series of retorts 7, arranged horizontally one upon the other, is located at one side of the furnace structure, the lower retort resting on the blocks or supports 8. These retorts are hollow and made of fire-clay or other refractory material, and each contains within it, or is lined by, a metal tube or pipe I. A similar set of retorts 7<sup>a</sup>,

each containing or lined by a metal tube or pipe I', is arranged on the blocks or supports 8<sup>a</sup> at the opposite side of the furnace. The metal tubes or pipes I are alternately connected at their ends by flanged couplings 10, as shown in Fig. 3, and the tubes or pipes I' are likewise alternately connected at their ends, and at the outer sides of the retorts 7 and 7<sup>a</sup> are provided ascending flue-spaces  $c c'$ , which are more or less covered along their upper ends by movable fire-clay plates  $e e'$ , that can be adjusted by means of openings, which are closed by doors or plugs  $f f'$ , Figs. 6 and 7. A series of fire-clay baffle-plates 5 are arranged horizontally between and supported by the inner sides of the series of retorts, and at the ends of these baffle-plates are provided alternating openings, the uppermost one of which is controlled by a damper J. A chamber 6, covered by the arched top of the furnace, is formed above the retorts and upper baffle-plate, such chamber being in communication at one end with a chimney. A gang of connected oil-vaporizing pipes  $a$  is embedded in one side wall of the furnace, and in the opposite side wall thereof is embedded a similar gang of connected oil-vaporizing pipes  $a'$ . The upper one of the pipes  $a$  is in communication with an oil-feed pipe G and the upper one of the pipes  $a'$  communicates with a similar oil-feed pipe G', these feed-pipes being supplied with petroleum or its products in any suitable manner. In the furnace-wall, below the oil-vaporizing pipes  $a$ , is arranged a gang of connected steam-superheating pipes  $b$ , the lower one of which is placed in communication with a steam-boiler K by a tube H, having a valve 31, and in the opposite furnace-wall, below the pipes  $a'$ , is arranged a similar gang of connected steam-superheating pipes  $b'$ , the lower one of which is also placed in communication with the boiler by a tube H', having a valve 31<sup>a</sup>. The upper one of the pipes  $b$  connects by an elbow  $b^4$  with a steam-injector 13, and the upper one of the pipes  $b'$  connects by an elbow  $b^5$  with a similar steam-injector 13<sup>a</sup>, said elbows being provided, respectively, with valves 24 and 24<sup>a</sup>. These injectors respectively connect with the front ends of the lower ones of the tubes or pipes I I' of the retorts 7 7<sup>a</sup>, and



said injectors also connect, respectively, with the lower ones of the pipes  $a a'$ , as represented by dotted lines in Fig. 1. A pipe-coupling 15, having an elbow 27, connects 5 the uppermost tube or pipe I of the retorts 7 both with the boiler K and with the branch or T-shaped pipe connection 16 17, that communicates with the main gas-delivery pipe 19, said coupling 15 having suitable valves 10 23 and 26 to control communication between the uppermost tube or pipe I and the boiler and T-shaped pipe. The uppermost tube or pipe I' of the retorts 7<sup>a</sup> communicates by an elbow M with the T-shaped pipe 16 17, such 15 elbow having a valve N to control the communication. A retort discharge-pipe 20, having a valve 30, rises from the main retort 3 and connects with the gas-delivery pipe 19, and this discharge-pipe also communicates 20 with the injector 13<sup>a</sup> by a branch pipe 25, having a valve 25<sup>a</sup> to control the communication.

For convenience in cleaning the metal tubes or pipes I I' their ends are provided with removable caps 12. 25

The products of combustion from the fire-chamber pass into the lateral passages 1 and 2 and around the retort, a portion rising through the flue-spaces  $c c'$ , and the remainder taking a circuitous course around the baffle-plates by reason of their alternating 30 end openings. The products of combustion, passing along the opposite sides of each set of pipe-lined retorts, impart a high degree of heat thereto, and also by heating the furnace walls impart the requisite degree of heat to the oil-vaporizing pipes and steam-superheating pipes. 35

The gas-generator described may be operated in connection with coal, steam, and oil to produce gas by supplying the main retort with coal, the gases from which rise through its discharge-pipe. The steam from the boiler is admitted to the gang of pipes  $b'$ , where it becomes superheated, and crude oil or other 45 product of petroleum is supplied to the gang of pipes  $a'$ , where the oil is vaporized and passes to the steam-injector 13<sup>a</sup>, so that the oil-vapor is forced by the steam into the lower one of the retorts 7<sup>a</sup>. The vaporized oil and steam are in their circuitous passage through the said retorts still further heated, and thereby converted into a fixed gas, which passes by the elbow-and-pipe connection into the 55 gas-delivery pipe, where such fixed gas mingles with the coal-gas rising from the retort through its discharge-pipe. Instead, however, of mingling the gases in the gas-delivery pipe, as stated, the valve 30 of the retort discharge-pipe may be closed and the coal-gas caused to pass through the branch pipe 60 25 into the steam-injector 13<sup>a</sup>, to be forced with the steam and vaporized oil into the retorts 7<sup>a</sup>, and there combined with the oil and steam vapors. The steam may be generated in the boiler K; or the latter can be employed simply as a steam dome or receiver, supplied with

steam from a suitable outside source; or the steam can be generated by closing the valve 24 and passing water through the feed-pipe 70 G to the heating-pipes  $a$ , through the injector 13, and into the retort 7, the valve 26 being closed and valve 23 being open, so that the steam formed in the retort 7 passes by elbow 27 into what I have termed a "boiler," to be 75 conducted by the pipe H' into the gang of steam-superheating pipes  $b'$ , while the petroleum or other oil is supplied by the feed-pipe G' into the gang of heating-pipes  $a'$ . In the operation last described the boiler K is simply 80 used as a steam-dome, and, further, in this operation the coal-gas from the main retort may be carried by the retort discharge-pipe directly to the gas-delivery pipe; or it can be conducted to the injector 13<sup>a</sup> by the branch 85 pipe 25, as before explained. Where the gang of pipes  $a$  is used to conduct water to the retorts 7 it will be obvious that such pipes then become water-heating pipes, and hence the said pipes may be termed "oil-vaporizing" 90 or "water-heating" pipes.

In order to observe the condition of the gas in the retorts 7 and 7<sup>a</sup>, I provide them at their ends with petcocks 21, whereby a small quantity of the gas can be allowed to escape. 95

For the manufacture of gas from steam and crude oil alone the main retort is not operated; but the valves 25<sup>a</sup> and 30 in the branch and discharge pipes 25 and 20 are closed. The steam is supplied to the superheating-pipes  $b b'$ , and the oil to the heating-pipes  $a a'$ . The steam and vaporized oil are then passed by two injectors into the respective sets of pipe-lined retorts, where such steam and oil vapor become converted into 105 a fixed gas, and are conducted to the gas-delivery pipe by the pipe-coupling and elbow-and-pipe connections before mentioned.

To produce a gas low in carbon and high in hydrogen the quantity of oil is reduced 110 and the quantity of steam increased in suitable proportion.

For making water-gas and coal-gas combined the main retort is charged with coal and steam supplied to the steam-superheating pipes  $b'$ , which passes by the injector 13<sup>a</sup> into the lower one of the vaporizing-retorts 7<sup>a</sup>. The coal-gas is conducted by the branch pipe 25 into said injector, and, together with the steam, is forced into the lower one of the 120 retorts 7<sup>a</sup>, the combined gases passing from the upper vaporizing-retort 7<sup>a</sup> to the gas-delivery pipe by way of the elbow-and-pipe connection.

The quality of the gas can be regulated by 125 controlling the quantity of steam admitted to the superheating-pipes through the medium of the valve in the steam-supply pipes H H'.

To observe the pressure in the pipe-lined 130 retorts, the upper one at each side may be provided with any suitable sight-tube or glass gage L.

It will be evident that by arranging the



two sets of oil-vaporizing or water-heating pipes, steam-superheating pipes, and pipe-lined retorts at opposite sides of the furnace structure one set can be used independently of the other set, and that one or both sets can be operated conjointly with the main retort, while the parts at one side can be readily cleaned without stopping the operation of the parts at the opposite side.

10 Having thus described my invention, what I claim is—

1. In a gas-generator, the combination, with a furnace structure, of a coal-gas retort, a gang of oil-vaporizing pipes at one side of the furnace structure, a gang of steam-superheating pipes, a series of retorts alternately connected at their ends, a steam and vaporized-oil injector connected with the two gangs of pipes and with one of the said alternately-connected retorts, a gas-delivery pipe for the latter, and pipe-connections between the gas-delivery pipe and the coal-gas retort and alternately-connected retorts, substantially as described.

25 2. In a gas-generator, the combination, with a furnace structure, of a gang of oil-vaporizing pipes and a gang of steam-superheating pipes, both located at one side of the furnace structure, a series of metallic pipe-lined retorts of refractory material, resting one directly upon another, and having the pipe-linings alternately connected at their ends, and a steam and vaporized-oil injector connected with the gangs of pipes and with one of the retorts, substantially as described.

3. In a gas-generator, the combination, with a furnace structure, of the gangs of oil-vaporizing pipes and steam-superheating pipes arranged at opposite sides of the furnace, the oil-feed pipes connected with the vaporizing-pipes, the steam-supply pipes connected with the superheating-pipes, a series of metallic pipe-lined retorts of refractory material, resting directly one upon another at each side of the furnace, each series having the pipe-linings alternately connected at their ends, connections between the oil-vaporizing pipes, superheating-pipes and the lower retorts, and a gas-delivery pipe having branch connections with the upper retorts, substantially as described.

4. In a gas-generator, the combination, with a furnace structure, of a series of superposed pipe-lined retorts alternately connected at their ends, a gas-delivery pipe connected with the upper retort, the steam-superheating pipes, connections between the latter and the lower retort, the baffle-plates located at one side of the pipe-lined retorts and having alternating end openings, the ascending flue between the opposite side of the retorts and the side wall of the furnace, and a fire-chamber, substantially as described.

5. In a gas-generator, the combination, with a furnace structure, of the steam-superheating pipes, pipe-lined refractory retorts alternately connected at their ends and in commu-

nication with the said pipes, the baffle-plates located at one side of the retorts and having alternating end openings, the ascending flue between the opposite side of the retorts and the side wall of the furnace, and a fire-chamber, substantially as described.

6. In a gas-generator, the combination, with a furnace structure having a fire-chamber, of a series of metallic pipe-lined refractory retorts, resting one directly upon another, and having the pipe-linings alternately connected at their ends, a series of baffle-plates located at one side of said pipe-lined retorts and having alternating end openings, and a gang of steam-superheating pipes connected with one of the retorts, substantially as described.

7. In a gas-generator, the combination, with a furnace structure having a central fire-chamber and opposite blocks or supports arranged at intervals to form opposite side flues, of a main retort arranged between the side flues, a series of superposed pipe-lined retorts on the blocks or supports at each side of the furnace, ascending flue spaces arranged, respectively, between the superposed retorts and the side walls of the furnace, and the baffle-plates located above the main retort and between the pipe-lined retorts at one side and those at the opposite side of the furnace structure and having alternating end openings, substantially as described.

8. In a gas-generator, the combination, with a furnace structure, of a main retort having a gas-discharge pipe, a series of retorts arranged in the furnace and rising above the main retort, a gang of oil-vaporizing pipes and a gang of steam-superheating pipes, both located at one side of the furnace, a gas-delivery pipe connected with the upper one of the series of retorts and with the gas-discharge pipe of the retort, a steam-injector connected with the lower one of the series of retorts and with the two gangs of pipes, and a valved branch pipe connecting the injector with the said gas-discharge pipe, substantially as described.

9. In a gas-generator, the combination, with a furnace structure, of a main retort, a series of superposed retorts rising above the latter, a gang of oil-vaporizing pipes and a gang of steam-superheating pipes located at one side of the furnace, a steam-injector connected with one of the superposed retorts and with the two gangs of pipes, a boiler, a gas-delivery pipe, a pipe-coupling connected with the gas-delivery pipe, the boiler, and the one of the superposed retorts, and provided with two valves to control communication between the retorts and the boiler and gas-delivery pipe, and a pipe-connection between the main retort and the gas-delivery pipe, substantially as described.

10. In a gas-generator, the combination, with a furnace structure, of a series of retorts at each side thereof, those of each series having their ends alternately connected,



a gang of oil-vaporizing pipes and a gang of steam-superheating pipes embedded in each side wall of the furnace structure, a valved steam-supply pipe for each gang of steam-superheating pipes, an oil-feed pipe for each gang of oil-vaporizing pipes, a steam-injector connecting the gangs of pipes at each side of the furnace with the retorts adjacent thereto, a gas-delivery pipe having a branch-pipe connection with both series of retorts, a boiler, and connections between the boiler and the retorts, substantially as described.

11. In a gas-generator, the combination, with a furnace structure having a fire-chamber, side flues, and ascending flue spaces at its opposite sides, of a main retort having a gas-discharge pipe, a series of superposed pipe-lined retorts arranged at each side of the furnace, those of each series having their ends alternately connected, a gang of

oil-vaporizing pipes and a gang of steam-superheating pipes embedded in each side wall of the furnace, a steam-injector connecting the gangs of pipes at each side with the adjacent pipe-lined retorts, a gas-delivery pipe, a steam-boiler, pipe-connections between the gas-delivery pipe and the upper retort of each series, a pipe-coupling connection between the boiler and the retorts at one side of the furnace, steam-supply pipes leading from the boiler to the respective gangs of steam-superheating pipes, and an oil-feed pipe for each gang of oil-vaporizing pipes, substantially as described.

In testimony whereof I have hereunto set my hand.

AMBROSE O. SMITH.

Witnesses:

THOMAS J. CHARLES,  
HARRY R. PROBASCO.