

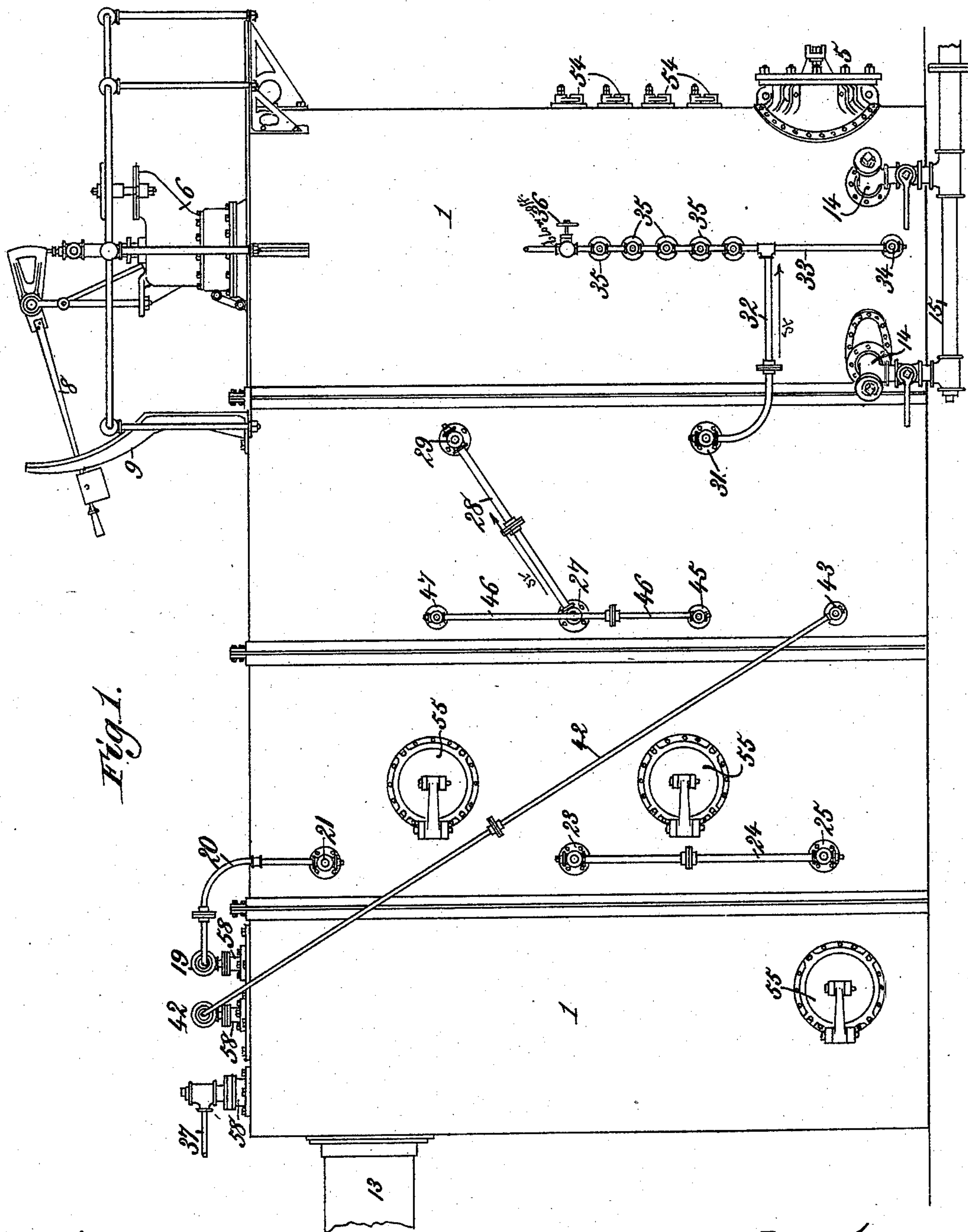
(No Model.)

6 Sheets—Sheet 1.

W. H. HARRIS.  
APPARATUS FOR MANUFACTURING GAS.

No. 579,110.

Patented Mar. 16, 1897.



Witnesses.  
Dennis Sumbly.  
Albert Everett.

Inventor.  
William H. Harris.  
By James L. Norris.  
Atty.



(No Model.)

6 Sheets—Sheet 2.

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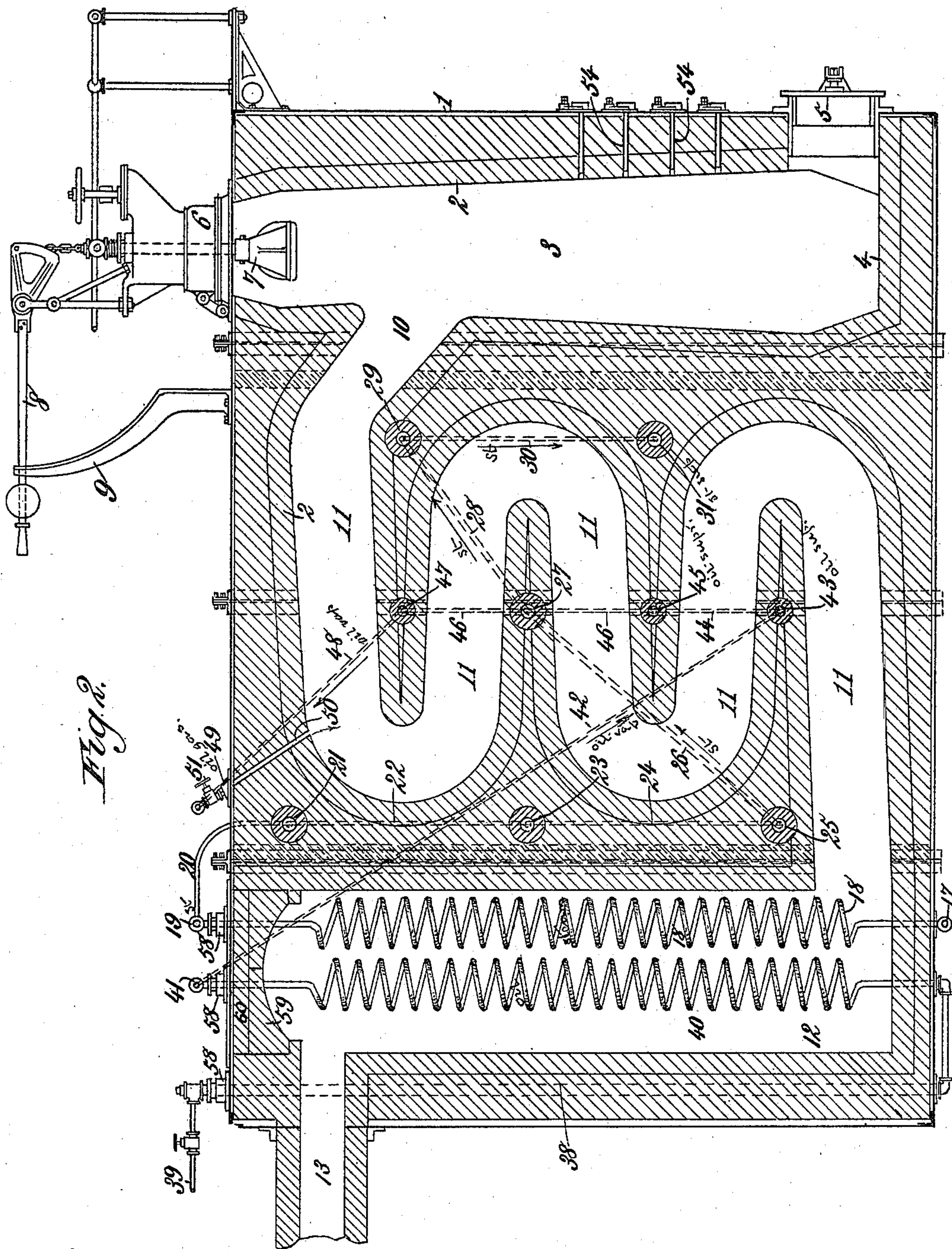


Fig. 2.

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(No Model.)

6 Sheets—Sheet 3.

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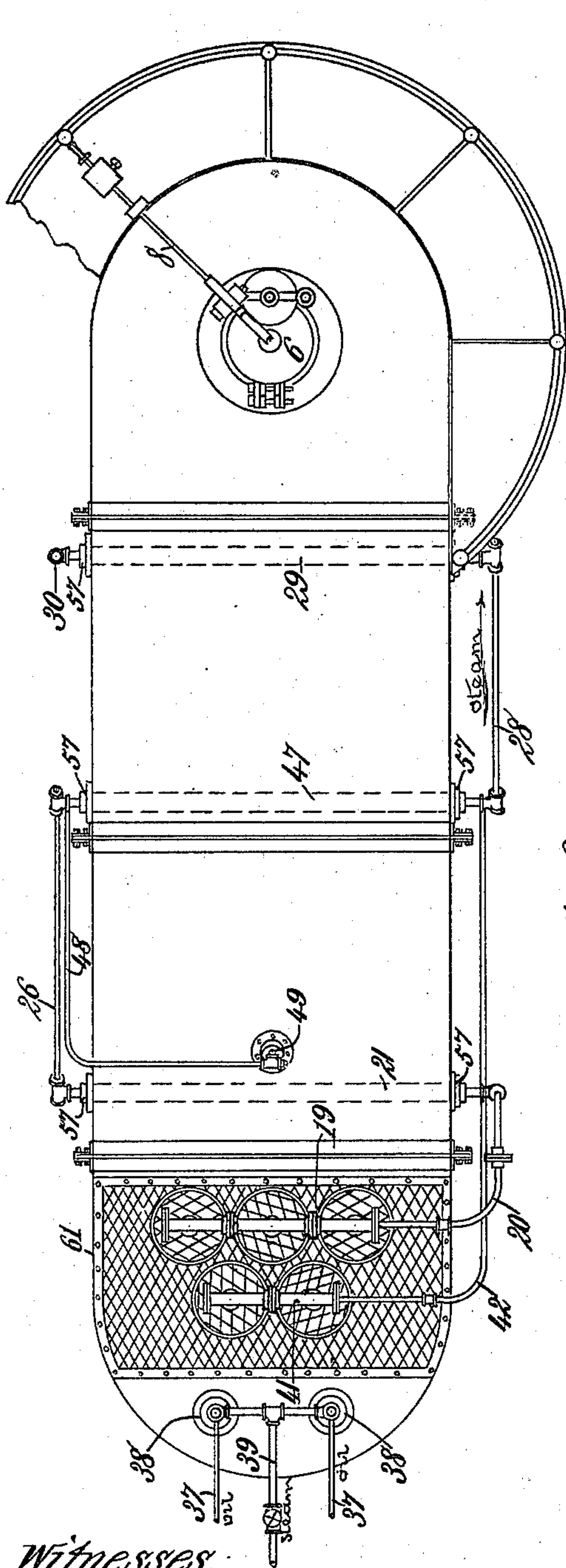


Fig. 3.

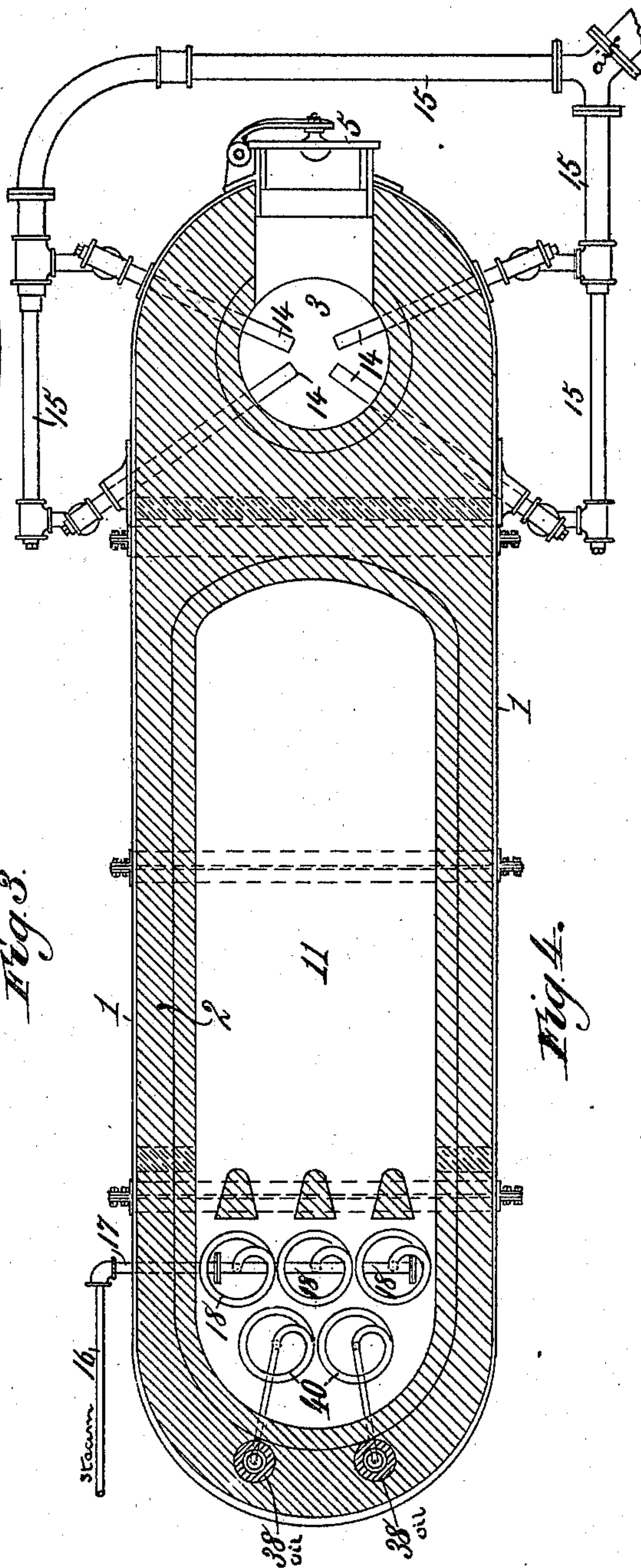


Fig. 4.

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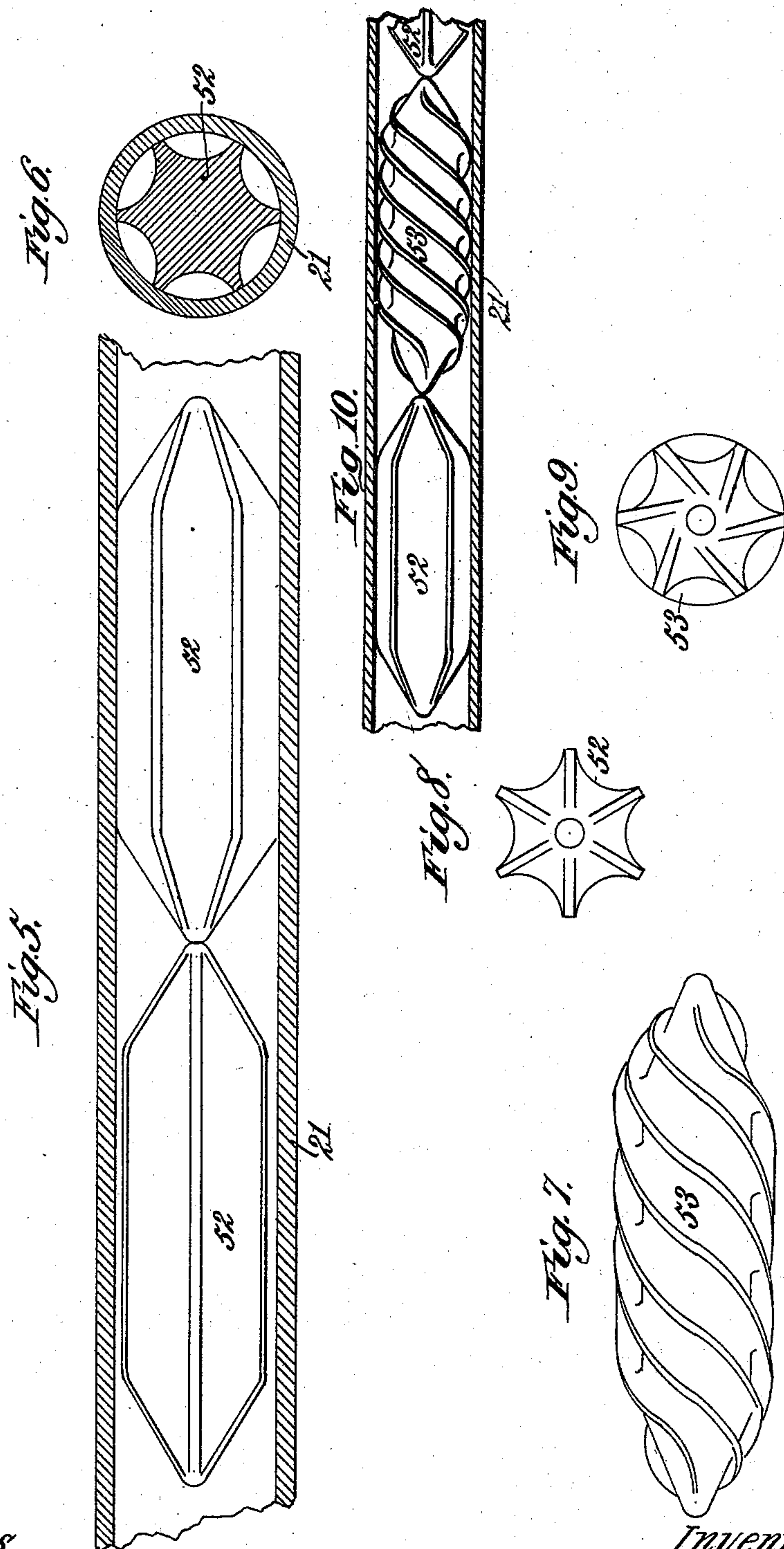
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W. H. HARRIS.  
APPARATUS FOR MANUFACTURING GAS.

No. 579,110.

Patented Mar. 16, 1897.



Witnesses:

Dennis Sumby  
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(No Model.)

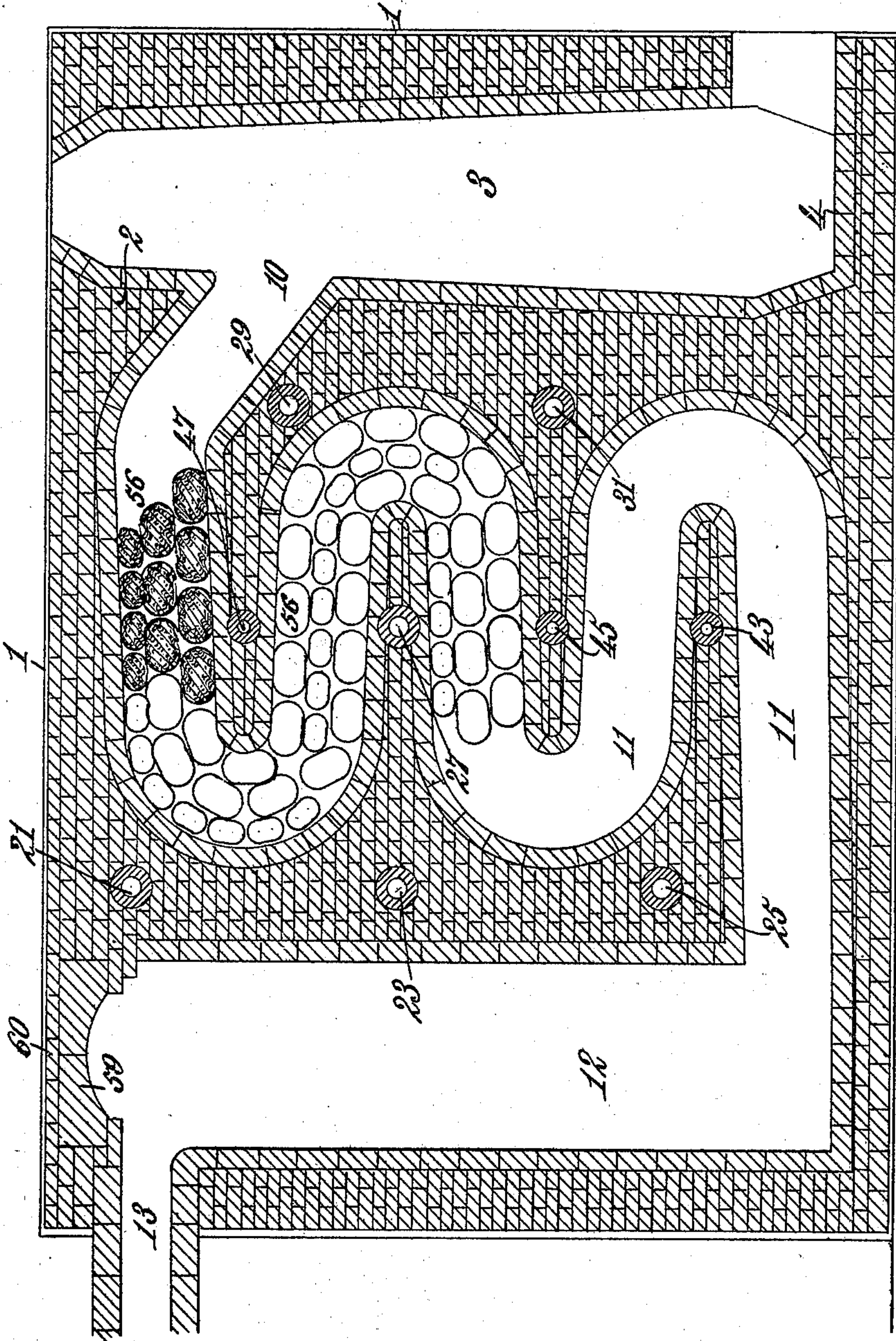
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Fig. 11.



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ATTORNEY



(No Model.)

6 Sheets—Sheet 6.

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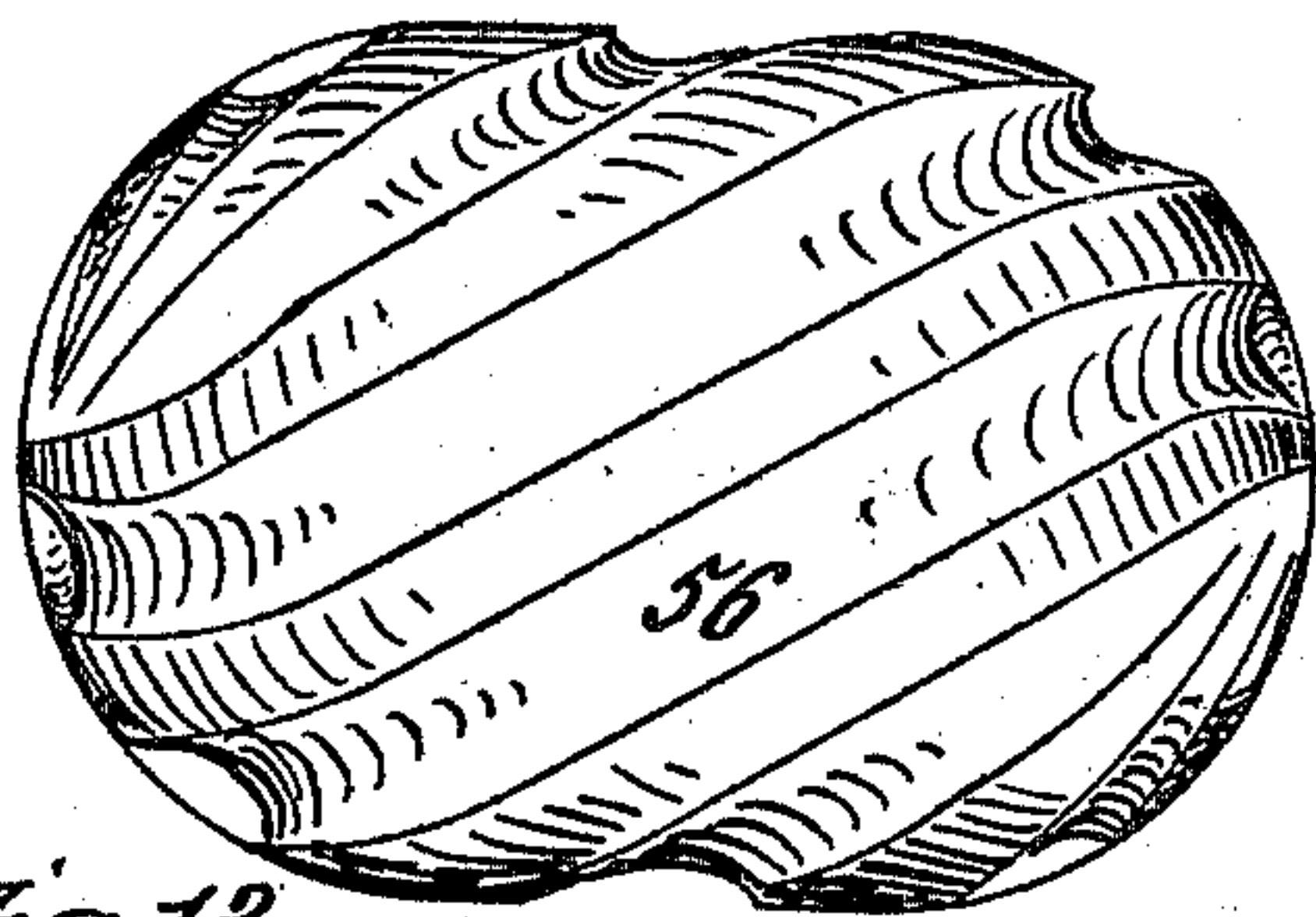


Fig. 13.

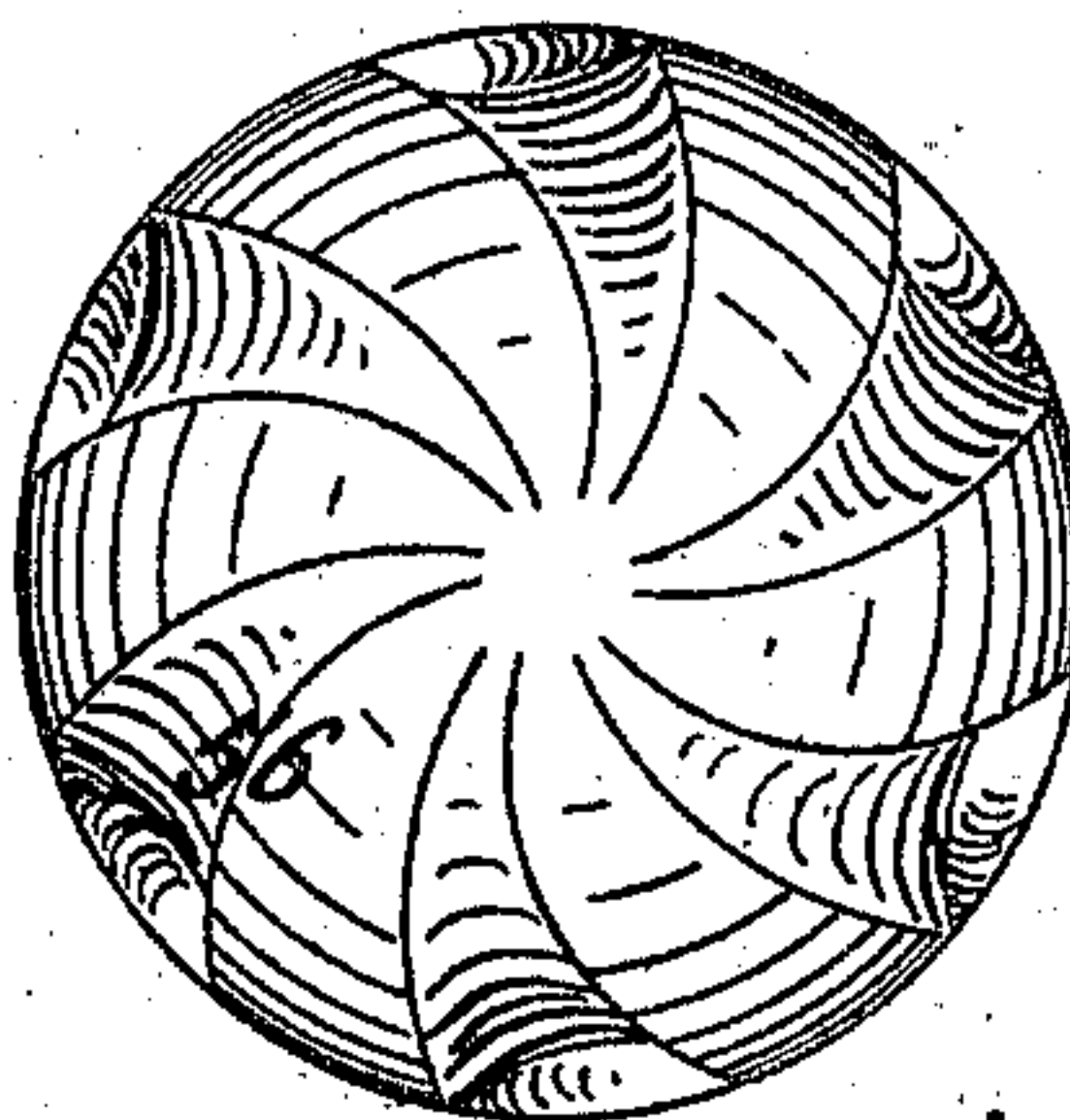


Fig. 14.

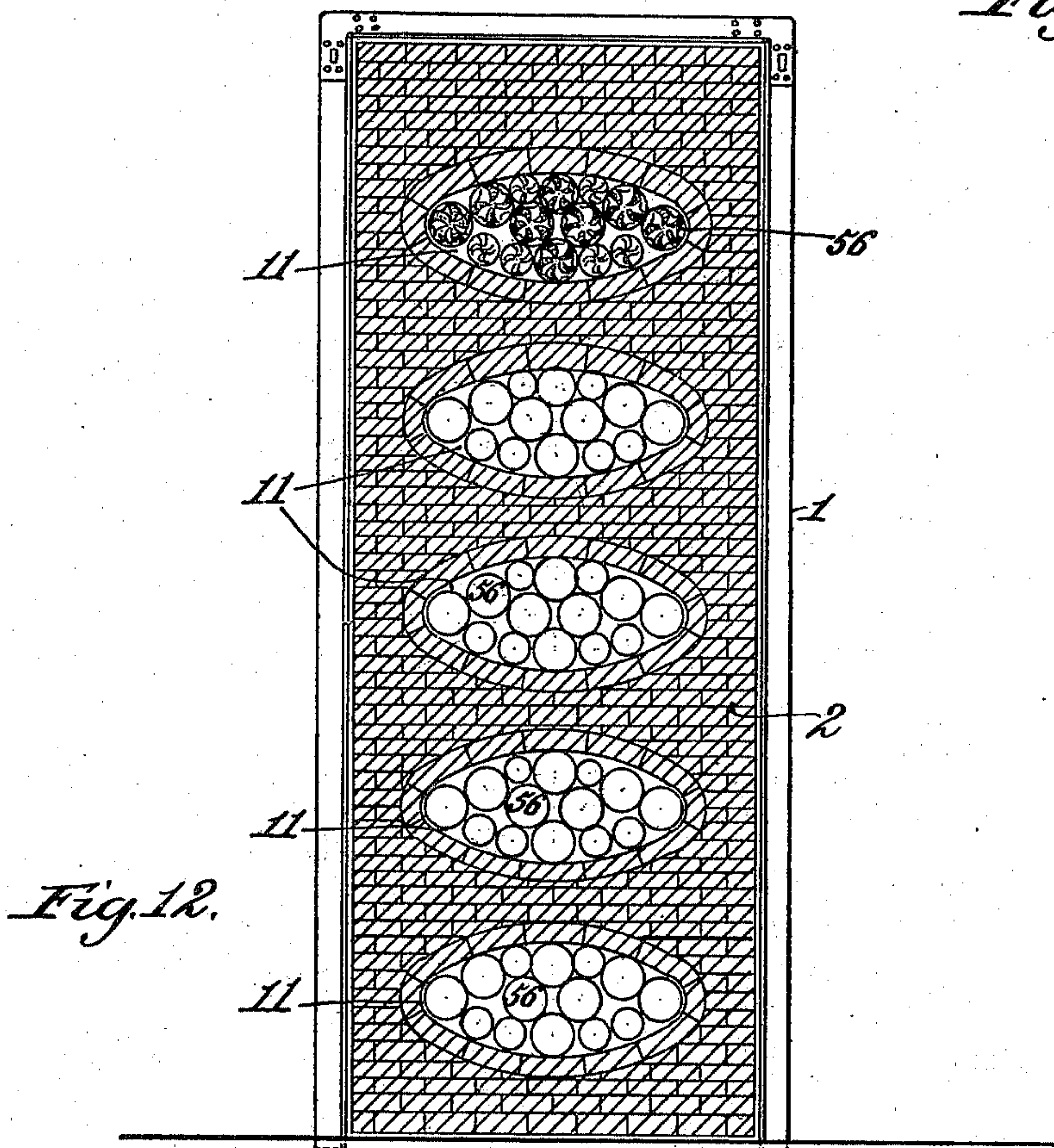


Fig. 12.

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INVENTOR

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# UNITED STATES PATENT OFFICE.

WILLIAM H. HARRIS, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR  
TO WILLIAM A. MILLIKEN, OF SAME PLACE.

## APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 579,110, dated March 16, 1897.

Application filed May 9, 1895. Serial No. 548,779. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM H. HARRIS, a citizen of the United States, residing at Washington city, District of Columbia, have invented new and useful Improvements in Apparatus for Manufacturing Gas, of which the following is a specification.

My invention relates to an improved apparatus for generating gas from bituminous or other soft coal with or without other hydrocarbon, steam and air being supplied thereto during the combustion of the coal and the required operations being conducted in such manner as to produce either fuel-gas or illuminating-gas by a continuous process carried on wholly in one direction and in an apparatus comprising but a single generator and connected regenerating-chamber.

It is the principal purpose of my invention to provide for the superheating of the steam in such manner that it will be thoroughly disintegrated before admission into the gas-generator and so that it will enter the generator in the form of hydrogen gas. For this purpose I pass the steam through superheating pipes or passages embedded in the structure constituting the regenerator, and I provide in each of said pipes or passages a series of baffles, preferably spiral or tortuous, adapted to impart a whirling movement to the steam and at the same time throw it into contact with the heated walls of the pipe or passage through which it is being conducted. By the whirling motion thus given to the steam during its passage through the superheaters it is violently agitated and subjected to such frictional action that a complete disintegration or decomposition is effected before reaching the heated gas-generator. In making illuminating-gas the hydrocarbon liquid employed for enriching purposes is also subjected by passage through superheaters of like construction to a similar whirling and disintegrating action, whereby the oil or other liquid hydrocarbon will become gasified before admission into the regenerator.

The invention consists in the features of construction and novel combinations of parts in a gas-generating apparatus, as hereinafter described and claimed.

In the annexed drawings, illustrating the

invention, Figure 1 is a side elevation of my improved gas-making apparatus. Fig. 2 is a central vertical longitudinal section of the same. Fig. 3 is a plan of the apparatus. Fig. 4 is a horizontal section through the lower part of the gas-generator and regenerating-chamber. Fig. 5 is an enlarged longitudinal section of a portion of one of the superheaters for steam or oil. Fig. 6 is a transverse section of the same. Fig. 7 is a view of a spirally-formed baffle that may be employed in the superheaters. Figs. 8 and 9 are end views of baffles. Fig. 10 is a longitudinal section of a portion of a steam or oil superheater and gasifier, showing spirally-formed and straightly-fluted baffles arranged alternately therein. Fig. 11 is a vertical longitudinal section of the regenerating-chamber, showing how spirally-grooved bodies of refractory material may be placed therein in lieu of spherical bodies to afford numerous tortuous passages for assisting in the fixing of the gas. Fig. 12 is a vertical transverse section of the same. Fig. 13 is a side view, and Fig. 14 an end view, of one of the spirally-grooved refractory bodies with which the regenerating-chamber is to be filled.

The reference-numeral 1 designates the sheet-metal casing of the usual inner refractory or fire-brick walls 2 comprised in a gas-generating apparatus. As shown in Figs. 2 and 11, the cupola-furnace or gas-generator 3 is provided at the bottom with a hearth 4, to which access may be had through a sealed door 5, of any suitable construction. At the top of the gas-generator is arranged a coal-feeding hopper 6, Figs. 1 and 2, governed by a bell-valve 7, adapted when closed to make a gas-tight seal at the top of the generator. This bell 7 may be operated by a weighted sector-lever 8 or other contrivance, and a rack 9 may be provided to secure the lever 8 when the bell is raised. The upper portion of the gas-generator 3 communicates through a flue 10 with a regenerating-chamber 11, preferably of serpentine form. This regenerating-chamber is substantially of the character shown and described in Letters Patent granted to me November 24, 1891, No. 463,965, and July 5, 1892, No. 478,425, and may, as there described, be filled with balls of refractory ma-



terial, such as silicate of alumina or other substance capable of absorbing and retaining a large quantity of heat without deterioration. Such balls are capable of resisting a long continuous high heat, and by reason of their spherical form they present numerous curvilinear flues or passages in which the gas will meet with such frictional resistance as will greatly assist in the fixing or regenerating operation. The exit end of the regenerating-chamber 11 communicates with the bottom of a vertical compartment 12, at the top of which is located a flue or conduit 13 for conducting the gas to any required point for purifying or for storage.

In the base of the gas-generator are introduced a number of converging twyers 14, Fig. 4, that respectively connect with pipes 15, through which air for supporting combustion may be supplied from any suitable fan or blower. The apparatus is arranged for the introduction of steam or steam products into the gas-generator both below and above the bed of fuel.

It is an important purpose of my invention to superheat the steam in such manner that a thorough decomposition thereof will be accomplished prior to its introduction into the gas-generator and so that a large volume of hydrogen gas may thus be put into the gas-generator both above and below the body of incandescent fuel.

Steam is caused to enter the apparatus through a pipe 16, Fig. 4, communicating with a pipe 17, Figs. 2 and 4, that is arranged transversely at the bottom of the compartment 12, and which in turn communicates with a manifold or series of coiled pipes 18, extended vertically in said compartment. At their upper ends the coiled pipes 18 communicate with a transversely-arranged pipe 19, Fig. 3. To one end of this pipe 19 is connected a tube 20, which connects at its other end with one end of a superheater 21, placed transversely in the upper rear portion of the fire-brick structure constituting the regenerator. The opposite end of this steam-superheater 21 connects with a pipe 22, (shown by dotted lines in Fig. 2,) which is extended downward on the outside of the regenerator to another steam-superheater 23, also extended transversely through the rear portion of the regenerator and connecting on the opposite side thereof with a descending pipe 24, Fig. 1, connecting with a steam-superheater 25, embedded in the lower rear portion of the regenerator and extended transversely through the same. To the opposite end of this superheater 25 is connected a pipe 26, Fig. 3, extended diagonally upward and forward on one side of the regenerator to connect with a steam-superheater 27, placed transversely in the regenerator at a point between two of the centrally-located branches of the serpentine regenerating-chamber. On the opposite side of the regenerator this steam-superheater 27 connects with an upward and forward in-

clined pipe 28, Figs. 1 and 3, that connects with one end of a steam-superheater 29, placed transversely in the upper forward portion of the regenerator. On the opposite side of the regenerator this steam-superheater connects through a descending pipe 30 with one end of another steam-superheater 31, extended transversely through the central portion of the wall separating the gas-generator and the regenerator. From the other end of the last-mentioned steam-superheater 31 is extended a pipe 32, Fig. 1, connecting with a vertically-arranged pipe 33, the lower end of which is provided with a branch 34, arranged to deliver superheated steam or its products at a point centrally in the base of the gas-generator 3 and below the bed of fuel therein. The upper portion of the pipe 33 is provided with branches 35, Fig. 1, for supplying superheated steam or its products to the gas-generator at points above the incandescent fuel and in directions at right angles to the ascending currents of the heated products of gas generation from the coal. To the upper end of the pipe 33 a blow-off valve 36 may be connected.

If it is desired to employ oil or some suitable liquid hydrocarbon for enriching purposes in the manufacture of a high candle-power illuminating-gas, such oil or liquid hydrocarbon may preferably be superheated and gasified before its admission to the regenerator. The oil or liquid hydrocarbon may be taken from a pump or reservoir (not shown) through pipes 37, Fig. 3, connecting with the upper ends of two vertically-arranged superheaters 38, Fig. 4, embedded in the rear wall of the regenerator. At their upper ends the superheaters 38 may connect with a pipe 39, Fig. 3, for admission of steam, which it is preferable to introduce or inject, together with the oil or other liquid hydrocarbon, to assist in gasifying the oil.

The lower ends of the two vertical oil superheaters or gasifiers 38 connect with the lower ends of spirally-coiled pipes 40, arranged vertically in the exit-compartment 12 of the regenerator. At their upper ends these coiled pipes 40 are connected by a transversely-arranged pipe 41, Fig. 3, one end of which connects through a tube 42, Fig. 1, with one end of an oil-superheater 43, extended transversely through the lower portion of the regenerator. At its other end this oil-superheater 43 communicates with a vertically-arranged pipe 44, located on one side of the regenerator and communicating with one end of a transversely-arranged oil-superheater 45, the other end of which communicates through a pipe 46, Fig. 1, with another transversely-arranged oil-superheater 47, which connects at its other end through a pipe 48, Fig. 3, with an injector-nozzle 49, communicating with a passage 50, Fig. 2, formed in the top of the regenerator and arranged for the introduction of the gasified oil thereto at a point in the rear upper portion of the regenerating-chamber. The injector-noz-



zle 49 may have a valve 51 for regulating the supply of hydrocarbon to enrich the gas in the regenerator.

In each of the several superheaters for steam and oil I prefer to provide baffles that will present frictional surfaces for the steam or oil, or steam and oil, as the case may be, to retard the progress of the same, impart a whirling motion, and cause the steam and oil to come into close contact with the walls of the superheating pipe, tube, or passage in which the baffles are placed. There may be placed in each superheating pipe, tube, or passage a series of baffles 52, Fig. 5, that may have any preferred form. As shown in Figs. 5 and 6, the baffles 52 may be made in the form of a body having conical ends and polygonal in cross-section and preferably grooved or fluted exteriorly and in longitudinal directions. If desired, spirally-fluted baffles 53, Figs. 7 and 9, may be employed in the superheating pipes, tubes, or passages. By the frictional surfaces and more or less tortuous passages that the baffles 52 or 53 present the steam or the oil, or the steam and oil, as the case may be, are agitated and quickly disintegrated with the assistance of the extended heating-surfaces afforded by the several superheaters. Thus the steam will become decomposed before its introduction into the gas-generator and the oil or other liquid hydrocarbon will become gasified before entering the regenerator. The location of a number of these superheaters within the walls of the regenerator, as shown, permits the utilization of the heat contained in said walls, and the location of the manifolds or coils 18 and 40 in the exit-compartment 12 of the regenerator tends to a further utilization of the hot gases to contribute to the superheating of the steam and oil required in the gas process.

As shown in Fig. 10, the superheaters for steam or oil may each contain a number of straight-fluted baffles 52 and spirally-fluted baffles 53, arranged end to end and alternating with each other, the spirally-fluted baffles being designed more particularly to impart to the passing steam and oil a whirling or cyclonic action that is intermittently checked again and again by the alternating straight-fluted baffles, thereby further increasing the efficiency of the superheaters in the intended purpose of accomplishing a complete disintegration and gasifying of the steam and oil prior to their direct application and utilization in the process of gas generating and carbureting.

In the operation of making gas a fire is kindled on the hearth of the generator 3, and bituminous coal or other coal is intermittently fed thereto by lowering the bell 7 as occasion may require. Air for supporting combustion is continuously admitted to the base of the generator in regulated quantities and the products of combustion are permitted to pass off through and thoroughly heat up the re-

generator. The generator and regenerator will be raised to a temperature of about 2,000° or 2,500° Fahrenheit, and this temperature, or even higher, will be readily maintained with great uniformity by reason of the non-conducting walls of the gas generator and regenerator. When the generator and regenerator are sufficiently heated for the making of gas, the decomposed steam and hydrogen product from the superheaters will be admitted to the generator 3, both below and above the incandescent-fuel bed. By its passage through the superheaters and in contact with the baffles contained therein, all of which are subjected to an intensely-high heat, the steam will be decomposed and will reach the generator largely in the form of hydrogen gas, which will mingle and combine with the carbon gases from the incandescent fuel in the generator. The introduction of the steam products into the generator above the fuel-bed and at an angle to the ascending currents of gases generated from the fuel will induce a whirling action that will greatly assist in a thorough mixture and recombination of the several gases. In passing through the regenerator the gases from the coal and steam are mingled with the gasified oil products introduced through the injector-nozzle 49 from the series of oil-superheaters hereinbefore described. The serpentine form of the regenerating-chamber and the bodies of refractory material contained therein will cause a rapid and thorough fixing of the gases.

The gas-generator 3 may be provided with a series of sight-holes 54 for inspection of the incandescent-fuel bed, and the regenerating-chamber 11 and compartment 12 may have doors 55, Fig. 1, located at convenient points to give access to the interior for cleaning purposes.

The bell 7 at the top of the gas-generator 3 and also the several doors of the gas-making apparatus are all constructed and arranged in such manner that they will be gas-tight when closed and proof against any escape of gas under back pressure. It is preferable to provide between the outer iron shell 1 and refractory brick work or walls 2 a non-conducting packing or lining of asbestos and cement, so that the iron shell will be kept cool and all the heat passed to and through the regenerating-chamber 11 without any loss by radiation. The entire heat generated or developed within the apparatus may thus be utilized in the fixing of the gas and in the superheating, gasifying, and disintegration of the steam and oil before they are introduced into the gas-generator and regenerating-chamber, respectively.

Instead of filling the regenerating-chamber 11 with balls of refractory material, as described and shown in my before-mentioned patents, I have found it advisable to employ as a filling for the said serpentine regenerating-chamber a number of spirally-fluted refractory bodies 56, Figs. 11, 12, 13, and 14,



which are similar in form to the spirally-fluted baffles 53, placed in the superheaters. The baffles 52 and 53 for the steam and oil superheaters may be made of iron or other metal or refractory material that will not fuse at the temperature to which the superheaters are subjected. The tortuous passages provided by filling the regenerator with these spirally-fluted bodies will greatly assist in effecting under great pressure a frictional, as well as heating, action in the fixing of the gas.

In order that no gas may escape at the various points of connection between the gas and oil superheaters and their pipe connections, gas-tight stuffing-boxes 57, Fig. 3, may be provided wherever required, and similar gas-tight stuffing-boxes 58, Figs. 1 and 2, are connected with the coils 18 and 40 and with the pipes through which steam and oil are conducted to the apparatus. With the provisions made for retaining the heat and preventing its loss by radiation a larger number of heat-units may be developed and utilized than by other similar gas processes, and the disintegration of the steam before its introduction into the generator, as well as the gasifying of steam and oil before introduction into the regenerator, will largely promote the economical production of a superior quality of gas.

As shown in Figs. 2 and 11, the top of the regenerator exit-compartment 12 may be constructed with manhole-arches 59, that can be removed to permit withdrawal of the coils 18 and 40 when necessary, an upper layer 60, of bricks or cement, being first removed. Above this part of the apparatus there may be placed a removable corrugated metal plate 61, Fig. 3, that will permit access to the manhole-arches 59 and their immediate covering.

The gas-making process is continuous, rapid, economical, and cleanly. The steam being superheated, thoroughly decomposed, and admitted to the generator mostly in the form of hydrogen gas, there will be no slackening of the fire, as by contact with wet steam, and the entire apparatus being so constructed as to readily maintain a high temperature throughout, there will be no condensation of gas and but little deposits of gas-tar or carbon. The gas will thus be produced without loss of illuminants and at reduced cost and will require little or no purifying.

What I claim as my invention is—

1. In a gas-making apparatus, the combination with a gas-generating chamber and a regenerating-chamber, of a series of steam-superheaters each consisting of a pipe, tube or passage located in the walls of the regenerator and each inclosing a series of baffles provided with alternating straight and spiral

passages to cause an intermittently-whirling motion of the passing fluid and throw it into frictional contact with the walls of the superheaters, and pipes or tubes connecting the said superheaters at their alternate ends and through which they communicate with the gas-generating chamber, substantially as described.

2. In a gas-making apparatus, a superheater for steam or oil, consisting of a pipe, tube, or passage, having therein a number of straight-fluted baffles and a number of spirally-fluted baffles placed end to end and alternating with each other, whereby the passing fluid is subjected to friction and an intermittently-whirling action and thrown into contact with the walls of the superheater, substantially as described.

3. In a gas-making apparatus, the combination with a serpentine regenerating-chamber, of a filling of spirally-fluted refractory bodies adapted to provide in said chamber a large number of tortuous heating and frictional passages, substantially as described.

4. In a gas-making apparatus, the combination with a gas-generator, of a regenerator having embedded in its walls a series of steam-superheaters and a series of oil-superheaters, each of said superheaters being provided in its interior with a series of fluted baffles and the steam-superheaters being in communication with the gas-generator below and above the bed of fuel therein, and the series of oil-superheaters being in communication with the regenerator-chamber through an injector-nozzle, substantially as described.

5. In a gas-making apparatus, the combination of a gas-generator provided at the top with a coal-feed and having inlets for steam above the fuel-bed and inlets for steam and air below the fuel, a serpentine regenerator-chamber communicating with the upper portion of the gas-generator, an exit-compartment communicating with the lower rear end of the serpentine regenerator-chamber, a series of steam-disintegrating superheaters and a series of oil-disintegrating superheaters embedded in the walls of the regenerator and communicating, respectively, with the gas-generator and the regenerator-chamber, and pipe-coils removably located in the exit-compartment of the regenerator and arranged for the introduction of steam and oil to the respective superheaters, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

WILLIAM H. HARRIS.

Witnesses:

JAMES L. NORRIS,  
J. FRED. KELLEY.