No. 887,861. PATENTED MAY 19, 1908.

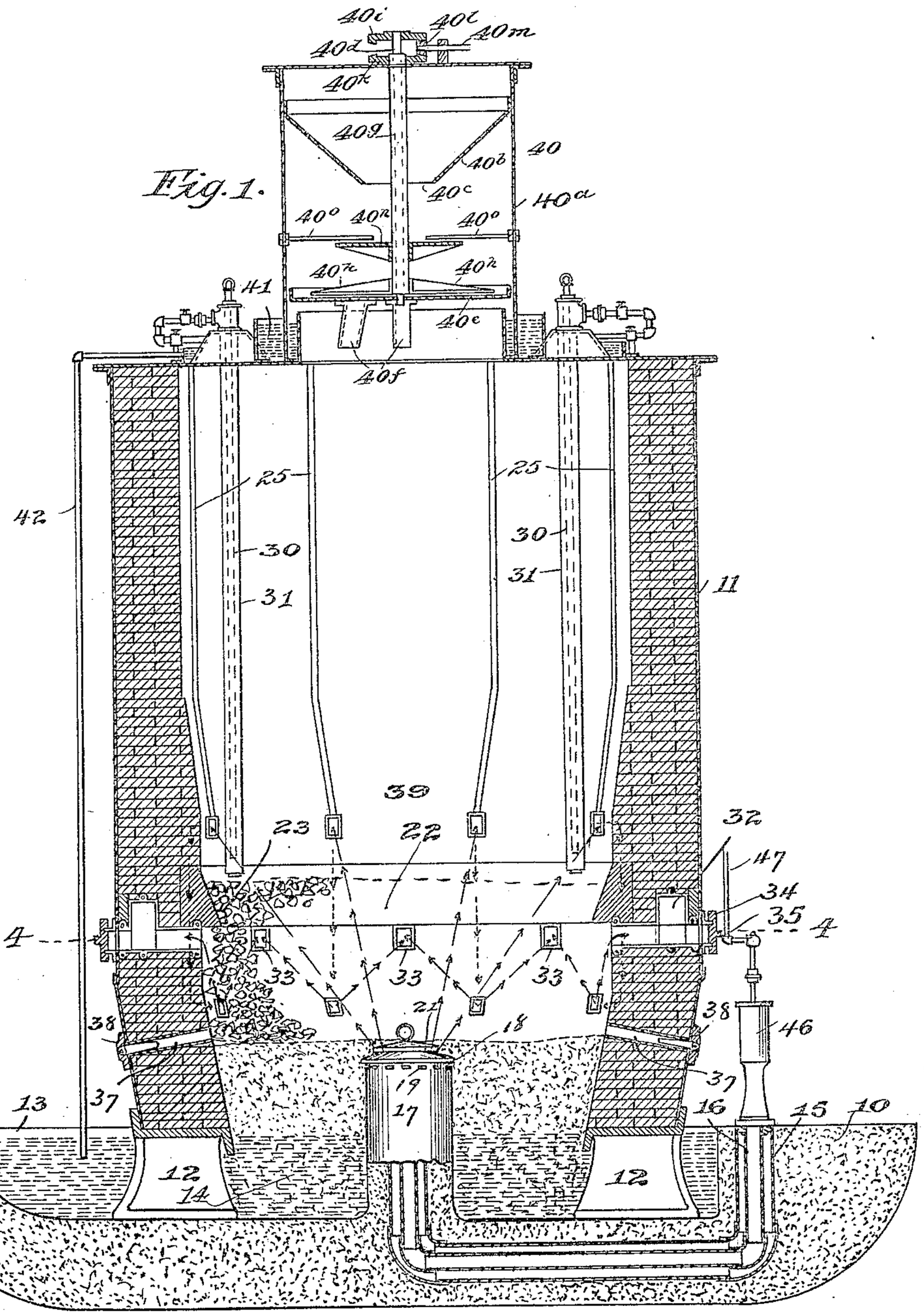
E. P. SNOWDEN.

METHOD OF MAKING PRODUCER GAS.

APPLICATION FILED JAN. 10, 1907.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses,
T. D. Mann,
S. N. Pond

Inventor,
Edward P. Snowden
By Offield, Towle & Linthicum
Attys.

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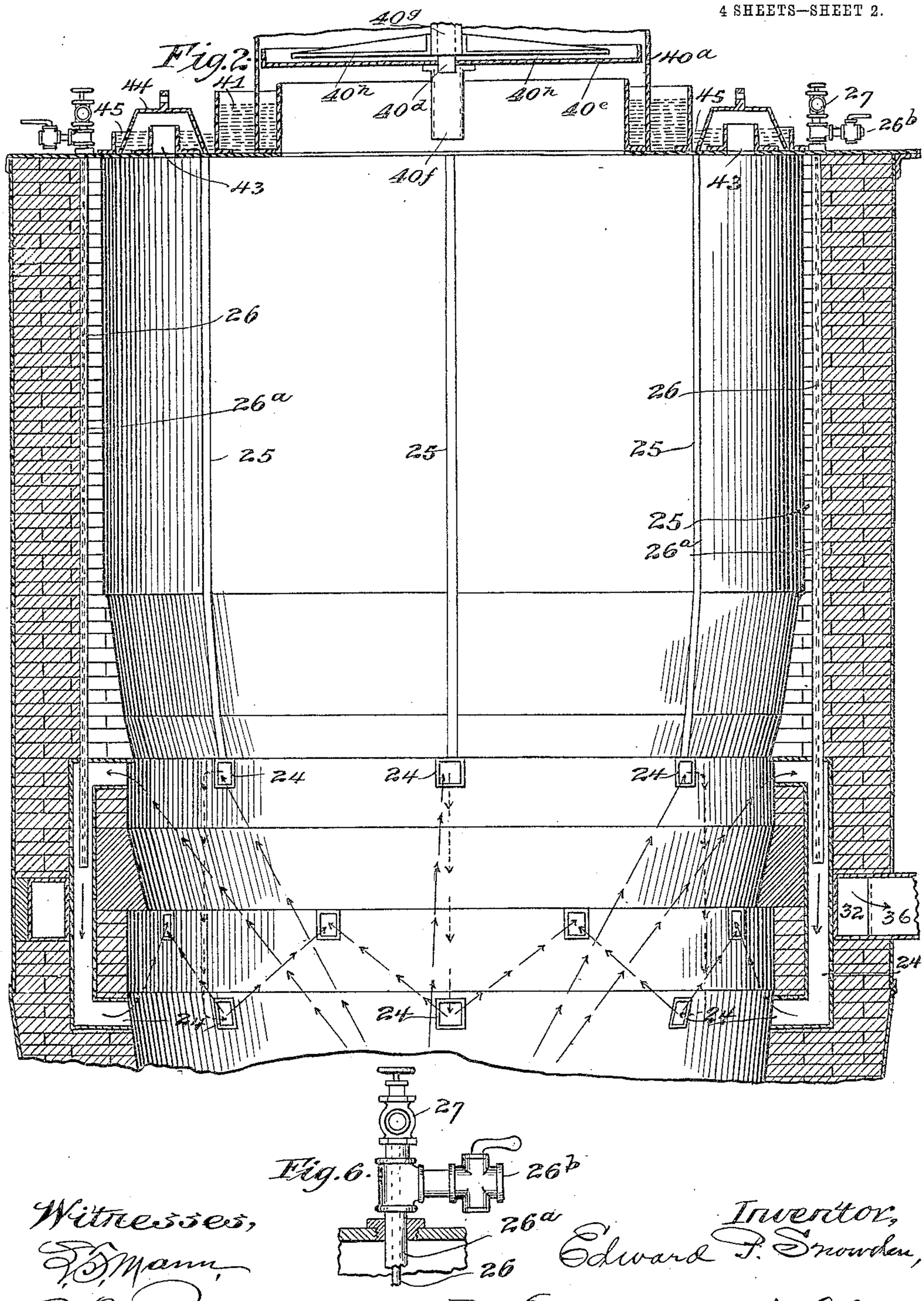
4 SHEETS—SHEET 2.

Fig. 2.



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F. D. Mann,
S. N. Pond

Inventor,
Edward P. Snowden,
By Offield, Towle & Linthicum
Attys.

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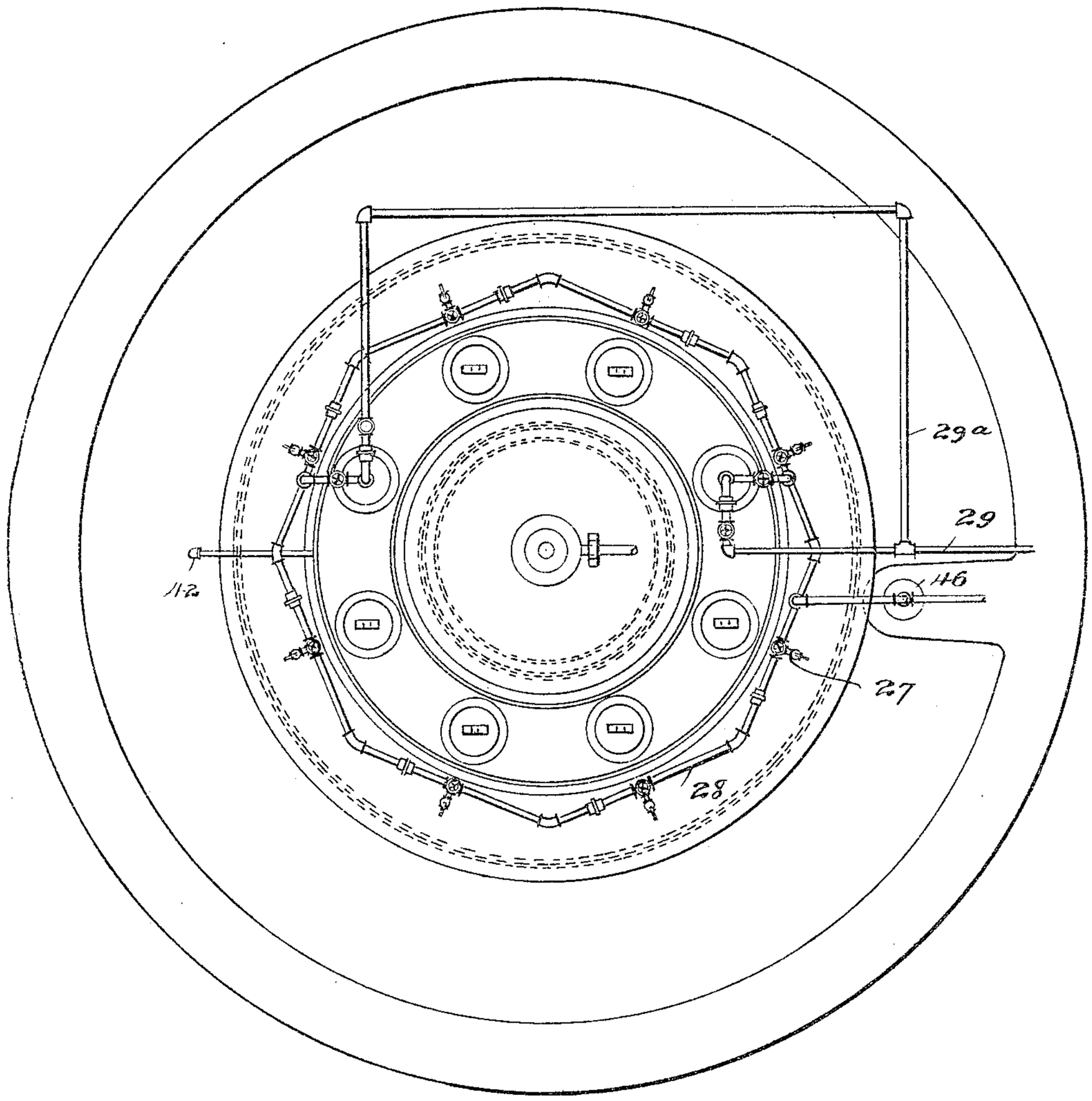
4 SHEETS—SHEET 3.

Fig. 3.



Witnesses,
F. D. Mann.
S. N. Pond.

Inventor,
Edward P. Snowden,
By Offield, Towle & Linthicum
Attys.

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4 SHEETS—SHEET 4.

Fig. 4.

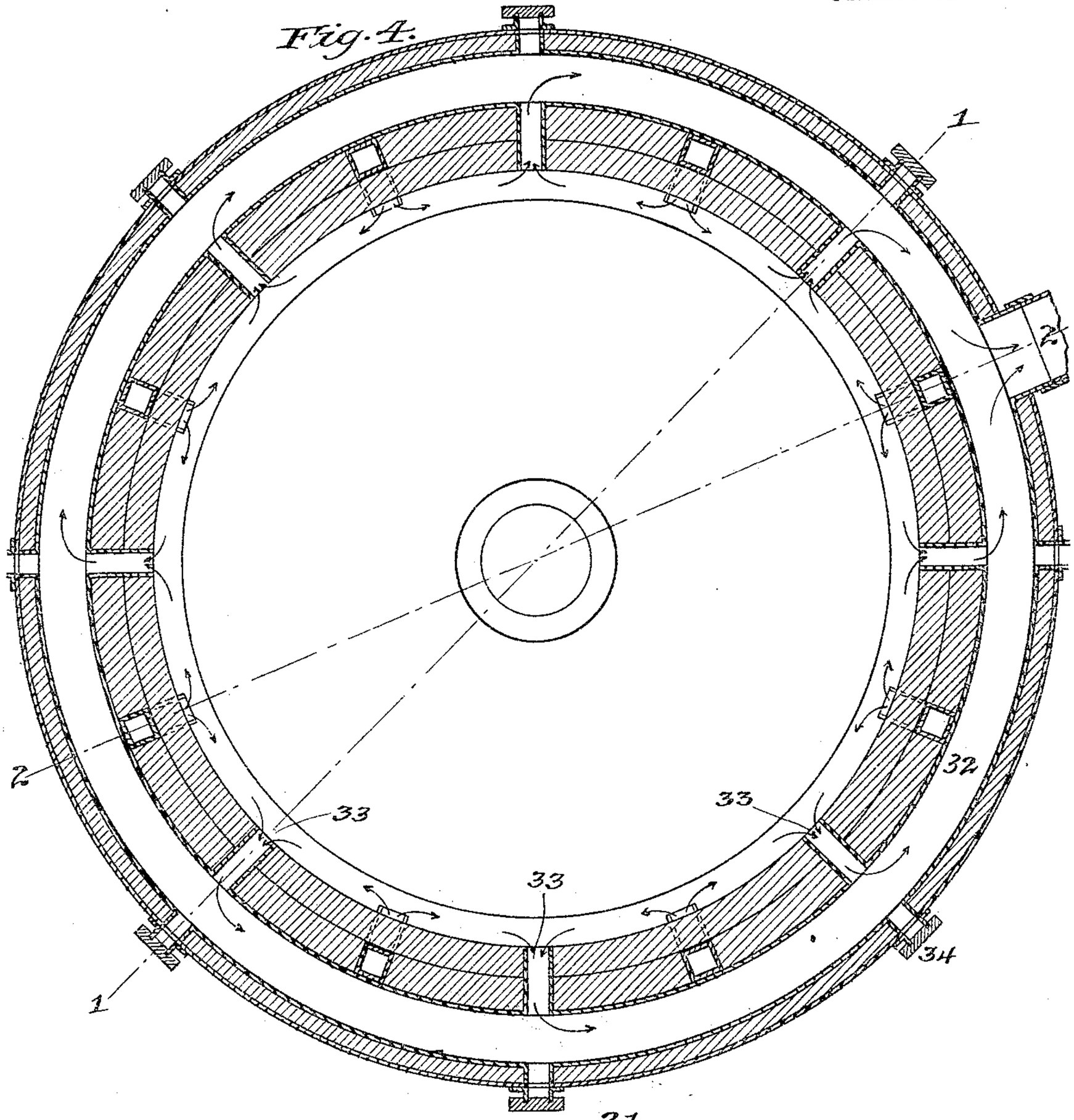
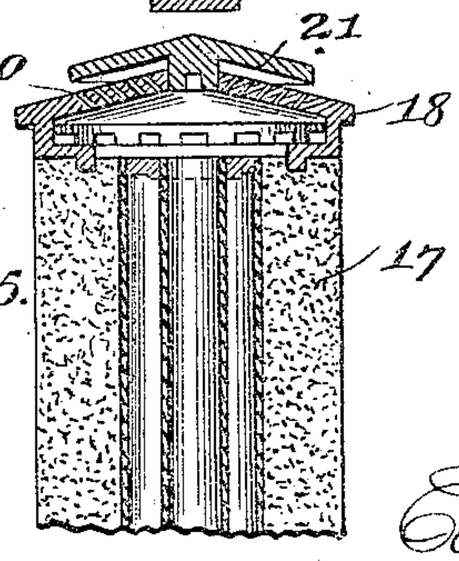


Fig. 5.



Witnesses,
L. D. Mann.
S. N. Pond.

Inventor,
Edward P. Snowden,
By Offield, Towle & Linthicum
Attys.

UNITED STATES PATENT OFFICE.

EDWARD P. SNOWDEN, OF ST. JOSEPH, MISSOURI.

METHOD OF MAKING PRODUCER-GAS.

No. 887,861. Specification of Letters Patent. Patented May 19, 1908.

Application filed January 10, 1907. Serial No. 351,705.

To all whom it may concern:

Be it known that I, EDWARD P. SNOWDEN, a citizen of the United States, residing at St. Joseph, in the county of Buchanan and State of Missouri, have invented certain new and useful Improvements in Methods of Making Producer-Gas, of which the following is a specification.

This invention relates to a novel and improved method of making what is known as producer gas, a product created by converting hydrocarbon compounds, more especially semi-anthracite and bituminous coals, lignite, and peat, into a fixed gas suitable for power and other commercial purposes; and the main object of the present invention is to effect the conversion of such compounds more simply and completely than has heretofore been possible.

It is well known that when carbonaceous fuel is burned with oxygen, carbonic acid gas is produced; and that when the latter is passed through a mass of incandescent carbon, it is converted into carbonic oxid. It is also well known that the products of distillation arising from the combustion of carbonaceous fuel containing a considerable per cent. of volatile matter will condense unless they are maintained at a temperature of above 350° F., and that it requires about 1100° F. to convert these products into a fixed gas.

The present invention contemplates maintaining the products of distillation at all times during the process above 350° F., so as to prevent any condensation of the hydrocarbon products; and it also contemplates subjecting these products to a temperature of above 1100° F. during their conversion into a fixed gas.

When atmospheric air is used to furnish the oxygen for the combustion of carbonaceous fuel, and steam is added thereto, the oxygen and hydrogen of which the latter is composed becomes dissociated at high temperatures, the oxygen thus liberated combines with some of the carbon, forming an additional supply of carbonic oxid, and the dissociated hydrogen enriches the first products of combustion and thus reduces the relative proportion of diluent nitrogen in the resultant compound. Upon the degree of heat at which the steam and condensable products are injected into the incandescent fuel, (and the sensible heat available over and above the temperature of about 1100° F.), depends the amount of steam and condensable matter that can be converted into fixed gas.

I am aware that attempts have been made to convert the condensable vapors and volatile matter from the top zone of generators into a fixed gas by conveying the same through pipes or conduits and reintroducing them into the combustion zone of the generator; but so far as I am aware a serious fault hitherto inhering in such methods of procedure has been the failure to maintain them at a sufficiently high temperature and the consequent liability of such vapors and volatile matter to condense prior to their reintroduction and conversion.

An important step of my present process, therefore, resides in maintaining such condensable vapors and volatile matter at a temperature considerably above the condensing point prior to their reintroduction to the combustion zone and their conversion into a fixed gas therein.

While it has heretofore been proposed to produce such a product as contemplated by the present invention by first passing air, or air and steam, through an incandescent carbonaceous fuel and subsequently repassing the products of combustion through incandescent fuel in order to give a fixed character thereto, yet so far as I know, this has never been successfully accomplished owing (1) to the condensing of the first products of distillation prior to reintroduction to the incandescent fuel; or (2) through lack of proper control of the direction of flow of the gases and volatile matter; resulting either in the diversion of the first products of combustion, unconverted into a fixed gas, into the delivery conduit for the latter, or the diversion of the fixed gases from their proper and intended course of travel into the path of travel of the original supply of oxygen and hydrogen.

In order that my improved process may be the more readily and fully understood, I have herein illustrated a form of apparatus well adapted for the carrying out of the said process, the construction and mode of operation of which I will now describe. Said apparatus is fully shown in the accompanying drawings, in which,—

Figure 1 is a central vertical sectional view on the line 1—1 of Fig. 4 through the complete apparatus; Fig. 2 is an enlarged vertical sectional view on line 2—2 of Fig. 4 through the main intermediate portion of the

furnace; Fig. 3 is a top plan view of the same, on an enlarged scale, more particularly showing the arrangement of the steam pipes and poke-holes; Fig. 4 is a horizontal sectional view on the line 4—4 of Fig. 1; Fig. 5 is a vertical sectional detail of the nozzle through which air or air and steam is introduced to the furnace from below; and Fig. 6 is a detail of the steam and air supply for the outer or annular fire through the reëntry conduits from the top of the producer.

Referring to the drawings, 10 designates a foundation of concrete or other suitable material on which the generator is erected, and 11 designates the main body or furnace of the generator constructed, as usual, of highly refractory fire-resisting material. This latter rests upon a suitable base 12 erected on the concrete or other foundation 10, within which latter is a basin 13 to accommodate a water-seal surrounding the base of the generator, said basin also constituting an ash bed in which rests an ash column indicated at 14 immediately beneath and supporting the fuel column. That portion of the interior of the furnace body immediately above the ash column is designed to support a body of incandescent fuel, the central portion at least of which consists of some form of carbonaceous compound, preferably some kind of bituminous or similar coal from which the carbonaceous elements of the gas to be produced are obtained.

Embedded in the foundation 10, and preferably surrounded by an insulating pipe 15, is a pipe 16, through which is passed air, or steam, or both together, for supporting combustion of the fuel in the generator. This pipe 16, with its surrounding and insulating pipe 15, extends upward through the ash column coincidently with the axial center of the generator, being preferably surrounded by a thick concrete insulation 17 (Fig. 5), and terminates in a suitably apertured cone-shaped deflector nozzle 18 designed to disperse and spray the incoming air or air and steam, so that the same may enter the superposed body of fuel in a thoroughly commingled and finely divided and distributed state. For this purpose the nozzle may be provided with an annular series of lateral apertures 19, and its cap or cover with oblique apertures 20, above which latter may be applied a deflecting cap or hood 21 serving to disperse in radial directions the oblique jets discharged through the apertures 20, and to protect the escape apertures from clogging.

22 indicates the intermediate or central portion of a body of incandescent fuel, and 23 indicates the surrounding or annular portion of the fire. In practice the portions 22 and 23 may, and commonly will, consist of a single body of incandescent fuel; but as a matter of fact the central and surrounding annular parts of the body of fuel constitute in effect two distinct fires having independent functions; for which purpose the central portion must be of some carbonaceous gas-producing fuel; while the outer or annular portion need only be of a combustible material capable of maintaining a degree of heat (1100° F. or higher) sufficient to convert the distilled hydrocarbons and volatile products generated by the central fire into a fixed gas.

Embedded in the walls of the generator at intervals therearound are vertical conduits 24, which conduits open at their upper ends into the chamber of the generator slightly above the upper surface of the fuel, and at their lower ends open into the chamber of the generator slightly above the plane of the bottom end of the incandescent body of fuel. The walls of the generator above the upper ends of the conduits 24 are vertically grooved, as indicated at 25 in alinement with the conduits 24, within which vertical grooves are inserted pipes 26 the lower ends whereof extend some distance into the conduits 24, as best shown in Fig. 2. These pipes are for the purpose of admitting superheated steam to form a strong suction in the conduits 24 for the purpose of drawing the products of combustion from the central portion 22 of the incandescent fuel, and also to supply oxygen for supporting combustion in the outer or annular fire 23, said steam pipes 26 being connected at their upper ends by suitably valved couplings 27 to an annular steam pipe 28, which latter is supplied from steam supply pipe 29 indirectly through superheating means herein shown as consisting of pipes 30 extending from the top of the generator nearly to the bottom of inclosing tubes 31, said pipes 30 being connected to the steam supply pipe 29 and its branch 29^a, and the tubes 30 being connected through valve-controlled branches 31 with the annular distributing pipe 28. It will be seen that by virtue of this arrangement the steam from the original source of supply passes first through the pipes 30 and tubes 31 which depend into the combustion chamber of the generator, and is thereby superheated prior to its introduction to the conduits 24. Surrounding the steam-pipes 26 I may also have enveloping air-pipes 26^a, controlled by valves 26^b, (see Fig. 6) for the purpose of introducing air along with the steam for the purpose of the better supporting combustion in the outer or annular fire zone 23.

Embedded in the wall of the generator between the planes of the upper and lower surfaces of the fire, is an annular conduit 32 designed to receive and carry off the fixed gas from the outer annular fire, for which purpose the conduit 32 has a series of inner radial ports 33 opening through the inner surface of the generator at intervals. The conduit 32 also has preferably a corresponding series of short radial ports 34 opposite

the radial ports 33 extending to the outer surface of the generator wall and covered by suitable caps 35, so as to constitute sight openings for observing the condition of the fire, poking, etc., at that level. The conduit 32 also communicates at one or more points with a discharge conduit indicated at 36 in Figs. 2 and 4, which latter connects with an exhaust blower or fan (not shown) whereby an induced draft is maintained in the delivery conduit 32.

The walls of the generator may also be provided with a series of sight holes 37 covered by caps 38 and located substantially opposite the normal bottom of the fuel column, so as to enable the location and condition of the bottom of the fuel column to be readily inspected.

In order to counteract shrinkage which occurs at the periphery or circumference of the fuel column, in case bituminous or similar fuel is used, and which therefore is apt to produce leakage or short-circuiting of the products of combustion and volatile matter at such points, from the top of the fuel column directly to the radial ports 33, I preferably employ an annular member 39 having a tapering and downwardly convergent inner surface located opposite the upper surface of the fuel body, so that a comparatively intimate contact of the fuel body with the wall of the furnace is maintained, notwithstanding the shrinkage of the fuel body, and leakage at such points is prevented, as will be more readily understood in connection with the description of the carrying out of the process in the apparatus illustrated.

On the upper end of the generator chamber is mounted a fuel feeding device indicated as a whole by 40, the purpose of which is to feed the coal uniformly and continuously to the fire beneath. The particular construction of this fuel-feeding device forms no part of the present invention, but the principal parts thereof comprise a fuel magazine 40^a containing in its upper portion a hopper 40^b having a central discharge opening 40^c, a vertical axially disposed shaft 40^d extending through the hopper, a rotary distributer 40^e secured to the lower end of said shaft with depending delivery chutes or tubes 40^f, a sleeve 40^g surrounding the shaft 40^d and provided with radial sweeps 40^h overlying the distributer 40^e, bevel gears 40^i and 40^k on the upper ends of the shaft and sleeve, respectively, and a driving pinion 40^l on a shaft 40^m operating said bevel gears, as shown. An intermediate distributer 40^n is also applied to the sleeve above the main distributer and first receives the coal from the hopper; the coal being displaced therefrom by inwardly projecting stationary fingers 40^o secured in the wall of the fuel magazine. This feeding device rests in a water seal 41 surrounding its lower end, which latter is provided with an overflow pipe 42 leading downwardly into the lower water seal 13 surrounding the base of the generator. The top of the generator is further provided with an annular row of poke-holes 43 (Fig.2) covered by removable caps 44 resting in water-seals 45 to prevent escape of gas at such points.

At 46 is indicated an injector through which air and steam, either or both, is forced into the inlet pipe 16, and 47 indicates a steam pipe through which steam is admitted, to operate the injector and supply steam when used.

My improved method of generating producer gas when carried out by the apparatus herein shown and described, is performed in the following manner. The fire having been started in the generator, and fuel fed thereto until an incandescent body of coal is produced substantially between the upper edge of the ring 39 and the plane of the sight holes 37, air or steam, but preferably the two commingled, is forced through the pipes 16, and is delivered through the spraying nozzle to the under side of the fire at the central zone thereof. By reason of the fact that the distance from the point of entry, of the air and steam, to the upper surface of the central portion of the fire is less than the distance from said point of entry to the outlet ports 33, such steam and air follows the shorter path, by virtue of the lesser resistance offered thereby, upwardly through the central portion 22 of the incandescent fuel, and rises above the surface of the central fire in the form of a mixture of carbonic acid gas, carbonic oxid, and the products of distillation of the coal and other volatile matter given off by the latter. During this time steam having been turned on through the pipes 26, and air through pipes 26^a, when required, a strong downward suction or siphoning effect is created through the reëntry conduits 24 just above the fire, and the products of combustion are thus drawn downwardly by such suction through said reëntry conduits and, commingled with the steam, or steam and air, enter the sides of the outer or annular fire zone near the bottom of the latter, through the lower ends of the reëntry conduits. The products of combustion and steam rise through the outer or annular fire until they reach the ports 33 of the annular conduits 32 embedded in the wall of the generator, being drawn toward the latter by the induced draft in conduit 32, and during this passage through the annular fire the steam or steam and air having supplied oxygen to maintain combustion, the carbonic acid gas is converted into carbonic oxid, and the products of distillation and volatile gases, being heated to or above 1100° F., are converted into a fixed gas, which is drawn off to the point of storage or consumption through the ports 13.

33, conduits 32, and outlet 36. It should be observed as constituting an important feature of the present process that the reëntry conduits 24 are, by virtue of their position in the generator, maintained at such a high temperature (above 350° F.) as to prevent lowering of the temperature of the products of distillation therethrough below that point, whereby condensation of such products of distillation or any part thereof is prevented. The discharge of the fixed gas through the ports 33, conduits 32, and discharge branch 36, is insured by reason of the induced draft and the shorter path between the lower ends of the reëntry conduits 24 and the ports 33 as compared with the distance between the lower ends of said reëntry conduits and the central zone of the fire body through which the original air and steam are passing.

The apparatus herein shown and described is not claimed in the present application, but forms the subject-matter of a companion application filed concurrently herewith, Serial No. 351,704.

I claim:

1. A method of converting hydrocarbon compounds into a fixed gas, which consists in maintaining a body of incandescent fuel having a central zone and a surrounding annular zone, passing an oxygen-bearing agent through one of said zones, and thence conducting the gases and volatile products thus generated under a temperature sufficient to prevent condensation into and through the other of said zones, whereby the carbon dioxid is converted into carbon monoxid and the condensable products of distillation are converted into a fixed gas, substantially as described.

2. A method of converting hydrocarbon compounds into a fixed gas, which consists in feeding fresh fuel onto a body of incandescent fuel, simultaneously passing air and steam through the central zone of said body of incandescent fuel, thence conducting the gases and volatile products thus generated under a temperature sufficient to prevent condensation beneath and through the outer zone of said body of incandescent fuel, whereby the carbon dioxid is converted into carbon monoxid and the condensable products of distillation are converted into a fixed gas, substantially as described.

3. A method of converting hydrocarbon compounds into a fixed gas, which consists in continuously feeding a gas-producing fuel upon an incandescent bed of the same and supplying oxygen to effect combustion of the fresh fuel by passing air or air and steam through the central portion of the incandescent mass, drawing off the gases evolved by the aid of an inducing current and under a temperature sufficient to prevent condensation, and then passing such heated gases through the outer portion of the incandescent mass and collecting the gas product upon their exit therefrom, substantially as described.

4. A method of converting hydrocarbon compounds into a fixed gas, which consists in continuously feeding a gas-producing fuel upon an incandescent body of the same and supplying oxygen to effect combustion of the fresh fuel by passing air or air and steam through the central portion of the incandescent mass, drawing off the gases evolved in the zone of contact between the fresh fuel and the burning mass by the aid of an inducing current and under a temperature sufficient to prevent condensation, and then passing such heated gases through the outer portion of the incandescent mass without commingling with the oxygen-bearing medium and collecting the gas product upon their exit therefrom, substantially as described.

EDWARD P. SNOWDEN.

Witnesses:

SAMUEL N. POND,

CHAS. A. HARVEY.