J. J. & F. C. NIX.

PROCESS OF PRODUCING GAS.

APPLICATION FILED SEPT. 25, 1912.

1,078,304. Patented Nov. 11, 1913.

Fig. 1.

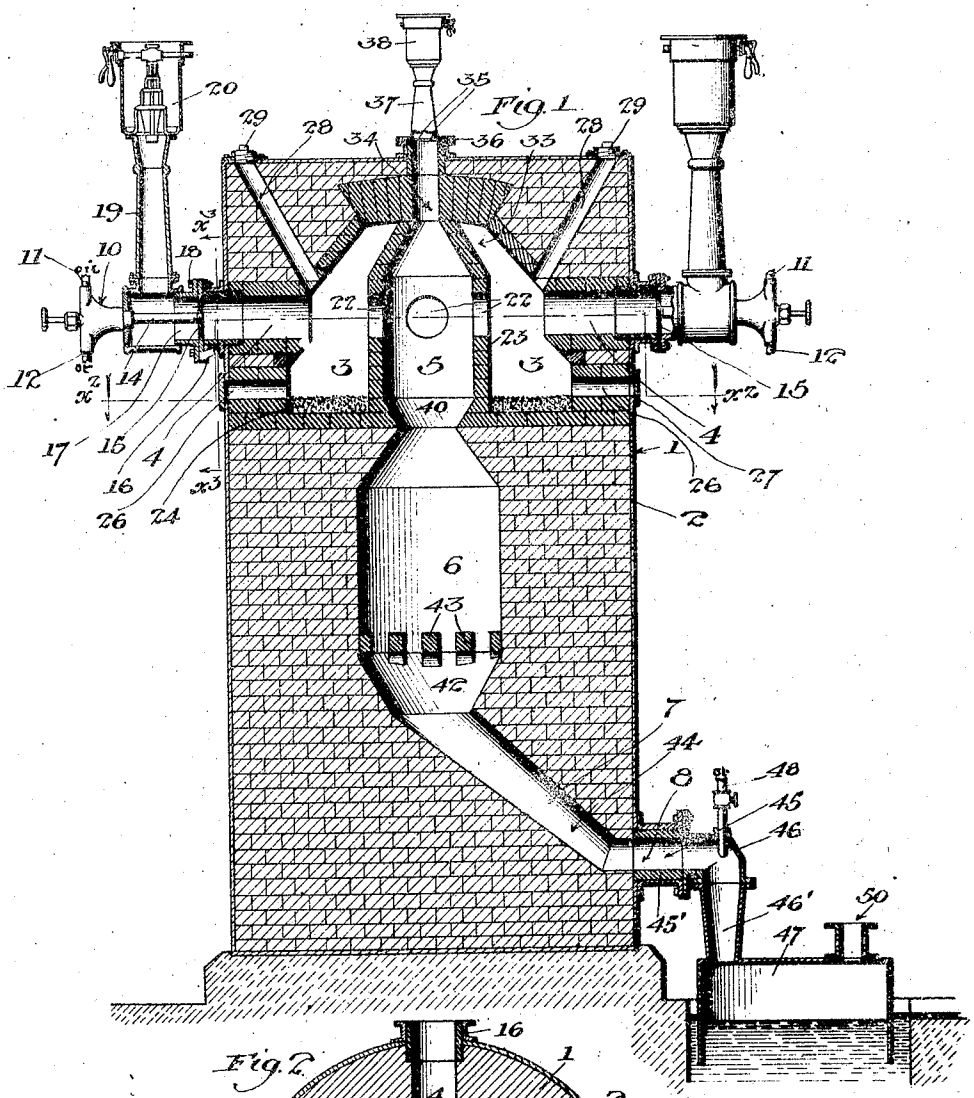


Fig. 2.

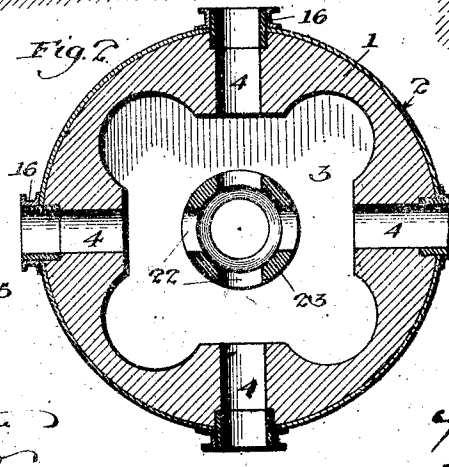


Fig. 3.

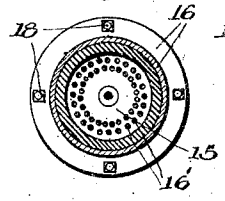
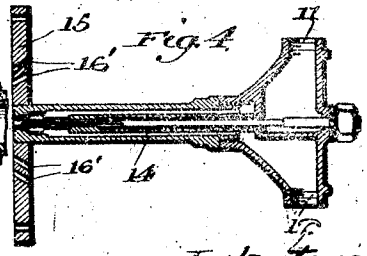


Fig. 4.



Witnesses:

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UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING GAS.

1,078,304. Specification of Letters Patent. Patented Nov. 11, 1913.

Application filed September 25, 1912. Serial No. 722,360.

To all whom it may concern:

Be it known that we, JOSHUA J. NIX and FRANK C. NIX, citizens of the United States, residing at Alhambra, in the county of Los Angeles and State of California, have invented a new and useful Process of Producing Gas, of which the following is a specification.

This invention relates to the production of gas from liquid hydrocarbons such as crude petroleum, petroleum residues or distillates, and the main object of the present invention is to provide for utilizing substantially all of the carbon of the fuel in the production of the gas.

A further object of the invention is to provide for the production of a gas which is free from tarry matter, as well as soot or free carbon.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate an apparatus suitable for carrying out the invention, and referring thereto: Figure 1 is a vertical section of the gas producer. Fig. 2 is a section thereof, on line x^2—x^2 in Fig. 1. Fig. 3 is an elevation of a plate for dividing air into fine streams in its passage to the burner. Fig. 4 is a vertical section of the burner.

The gas producer comprises a casing or producer body 1, formed preferably of masonry having, if desired, a shell 2 of sheet metal whereby it is bound together, said casing or body 1 being formed interiorly with any desired number of primary combustion or generator chambers 4, an equalizing chamber 3 communicating with said chambers 4, a secondary combustion and fixing chamber 5 within said chamber 3, and communicating therewith and with a supplementary fixing chamber 6 below said central chamber 5 and communicating at its upper end with said central chamber 5 and at its lower end with an outlet passage 7, leading downward, preferably obliquely to an outlet 8 for the produced gas. The parts exposed to the most intense heat, for example, the walls of the combustion chambers 4 and 5 and of the chamber 3, may be formed of or lined with fire brick.

Any desired number of primary combustion chambers 4 may be provided, said chambers 4 extending horizontally from the outside of the casing into communication with the chamber 3 and being sufficiently elongated to enable the operation of the initial partial combustion to be effected therein. The fuel is supplied to said chambers 4 through an oil atomizer 10, provided with an oil supply pipe 11 and steam supply pipe 12, the steam being supplied under sufficient pressure and in sufficient quantity to force the oil in a fine spray through a nozzle pipe 14 extending through a plate 15 secured at the outer end of a tubular fitting 16, secured to the outside of the shell 2. Said plate 15 has a plurality of perforations 16′ arranged in two or more circular series concentric with the outlet nozzle, and means are provided for forcing air at a moderate pressure through these holes. The perforations 16 extend obliquely inward at an acute angle to the direction of the outlet nozzle, so as to converge toward a point within the chamber 4, in the line of the jet from atomizer nozzle pipe 14. For this purpose a blower or pumping device 20 is connected to a tubular member 17, secured on the outside of said plate 14, for example, by bolts 18, said tubular member 17 communicating through a pipe 19 with said blower. Said blower is preferably a steam jet blower, for example, of the compound type illustrated, it being of advantage in working with some fuels to supply steam along with the air as hereinafter set forth.

The chamber 3 communicates with all of the primary combustion chambers 4 and communicates with the chamber 5, through ports or openings 22 in the cylindrical wall 23 of said chamber 5, said openings 22 being directly opposite the respective chambers 4 so that the hot gases issuing from said chambers 4 are not obstructed by any solid wall. The chamber 3 extends below

the chambers 4 and the openings 22 to form a storage chamber 24 for reserve carbon, this portion of the chamber 3 being provided with cleanout passages 26 having doors or closures 27. Passages 28 may extend upwardly from the chamber 3 and be closed at the top by removable plugs 29 so as to enable a supply of carbon to be deposited in the lower part of the chamber 3 in starting the producer in operation.

The secondary combustion and fixing chamber 5 is extended above the level of the preliminary combustion chambers 4, forming a superheating chamber or space 33 at the upper portion of the chamber 3, surrounding the central chamber 5. Auxiliary air supply means are preferably provided for this chamber 5, the casing 1 being provided with a vertical passage 34 extending upwardly from the central chamber 5 and communicating at its upper end through perforations 35 in a plate 36, with a pipe 37 provided with a steam jet blower 38. At its lower end, the chamber 5 is contracted, forming a throat 40 communicating with the upper end of the supplementary fixing chamber 6 which extends or flares downwardly from said throat and is again contracted at its lower portion as shown at 42. Arches 43 may be provided in chamber 6 to aid in the final fixing operation, as hereinafter set forth. From the bottom of chamber 6, a discharge passage 44 extends obliquely down through casing 1 to an outlet tube 45 lined with firebrick, as indicated at 45′ and communicating with an ejector casing 46 which extends downwardly into a box 47. A steam pipe 48 projecting downwardly into casing 46, in line with the outlet portion 46′ thereof, produces an ejecting action on the gas in the casing and tends to draw the gas from the chamber 6 and to maintain a condition of suction in said chamber. Box 47 may be immersed in water and be open at the bottom and is provided with outlet 50 leading to the service pipe or to any means for conducting away, storing, or using the gas.

The process constituting our invention consists in atomizing liquid hydrocarbon, impinging on the atomized liquid, streams of air and steam at sufficient velocity to break up the air and steam into a state of fine subdivision, that is, to atomize the air and steam, causing said atomized air and steam to burn a portion of the liquid hydrocarbon under a condition of pressure, then admitting a secondary supply of air and steam to produce a further partial combustion at higher temperature and under a condition of pressure, then allowing the produced gas to expand to a condition of partial vacuum and while in such expanded condition, causing the portions of such gas to be intermixed, to fix the gas.

A further feature of the process is the accumulation of solid carbon from the partial combustion at times of excess of fuel supply over air supply and utilization of the resulting body of solid carbon in furnishing heat and carbon to the gas at times of deficient fuel supply.

Another feature of the process is the conversion of any free carbon in the produced gas into combustible gas by admitting steam to the gas while the gas is at a temperature sufficiently high to enable the free carbon therein to dissociate the steam.

A further object of the invention in this connection is to utilize the same steam for formation of water gas in this manner and for ejection of the produced gas.

The process is carried out in the above described apparatus as follows: Oil and steam are supplied to the burner or atomizer 10 through pipes 11 and 12, so as to cause a jet of atomized oil to issue from the nozzle pipe 14 into the generators or primary combustion chambers 4. Atomized air is also forced into said chambers by the steam blower 20 through perforations 16′, said air being divided by said perforations into a large number of fine streams which enter at the circumferential portion of chamber 4 and converge so as to impinge on the jet of atomized oil at high velocity, causing intimate and thorough mixture of the steam, air and oil, the mixture of air and oil being ignited and burned within the primary combustion chamber. The combustion being concentrated by impinging the air on the oil in this manner, this high temperature is maintained at the point of partial combustion, so that the primary combustion is substantially completed before the gaseous parts leave the primary combustion chamber and enter the chamber 3. The chamber 3 serves as an equalizing chamber, both mechanically and chemically, the products from the several burners entering this common chamber, so that the pressure thereof is equalized and the chemical constituents of the gas is maintained constantly by the action of the carbon deposited in the lower portion of this chamber. At times when the fuel supply runs in excess of the air supply, so that an excessive amount of free carbon is produced, the major portion of such carbon will settle into the lower portion of this chamber which is made of relatively large area so as to produce a substantially dead space in which the solid matter may settle by gravity. On the other hand, at times when the fuel supply is deficient so that free oxygen is present in the produced gas in chamber 3, said gas will be at sufficiently high temperature to enable this free oxygen to take up carbon from the body of free carbon in the bottom of chamber 3. By providing this reserve supply of carbon, we

are enabled to push the carbon content of the gas to a maximum, while reducing the amount of free carbon in the gas to a minimum. In this connection it will be understood that the retention of this body of carbon at high temperature in contact with the gas, serves to increase the capacity of the gas for taking up carbon in the combined conditions.

The gas passes from the chamber 3 through the apertures 22 in the wall 23, to the secondary combustion and fixing chamber wherein it encounters a blast of auxiliary air and steam passing into said chamber from the steam blower 38, this auxiliary air being superheated by contact with the walls of the chamber 5 which are maintained at high temperature by conduction through said wall of the heat of the gases in the upper part of the chamber 3. The air and gas being at high temperature cause a second combustion resulting in a still higher temperature, the effect of which is to break up any tarry matter present in the gas and tend to the formation of carbon monoxid by reaction of any free carbon present with any carbon dioxid present in the gas. The combustions heretofore described in the primary and secondary combustion chambers take place under a condition of pressure maintained by the steam blowers 20 and 36, this pressure being, for example, about one ounce more or less to the square inch. On reaching the bottom of the chamber 5, the gas issues through the contracted outlet or throat 40 into the supplementary fixing chamber 6, the gas expanding in this operation to a condition of partial vacuum, say one-tenth ounce to the square inch, more or less, and this expansion tending to set free a portion of the carbon, and the resulting free carbon being then mixed with the hot gases in the chamber 6 so as to combine with any free oxygen present, or reaction of any carbon dioxid present to form carbon monoxid. The chamber 6 is preferably of large capacity so as to retain the gases therein a sufficient time at a high temperature to produce the mixing required for fixing the gas. In general, there will be some free carbon remaining in the gas after passing through the mixing chamber 6, and as the gas is drawn through the outlet 45 by the ejector 48, the steam supplied at such ejector reacts with such free carbon in the gas to form water gas. While the process if properly carried out with suitable fuels, results in the production of gas which is substantially clear of free carbon, it will be understood that under certain conditions, for example, in using unusually heavy fuels, more or less free carbon will pass the ejector 48, the washbox 47 being provided to collect and remove from the gas such free carbon.

An important feature of the present invention is that the vacuum in the supplementary fixing chamber is drawn from the condition of pressure in the chamber 5 so that the combustion takes place under pressure and is followed by expansion to a condition of partial vacuum. This is in distinction to those processes wherein combustion takes place in a partial vacuum resulting from suction on a combustion chamber which draws directly from the atmosphere.

In case heavy fuels are used, containing higher percentage of carbon, the use of the steam blower 20 is of advantage in that it supplies steam along with the incoming air, and in this connection we prefer to provide sufficient steam to saturate the air, this steam being operative chemically as well as mechanically, its chemical effect being to react with the carbon to form combustible gas. In case a hydrocarbon with relatively low percentage of carbon is used, any means such as an ordinary air blower may be used for supplying the air, but it is desirable, in any case, to furnish steam to the air.

While the air pressure in the primary combustion chamber is small, the pressure of the air from the steam blower or positive blower before it passes through perforations 16 is much higher, say eight pounds more or less, per square inch, so that the stream of air is forced through said perforations at high velocity, providing jets of great mixing power. This provides for a compound or double atomization, the first atomization being effected by the steam coming in with the oil, and the second atomization being effected by the jets of air saturated with steam.

What we claim is:

1. The process of producing gas, which consists in producing a jet of atomized liquid hydrocarbon by means of steam, directing jets of air under pressure and steam, at high velocity, at an acute angle into said jet of atomized liquid hydrocarbon, so as to cause the atomized jets of air and steam to forcibly impinge on the jet of atomized hydrocarbon and produce a further atomization and mixture of the hydrocarbon, air and steam, causing the resulting mixture of air, steam and hydrocarbon to burn under a condition of pressure above atmospheric pressure and withdrawing the resulting gases from the place of combustion.

2. The process of producing gas, which consists in producing a jet of atomized liquid hydrocarbon by means of steam, directing jets of air under pressure and steam at high velocity at an acute angle into said jet of atomized liquid hydrocarbon, so as to cause the atomized jets of air and steam to forcibly impinge on the jet of atomized hydrocarbon and produce further atomization and mixture of the hydrocarbon, air and steam, causing the resulting mixture of air, steam and hydrocarbon to burn under a condition of pressure above atmospheric pressure, and

withdrawing the resulting gases from the place of combustion, directing into the resulting gases jets of steam and air at high velocity to produce a further combustion and withdrawing gases resulting from said further combustion.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 20th day of September, 1912.

JOSHUA J. NIX.
FRANK C. NIX.

In presence of—
ARTHUR P. KNIGHT,
MARTHA M. LANGE.