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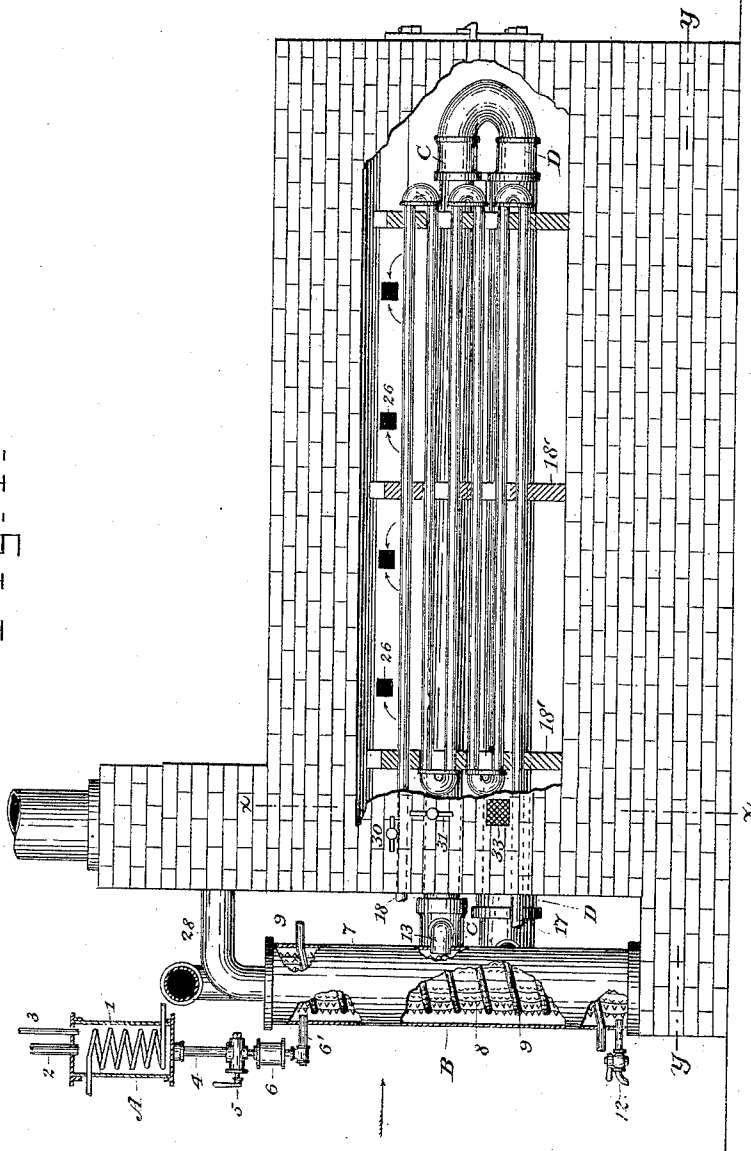
4 Sheets—Sheet 1.

J. S. ROGERS & J. H. BAKER.
APPARATUS FOR MANUFACTURING HEATING AND ILLUMINATING GAS.

No. 465,077.

Patented Dec. 15, 1891.

Fig. 1-



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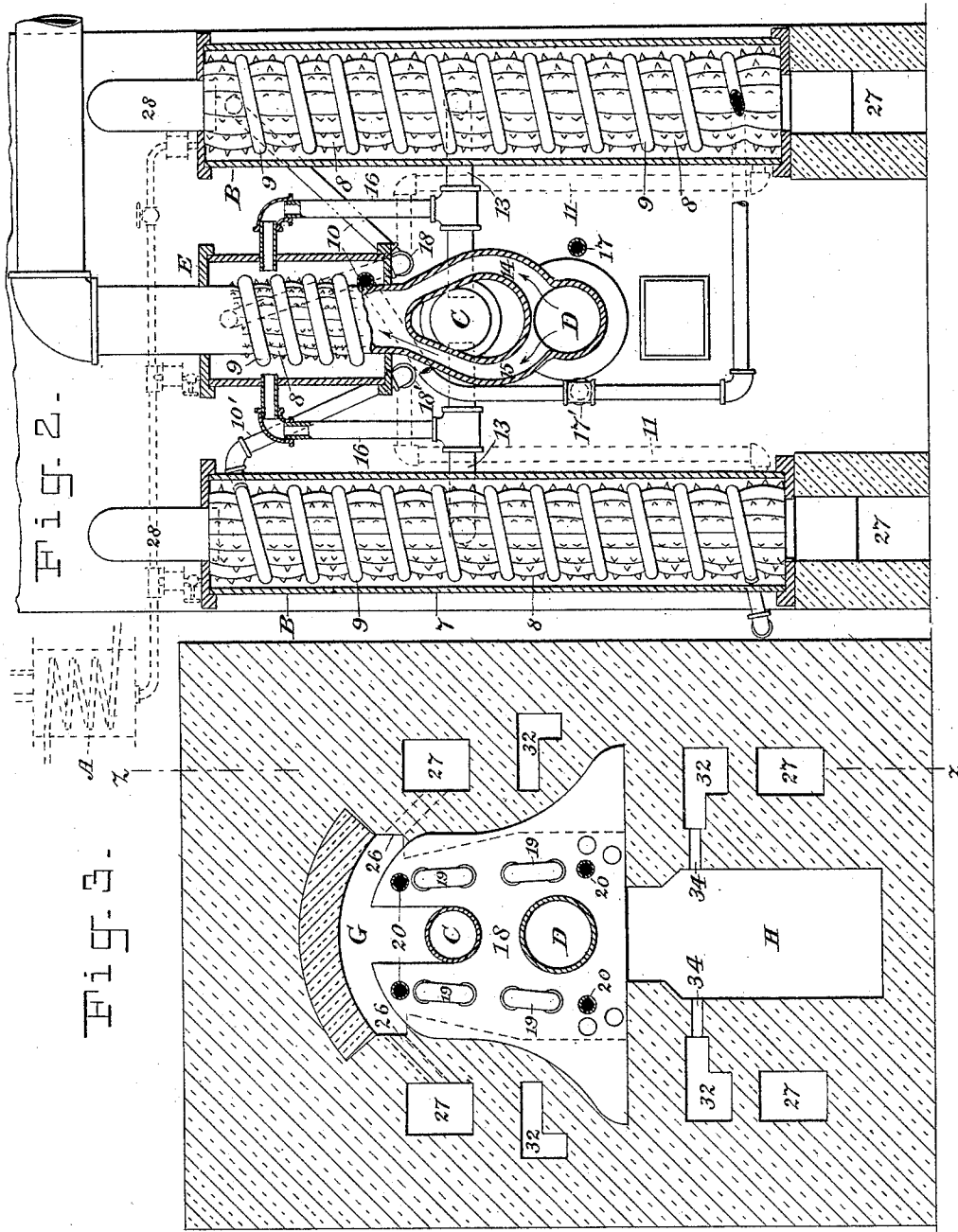
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Fig. 4.

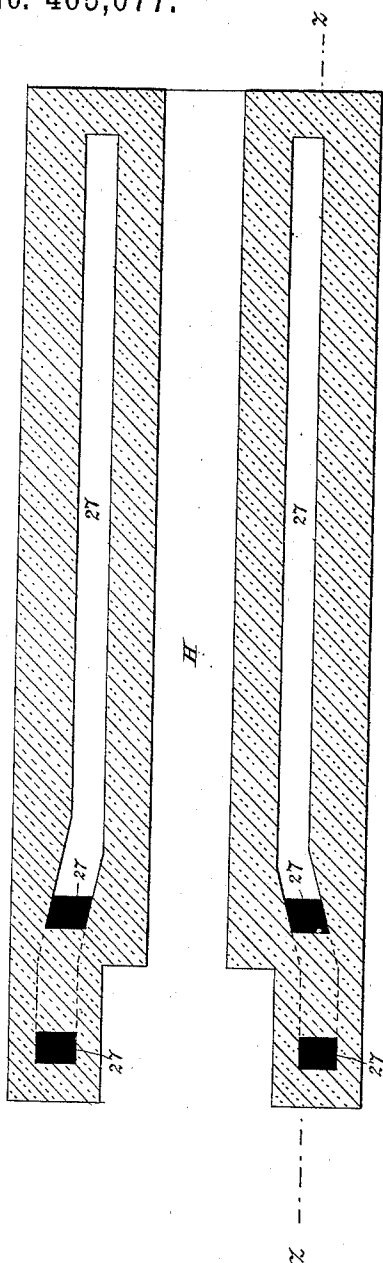
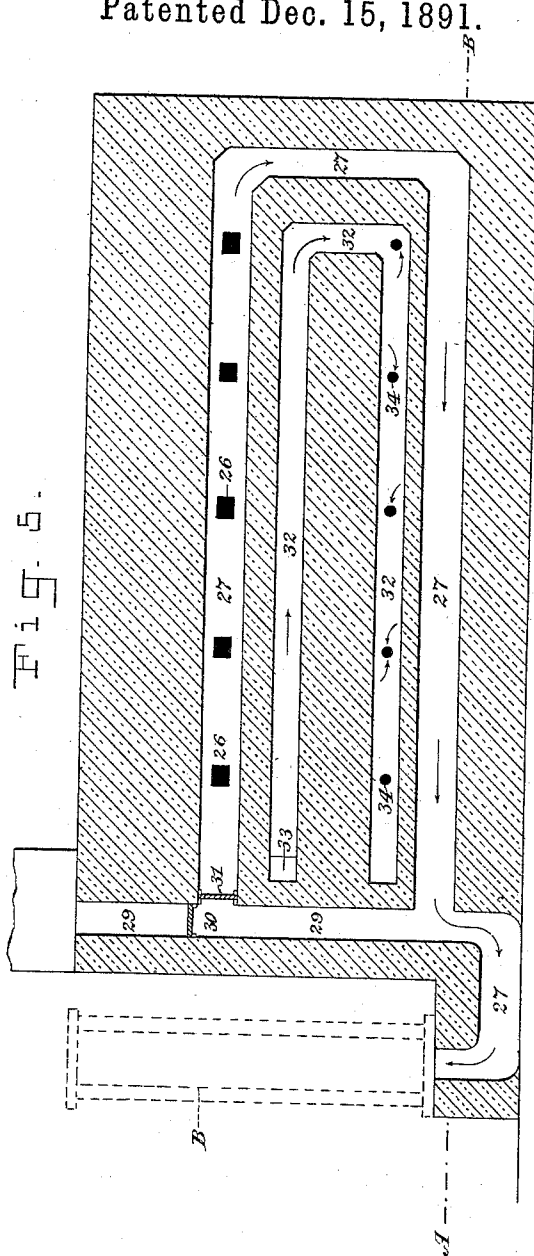


Fig. 5.



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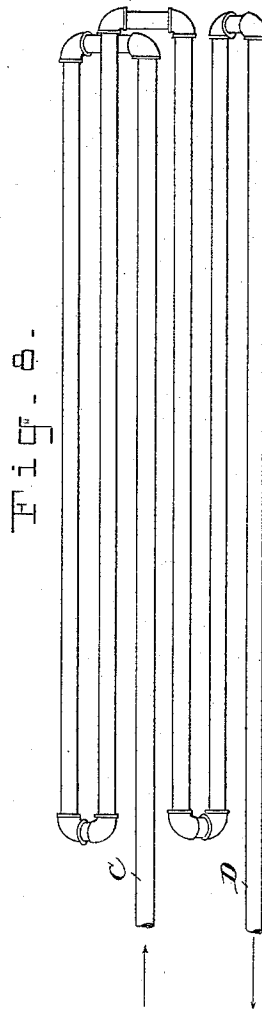
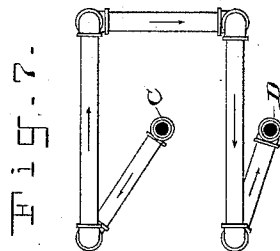
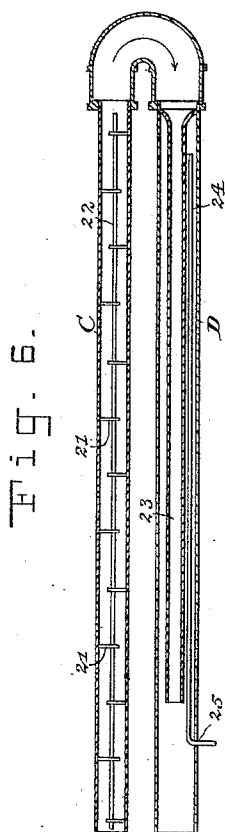
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UNITED STATES PATENT OFFICE.

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APPARATUS FOR MANUFACTURING HEATING AND ILLUMINATING GAS.

SPECIFICATION forming part of Letters Patent No. 465,077, dated December 15, 1891.

Application filed June 3, 1890. Serial No. 354,122. (No model.)

To all whom it may concern:

Be it known that we, JAMES S. ROGERS, of Rockport, in the county of Essex and State of Massachusetts, and JAMES H. BAKER, of Saratoga Springs, in the county of Saratoga and State of New York, citizens of the United States, have invented certain new and useful Improvements in Apparatus for Manufacturing Heating and Illuminating Gas; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part hereof.

Our invention relates to apparatus for the manufacture of heating and illuminating gas from hydrocarbons, and also to the process of and apparatus for the manufacture of heating and illuminating gas from hydrocarbons and water, which consists of certain steps or methods of procedure and in the apparatus necessary for carrying the same into effect, all of which will be more fully described hereinafter, and pointed out in the claims.

In the accompanying drawings, forming part of this specification, and in which like letters and figures of reference refer to similar parts wherever found throughout the several views, Figure 1 is a side elevation of a furnace provided with our improved apparatus for manufacturing gas, part of the side wall being removed and portions of the apparatus being broken away so as to show the interior construction. Fig. 2 is a front elevation, looking in the direction of the arrow shown in Fig. 1, the furnace being shown only in outline and portions of the vaporizers, connecting-pipes, retorts, &c., being shown in section. Fig. 3 is a vertical section on the line XX of Fig. 1, showing the plan of the furnace, the arrangement of the flues and air-conduits, and the braces by which the gas-retorts and steam-pipes used in the manufacture of the gas are held in place. Fig. 4 is a horizontal longitudinal section of the furnace on the line YY of Fig. 1. Fig. 5 is a longitudinal vertical section of Figs. 3 and 4 on the line ZZ, one of the vaporizers being shown in dotted lines; and Figs. 6, 7, and 8 represent details

in the construction and arrangement of the retorts employed by us for superheating the vaporized hydrocarbons and for mingling superheated steam therewith.

The object of our invention is to produce a fixed gas of superior quality for heating or illuminating purposes from hydrocarbons or from hydrocarbons and water or steam by a simple and economical process, and in an apparatus cheaply constructed and readily understood and operated, and which may be adapted to furnaces of ordinary construction with but little, if any, modification, or which may be used in connection with our improved form of furnace designed for use in connection with our improved apparatus for the manufacture of gas, as hereinafter described and claimed.

We are aware that many attempts have been made to produce a fixed gas such as we manufacture from hydrocarbons or from hydrocarbons and water or steam by various processes and forms of apparatus, but, so far as we know, with only partial success, and this want of success has resulted, principally, from defects in the apparatus employed and in the methods pursued. Under our process we may form the gas from hydrocarbons alone, after which atmospheric air may be mingled therewith, if desired, in the well-known manner; or we may, after the hydrocarbons have been converted into a fixed gas and while superheated to a high degree, mingle therewith gas formed from steam also highly superheated, thereby producing a gas possessing the necessary qualities for heating or illuminating, as may be desired. The purposes for which the gas is intended will govern to some extent the amount of the gas formed from steam employed in the process. When the gas is to be used for heating, the quantity of the steam product employed is increased or decreased, as may be desired, thereby producing a greater or less proportion of hydrogen, and the heat and light giving qualities of the gas may be regulated in this manner by simply increasing or diminishing the amount of the steam product employed in its manufacture.

We will now first describe our apparatus

for producing gas from hydrocarbon alone and then the modification of such apparatus by which the gas is produced from hydrocarbon and water or steam.

5 Referring to the drawings and the reference letters and numerals thereon, A, Fig. 1, designates a device for heating hydrocarbons, which consists of a casing closed at the top and bottom, provided with a steam-coil 1,
10 through which steam from any source is passed, both the inlet and outlet thereof being controlled by suitable valves of ordinary construction. Hydrocarbon is conducted to the heater by means of a pipe 2, filling all the
15 space not occupied by the steam-coil 1. The hydrocarbon is taken from a storage-tank situated above the heater, and this tank, being kept filled at a uniform height by means of an automatic valve of well-known construction, allows a steady and equal pressure of
20 the liquid flowing into the heater. The hydrocarbon thus brought into contact with the steam-coil is raised to a degree of heat which materially assists in its vaporization, and the
25 temperature of the hydrocarbon in the heater can be shown at all times by placing a thermometer at some convenient point, as at 3. The hydrocarbon, being thus heated, is conducted through a pipe 4 and regulating-valve
30 5 through a sight-glass 6, which enables the operator to see at all times the flow there-through and assists in detecting instantly any irregularity in the feed, and then passes into the vaporizer B through the pipe 6'.
35 The object of the vaporizer B is to vaporize the hydrocarbon rapidly, perfectly, and with the greatest economy. It consists of a cylindrical pipe or casing 7, inclosing a pipe or casing 8, the outer casing being closed and
40 the inner one open at the top and bottom. The smaller or inclosed pipe or casing 8 is so arranged as to serve as an escape-flue for a short distance of the heated gases or products of combustion in such a manner as to make
45 a large portion of the heat of such gases or escaping products of combustion available for the purpose of vaporizing the hydrocarbons. Hydrocarbons being admitted into the chamber between the outer and inner
50 casings or pipes near the top and preferably against the surface of the inner pipe or casing 8 are more or less fully vaporized, according to the degree of heat attained by such pipe. To increase this heat and radiate it
55 as much as possible, conical projections are cast or otherwise formed on the surface of this pipe 8, and to still further assist in the process of vaporization this pipe is creased or grooved spirally from top to bottom, and
60 in this groove is wound or coiled a pipe 9, preferably of copper or iron, which fits snugly within the said groove, sinking about half its diameter therein. Through this pipe 9 is passed superheated steam taken, preferably,
65 from steam-pipes arranged within the furnace, as hereinafter described. This superheated steam may be caused to enter the

coiled pipe 9 at the top by means of pipes 10, as shown in Fig. 2, or it may, if preferred, be introduced at the bottom by means of pipes
70 11, as shown in dotted lines in said Fig. 2. The hydrocarbon in a heated condition passes into the vaporizer at the top, as shown, and, impinging upon the surface of the inner pipe 8, strikes the steam-coil 9 and follows around
75 it, traversing the whole length thereof from top to bottom. If from any cause particles of hydrocarbon leave the coil and drop, they are at once caught either on the surface of or the projections on the pipe 8 or on the
80 lower coils of the pipe 9, and the result is to vaporize all or nearly all of the hydrocarbon before it reaches the bottom of the chamber. If for any reason a portion of the hydrocarbon is not vaporized, it is allowed to run off
85 through a pipe 12 at the bottom of the vaporizer, and thence to a seal, where it is caught and saved for future use. As fast as vapor is formed it is allowed to escape through a
90 pipe 13, which communicates with the vaporizer, as shown in Figs. 1 and 2, by which it is conveyed into one branch C of a retort located within the furnace, and, passing through this branch of the retort and returning
95 through the return branch D, each of said branches being heated to a high degree, it is converted into a fixed gas and emerges from the return branch of the retort D through the pipes 14 and 15, as shown in Fig. 2. These
100 pipes 14 and 15 in the form of apparatus illustrated, in which three vaporizers are employed in connection with one furnace, after passing around the end of the upper branch of the retort C, unite and pass through a
105 small or central vaporizer E, which in internal construction is identical with that of the large vaporizers B, it having a central pipe or flue 8 grooved and covered with conical projections and having a steam-pipe 9 wound or
110 coiled around it, through which superheated steam is passed and against all of which hydrocarbon is thrown for the purpose of vaporization, as hereinbefore described.

The vapor formed in the central vaporizer E passes through pipes 16, as shown in Fig. 115 2, which communicate with the pipes 13, which convey the vapor from the large vaporizers, and thus all the vapor formed from the several vaporizers is admitted to the upper branch C of the retort. The hot fixed gas
120 which passes through the inner pipe 8 of the central vaporizer necessarily throws off a large amount of heat, which is utilized, as shown, for vaporizing hydrocarbons, exactly as the escaping products of combustion are
125 utilized in the main vaporizers B. It will be seen that all the gas formed from the hydrocarbon or from hydrocarbon and steam, as hereinafter described, by the apparatus illustrated passes through the inner pipe 8 of the
130 central vaporizer. It is then cooled to the required degree, if necessary, by any of the well-known methods, after which it is reduced to the required candle-power by the

admission of atmospheric air and is conveyed into a gas-holder in the usual manner by an exhauster such as in ordinary use.

In Figs. 1, 2, and 3 we have shown the system of pipes by which steam is superheated and used in the process of vaporization, and in Fig. 6 the means by which steam, after being converted into a fixed gas, is mingled with the fixed gas formed from the hydrocarbon and a resultant fixed gas composed of these two products produced. Fig. 1 shows a system of these pipes for superheating the steam after it comes from the generator. These pipes are arranged longitudinally on the braces which support the separate branches of the retort. They preferably consist of separate coils arranged on each side of the retort, and from one coil is taken superheated steam for one of the large vaporizers and for the central or small vaporizer and from the other superheated steam for the other large vaporizer. As shown, steam enters these coils at 17, Fig. 2, and emerges at 18, and is conducted thence by pipes 10 to the top of one of the large vaporizers B and to the central vaporizer E. After passing through these vaporizers it again enters the superheating-coils at 17' and emerges at 18', from which point it passes to the other large vaporizer through the pipe 10', and is then preferably conducted to a water-heater and utilized for the purpose of heating water before it is supplied to the boiler, and thus the same steam is used over and over again, thus greatly economizing in the amount of fresh steam taken from the boiler.

It is evident that the exact arrangement of pipes above described need not be followed closely in practice, as in some instances it might probably be preferable to connect the steam-supply with the bottom of the vaporizers by means of pipes 11, as shown in dotted lines, and we do not limit ourselves to any arrangement of these pipes other than such a form thereof as will conduct the superheated steam from the coils within the furnaces through the coils 9, arranged within the vaporizers, for the purposes set forth herein. It is also evident that we may limit ourselves to a single vaporizer in connection with the retort or increase the number beyond that herein described and shown without departing from the scope of our invention, the arrangement of steam-pipes and other details of construction being such in all cases as may be rendered necessary by the number of vaporizers employed.

The braces 18' for sustaining and holding in place the retort and steam-pipes within the furnace may be constructed in any desired manner; but we prefer to have them set in the brick-work when the furnace is built and so arranged that the retort and steam-pipes may be put in after the brick-work is finished or removed at any time without disturbing the same or injuring the retort or pipes. The position and construction of these braces is

shown in Fig. 3, the central openings being designed to receive the separate branches C and D of the retort, the end couplings of the steam-coils being shown at 19, and the entrance and exit ends of the same being shown as immediately above and below said couplings at 20. The other two openings 21 on the right and left, at the bottom, are for the admission of pipes connected with a mixer for supplying gas to aid combustion. This latter feature of construction, however, forms no part of the invention claimed herein.

In Fig. 6 is shown the means employed by us for retarding the flow of vapor or gas through the retort and compelling it to pass in contact with the heated walls or surfaces thereof, and also the means for mingling superheated steam or a fixed gas formed therefrom with the gas formed from hydrocarbon. The first consist of segmental diaphragms or plates 21, which are preferably of such shape and size as to occupy the greater portion of the area of the retorts in cross-section, arranged alternately, as shown, and held in position by any means desired, but preferably by being placed or strung upon a rod 22, as shown. The object of this construction is to retard the flow of the gas through the retort and to compel it to pass in contact with the walls of the retort in order that it may be heated to the required degree. These diaphragms or plates are preferably arranged in the upper branch of the retort, or the one into which the vapor first enters; or, if more than two branches be employed or the retort be composed of a series of tubes, as shown in Figs. 7 and 8, they may be arranged in all the tubes or branches thereof except the last, or the one from which the gas leaves the retort.

The means for mingling the gas formed from hydrocarbons with that formed from steam are arranged in the return or lower branch of the retort, and consist of a tube 23, preferably of copper, placed within the branch D of the retort and flanged or enlarged at the inner end, so as to fit tightly the inner wall of the retort, thus compelling the gas to pass through the inner tube. This pipe or tube 23, as shown, does not extend the entire length of the retort. Within the annular space between the inner walls of the retort and the inner tube 23 is placed a steam-pipe 24. This pipe enters the retort, preferably at or near the outer end, and runs back to a point at or near the junction of the pipe 23 with the retort. The inner end of the pipe 24 is left open, and steam, preferably from the superheated coils within the furnace, is admitted at some convenient point, as 25, and escapes from the inner open end of the pipe and surrounds the tube 23. This steam, being superheated to a high degree, is decomposed. The product is a fixed gas, and the constituent elements thereof, largely hydrogen, unite with the fixed gas passing through tube 23, formed from hydrocarbons, at the open end of said tube, and a fixed gas of greater body and

heat-giving power than that produced from either hydrocarbons or steam separately is produced. A result to some extent similar may be produced without the employment of tube 23; but we prefer the method of construction herein described and illustrated. By this construction the vapor from the hydrocarbons is kept separate from that of the steam till both are decomposed and formed into fixed gases, and this is requisite in order to produce a perfect fixed gas by a combination of these substances.

Instead of forming the retort with but two branches, as hereinbefore described, we may employ a number of branches or coils, as shown in Figs. 7 and 8, the former being a transverse section showing the plan of the arrangement of the separate branches or coils of the retort. In this case, however, the means for mixing the gases formed from hydrocarbons and steam should be located in the return branch D, as hereinbefore described.

We come now to the description of the furnace, sectional views of which are given in Figs. 3, 4, and 5.

Fig. 3 shows an opening, which extends from front to rear of the furnace, the form of the lower part thereof in cross-section being shown in full lines and that of the upper portion partly in full and partly in dotted lines. The upper and lower parts of this opening are designated by the letters G and H, respectively, and in the upper opening G are placed the retort and superheating steam-pipes, hereinbefore described, the burners or heating apparatus being located in the lower division or part H of the combustion-chamber. This opening is closed, preferably, with iron plates backed with brick after the walls are all built, and the pipes, retorts, burners, &c., put in position. The upper part G is provided at the rear with a door through which the steam-pipes may be removed or other repairs made, and the lower part is also preferably provided at the rear with a sight-opening and means for admitting air, if air be required. The burner extends, when in position, from one end of the chamber H to the other and preferably almost to the top thereof. The flames rising in the chamber G impinge on all the pipes therein, and the contraction of the side walls near the upper part of chamber G, as shown in dotted lines in Fig. 3, compel the flames and heated gases of combustion to strike the upper pipe of the retort and the upper coils of the steam-pipes, thus keeping both the upper and lower pipes equally hot. Small diving-flues 26 are constructed at intervals along the side walls near the top of chamber G, which carry the products of combustion into flues 27, arranged longitudinally in either side wall, and these flues return at the rear, as shown at Fig. 5, and pass forward, downward, and upward through the vaporizer B and pipes 28 to the chimney. The flues 29, with which the flues 27 communicate, connect directly with the chimney, and by opening dampers 30 and

31 (see Figs. 1 and 5) the escaping products of combustion will pass directly through flue 29 into the chimney; or by closing damper 31 and leaving 30 open the draft will pass through both branches of the flue 27 and up through flue 29 to the chimney. By closing damper 30 the draft is compelled to pass through the lower part of flue 29 and the lower return portion of flue 27 and up through the vaporizers B to the chimney, and by closing both of the dampers 30 and 31 the draft is compelled to pass through the entire length of flue 27 and up through the vaporizers B into the chimney.

In Fig. 5 is shown the air-supply flue, by means of which air is heated to aid in combustion, this flue being similar in form to flue 27, passing downward and forward, as shown. One of these flues 32 is arranged on each side of the furnace and entirely inclosed in the side walls thereof. The air is admitted at 33 through the side wall of the furnace, and, passing backward, as indicated by the arrows, returns through the lower branch of the flue and enters the fire-box or combustion-chamber through small openings or perforations 34. These openings are preferably formed by perforating the bricks, and these bricks, becoming highly heated, also aid in heating the air to a high degree. This hot air enters the chamber H, preferably at a point just above the burners, as shown at 34, Fig. 3, and immediately unites with the burning gases. The amount of air admitted to the air-flue may be regulated at 33 in any desired manner.

Instead of the flue 32 for heating the air to aid in combustion, we may employ a single chamber, to which air may be admitted and heated before entering the combustion-chamber, and many other changes in the construction and combinations of the various portions of the apparatus herein described may be made without departing from the scope of our invention; but one pipe would be sufficient to connect the retort with the central tube of the central vaporizer, (shown in Fig. 2,) and it is possible to convert the hydrocarbon into vapor in the vaporizers B by means of superheated steam alone, the coil 9 being so arranged as to accomplish this object without the aid of the escaping products of combustion.

The advantages gained by this apparatus for producing a fixed gas from hydrocarbons or from hydrocarbons and steam are many. By putting all the hydrocarbon into the retort in the form of a vapor the possibility of "coking" in the retort from any cause is absolutely avoided. The amount of hydrocarbon converted into a fixed gas in a given time is materially increased, since the work of fixing the gas is half accomplished before the vapor is admitted into the retort. The cost of vaporizing the hydrocarbon is reduced to a minimum, as the heat required to keep the retort in proper condition for "fixing"

the gas is sufficient to superheat the steam necessary in the process of vaporization, and the escaping products of combustion also materially aid therein, the heat therefrom being otherwise thrown away. The hot gas is cooled somewhat by yielding its heat to the central vaporizer, thus making this vaporizer doubly beneficial.

Having fully described our invention, we claim and desire to secure by Letters Patent—

1. In an apparatus for the production of gas from hydrocarbons, the combination, with a furnace, of a retort located therein, a vaporizer communicating therewith by means of a pipe, a hydrocarbon supply and heater also in communication with said vaporizer by means of a small jet-pipe, and a pipe communicating with the vaporizer for carrying away the residuum or other substance that cannot be vaporized, substantially as described.

2. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a retort located therein, a vaporizer in communication therewith by means of a pipe, as 13, and a hydrocarbon supply and heater also in communication with the vaporizer by means of a small jet-pipe, substantially as shown and described.

3. In an apparatus for producing gas from hydrocarbons, the combination, with a retort-furnace and retort located therein, of a hydrocarbon-supply and a vaporizer having an inner and an outer tube or casing and an annular space between said tubes or casings closed at the top and bottom, the inner tube or casing being open at the top and bottom and the annular space being in communication with the hydrocarbon-supply and with the retort, substantially as shown and described.

4. In an apparatus for producing gas from hydrocarbons, the combination, with a retort-furnace and hydrocarbon-supply, of a vaporizer consisting of an inner and an outer tube or casing and having an annular space closed at the top and bottom between said tubes or casings, a steam-coil within said space, and means for conducting the products of combustion from the furnace through the central tube or casing, substantially as shown and described.

5. In an apparatus for producing gas from hydrocarbons, the combination, with a retort-furnace, of a vaporizer having an inner and an outer tube or casing and an annular space between said tubes or casings closed at the top and bottom, the inner tube being open at the top and bottom and grooved or corrugated and provided with projections on its outer surface, and means for conducting the products of combustion from the retort-furnace through the inner tube of the vaporizer, substantially as shown and described.

6. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer having an inner and an outer casing and an annular chamber be-

tween said casings, a retort located within the furnace in communication with the annular chamber, and escape-flues communicating with the furnace and with the inner casing of the vaporizer, substantially as shown and described.

7. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer having an inner and an outer casing and an annular chamber between said casings, a retort within the furnace communicating with the annular chamber, escape-flues communicating with the furnace and with the inner casing of the vaporizer, and means for heating air to aid in combustion, substantially as shown and described.

8. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer having an inner and an outer casing and an annular chamber between said casings, a retort within the furnace communicating with said annular chamber, a steam-coil located in said annular chamber, and a steam-coil within the furnace in communication therewith, substantially as shown and described.

9. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer having an inner and an outer casing and an annular chamber between said casings, a retort within the furnace communicating with the annular chamber, a steam-coil arranged within said chamber in communication with the steam-coil within the retort-furnace, and means for conducting the products of combustion from the retort-furnace through the central casing of the vaporizer, substantially as shown and described.

10. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer consisting of an inner and an outer tube and having an annular chamber between said tubes, a steam-coil arranged within said chamber, a hydrocarbon supply and heater communicating with said chamber, a retort within the furnace in communication with said chamber, steam-coils arranged within the furnace and communicating with the steam-coil within the annular chamber of the vaporizer, and means for conducting the hot gases of combustion through the central tube of the vaporizer, substantially as shown and described.

11. In an apparatus for producing gas from hydrocarbons, the combination of a furnace, a retort therein, a vaporizer having a steam-coil located therein, and a hydrocarbon supply and heater communicating therewith, the vaporizer being located outside of the furnace, the construction and arrangement being such that the hydrocarbon is admitted to the vaporizer in small jets or quantities, substantially as shown and described.

12. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace and retort, of a vaporizer consisting of

an inner and an outer casing and having an annular chamber between said casings in communication with the retort, and a steam-coil located in said chamber, and a hydrocarbon supply and heater communicating with said annular chamber, substantially as shown and described.

13. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer having a steam-coil arranged therein in communication with a steam-coil arranged within the furnace, a retort within the furnace also in communication with the vaporizer, and a hydrocarbon supply and heater in communication with the vaporizer, substantially as shown and described.

14. In an apparatus for producing gas from hydrocarbons, the combination, with a retort consisting of a U-shaped pipe, of a series of vaporizers in communication with one branch of the retort, another vaporizer consisting of an inner and an outer tube or casing forming an annular chamber also in communication with the same branch of the retort, and means for connecting the retort with the inner tube or casing of the last-mentioned vaporizer, substantially as shown and described.

15. In an apparatus for producing gas from hydrocarbons, the combination of two or more vaporizers, one of which consists of an inner and an outer tube or casing forming an annular chamber, a gas-retort in communication with said vaporizers, and means for conducting the heated gases from the retort through the inner tube or casing of one of said vaporizers, whereby the heated gases from the retort are caused to assist in the process of vaporization, substantially as shown and described.

16. In an apparatus for producing gas from hydrocarbons, the combination of two or more vaporizers, one of which consists of an inner and an outer tube or casing forming an annular chamber between said tubes or casings, a steam-coil arranged in said annular chamber, a gas-retort in communication with each of said vaporizers, and means for conducting the heated gases from the retort through the inner tube of the vaporizer having the inner and the outer tube or casing, substantially as shown and described.

17. In an apparatus for producing gas from hydrocarbons, the combination of a vaporizer consisting of an inner and an outer tube or casing forming an annular chamber between the same, and a gas-retort having a series of branches, one of which is in communication with the annular chamber of the vaporizer and one of which is in communication with the inner tube or casing, substantially as shown and described.

18. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a series of vaporizers provided with steam-coils in communication with steam-coils arranged within the furnace, a retort

within the furnace, and means for conducting the heated gases from the retort through one of said vaporizers, substantially as shown and described.

19. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a series of vaporizers consisting of an inner and an outer tube or casing forming an annular chamber between the same, steam-coils arranged within said chambers in communication with steam-coils arranged within the furnace, a gas-retort in communication with the annular chamber in each of said vaporizers, and means for conducting the heated gases from the retort through the inner tube or casing of one of said vaporizers, substantially as shown and described.

20. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a series of vaporizers, each of which is provided with a steam-coil in communication with a steam coil or coils arranged within the furnace, and a retort within the furnace in communication with each of the vaporizers, substantially as shown and described.

21. In an apparatus for producing gas from hydrocarbons, the combination, with a retort-furnace, of a series of vaporizers, each of which is provided with a steam-coil in communication with a steam coil or coils within the furnace, a retort within the furnace in communication with each of said vaporizers, and means for conducting the products of combustion from the furnace through one or more of said vaporizers, substantially as shown and described.

22. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace and retort located therein, of a series of vaporizers, each of which is in communication with the retort, one or more of said vaporizers being provided with a steam-coil in communication with a steam-coil arranged within the furnace, and means for conducting the heated gases from the retort through one of said vaporizers, whereby said heated gases are caused to assist the steam in the process of vaporization, substantially as shown and described.

23. In an apparatus for producing gas from hydrocarbons, the combination, with a retort-furnace, of a series of vaporizers provided with steam-coils arranged therein in communication with steam-coils arranged within the furnace, each of said vaporizers being in communication with the gas-retort located within the furnace, flues or passages by which the products of combustion are conducted from the furnace through one or more of said vaporizers, and means for conducting the heated gases from the retort through one of said vaporizers, whereby the products of combustion and the hot gas from the retort are each caused to assist the steam in the process of vaporization, substantially as shown and described.

24. In an apparatus for producing gas from hydrocarbons, the combination, with a fur-

nace, of a vaporizer, a retort within the furnace in communication therewith, in which the vapor is superheated, a steam-supply and means for superheating the steam, and a pipe, as 24, in communication therewith for conducting the superheated steam into the gas-retort and mingling the same with the superheated gas formed from the hydrocarbons, substantially as shown and described.

25. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a vaporizer outside of the furnace, a retort within the furnace consisting of a series of connecting-pipes, one of which is in communication with the vaporizer and in which the vapor is superheated and reduced to a fixed gas, a steam-supply and superheater in which the steam is reduced to a fixed gas, and means for mingling the fixed gas formed from the steam with that formed from the hydrocarbons, substantially as shown and described.

26. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a retort located therein, a vaporizer in communication therewith by means of a pipe, as 13, and a hydrocarbon supply and heater in communication with the vaporizer by means of a small jet-pipe, the vapor being superheated and reduced to a fixed gas within the retort, a steam-supply and superheater in which steam is reduced to a fixed gas, and means for mingling the fixed gas formed from the steam with that formed from the hydrocarbons, substantially as shown and described.

27. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a retort, a vaporizer in communication therewith, the retort being provided with an inner inclosed tube, as 23, an annular space closed at one end being formed between the walls of the retort and said tube, and a superheated-steam-supply pipe communicating with said annular space, substantially as shown and described.

28. In an apparatus for producing gas from hydrocarbons, a retort consisting of two or more pipes, one of which is provided with diaphragms or plates, as 21, and the other with a tube, as 23, the latter closed at one end and forming an annular space within the retort, and a superheated-steam-supply pipe, as 24, communicating with said annular space, substantially as shown and described.

29. In an apparatus for producing gas from hydrocarbons, the combination, with a furnace, of a retort arranged therein, a vaporizer outside of said furnace and in communication with the retort, the furnace being provided with a central longitudinal opening or chamber G H, and flues or passages in communication therewith and with the vaporizer, whereby the escaping products of combustion are conducted through the vaporizer, substantially as shown and described.

30. In an apparatus for producing gas from

hydrocarbons, the combination of a furnace and vaporizer, the furnace having the longitudinal opening or chamber G H, the flues 26 in communication with the chamber G H, the flues 27 in communication with the flues 26, and the flues 29 in communication with the flues 27, the flues 27 being also in communication with the vaporizer, substantially as shown and described.

31. In an apparatus for producing gas from hydrocarbons, a furnace having the central longitudinal opening or chamber G H, the flues 26 in communication therewith, the flues 27 in communication with the flues 26, and the flues 29 in communication with flues 27, in combination with a retort and vaporizer, and means for conveying the products of combustion through the vaporizer, substantially as shown and described.

32. In an apparatus for producing gas from hydrocarbons, a retort-furnace having the central longitudinal opening or chamber G H, the diving-flues 26, communicating with said chamber G H, the flues 27, communicating with said flues 26 and extending backward, downward, and forward, and the flues 29, communicating with each end of the flues 27, substantially as shown and described.

33. In an apparatus for producing gas from hydrocarbons, a retort-furnace provided with the central longitudinal chamber G H, the diving-flues 26, communicating with the top of said chamber, the flues 27, extending backward, downward, and forward and in communication with the flues 26, the flues 29 in communication with the flues 27, and the hot-air chambers or flues 32, extending backward, downward, and forward, in communication with the chamber G H by means of the passages 34, substantially as shown and described.

34. A vaporizer consisting of an inner and an outer tube or casing, an annular space closed at the top and bottom between said tubes or casings, the inner tube being grooved and provided with a steam-coil, substantially as shown and described.

35. In an apparatus for producing gas from hydrocarbons, the combination of a vaporizer, a gas-retort consisting of two or more tubes, one of which is in communication with the vaporizer, and a second vaporizer consisting of an inner and an outer casing forming an annular chamber also in communication with the same tube of the retort, the inner casing being open at both ends, and a pipe or pipes forming a communication between another tube of the retort and the said central casing of the vaporizer, substantially as shown and described.

36. In an apparatus for producing gas from hydrocarbons, the combination of a vaporizer having an inner and an outer tube or casing, a gas-retort one end of which is in communication with the space between said casings, and a pipe or pipes connecting the other end of the retort with the central tube or casing of the vaporizer, whereby the heated gases

from the retort are caused to assist in the process of vaporization, substantially as shown and described.

37. In an apparatus for producing gas from
5 hydrocarbons, the combination of a vaporizer and a retort consisting of the pipes or branches C D, one of which is in communication therewith, the other branch of the retort being provided with an inclosed tube, as 23, one end of
10 which is enlarged or flanged, so as to fit tightly

the inner wall of the retort, and a superheated-steam pipe in communication with the annular space between the walls of the retort and the inner tube 23, substantially as shown and described.

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