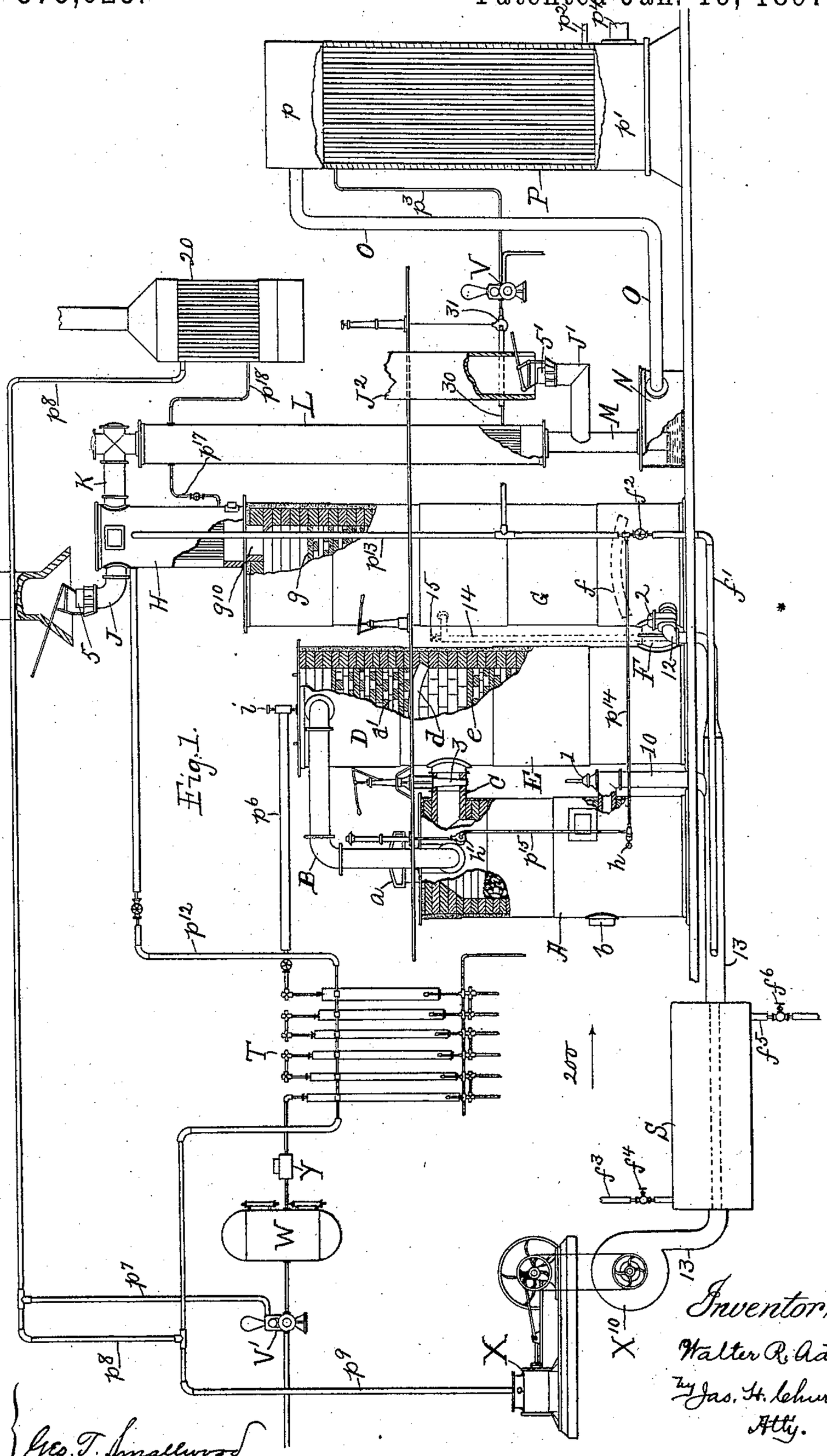
(No Model.) 2 Sheets—Sheet 1.

W. R. ADDICKS.

METHOD OF AND APPARATUS FOR PRODUCING WATER GAS.

No. 575,625. Patented Jan. 19, 1897.



(No Model.) 2 Sheets—Sheet 2.

W. R. ADDICKS.

METHOD OF AND APPARATUS FOR PRODUCING WATER GAS.

No. 575,625. Patented Jan. 19, 1897.

Fig. 2.

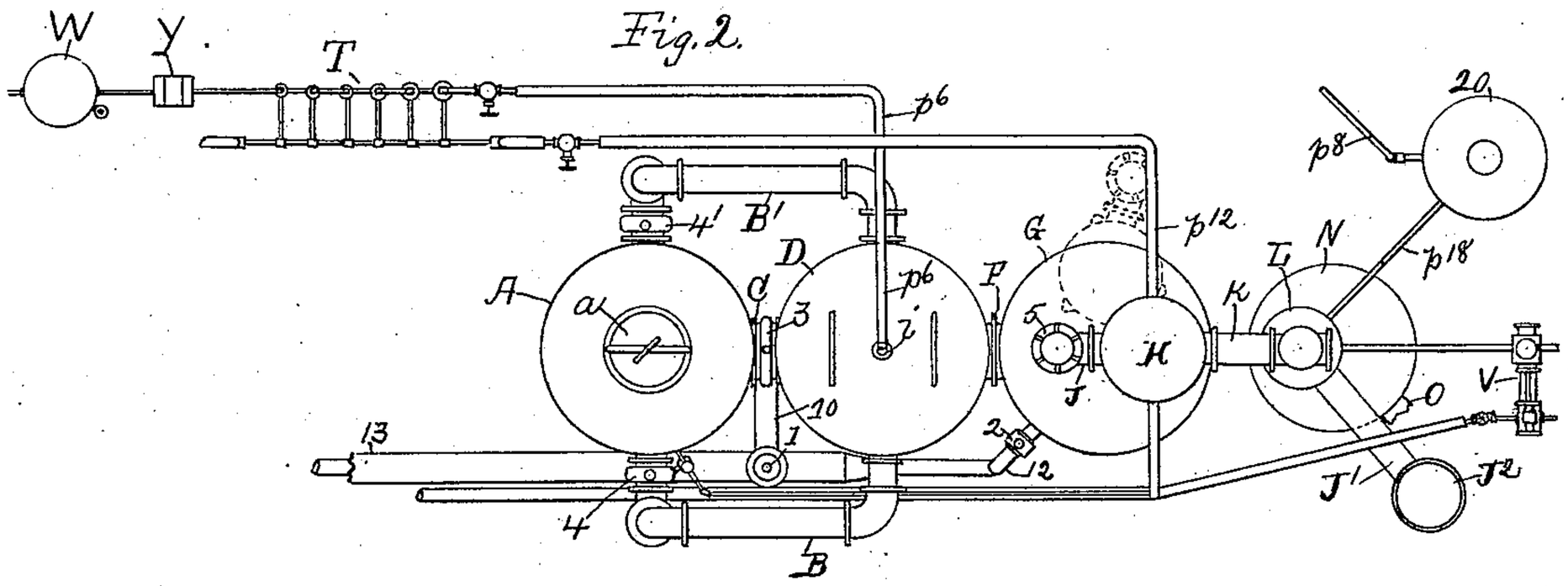
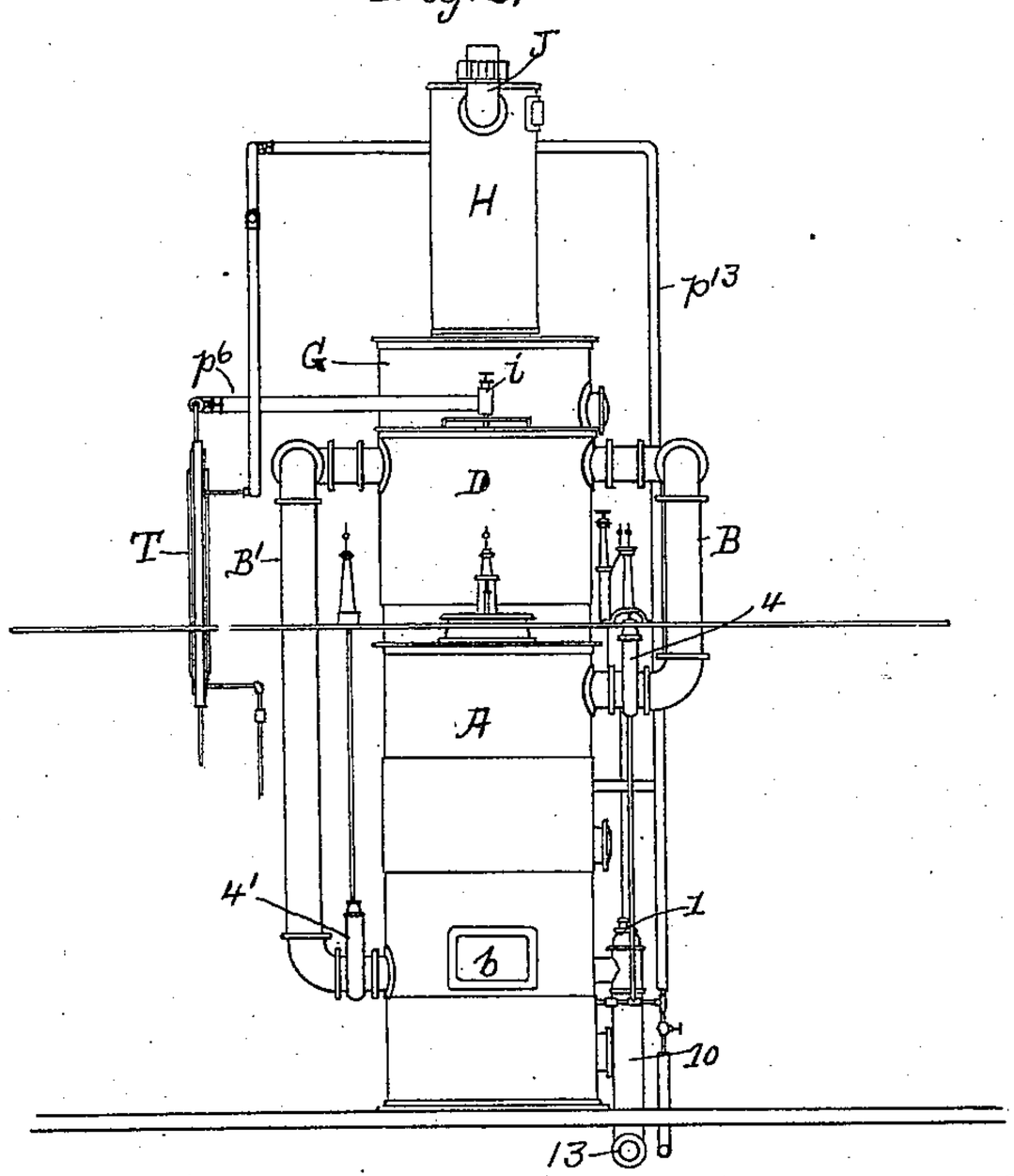


Fig. 3.



Attest.
J. Murphy.
Geo. T. Smallwood.

Inventor.
Walter R. Addicks
by Jas. H. Churchill
Atty.

UNITED STATES PATENT OFFICE.

WALTER R. ADDICKS, OF BOSTON, MASSACHUSETTS.

METHOD OF AND APPARATUS FOR PRODUCING WATER-GAS.

SPECIFICATION forming part of Letters Patent No. 575,625, dated January 19, 1897.

Application filed August 19, 1893. Serial No. 483,499. (No model.)

To all whom it may concern:

Be it known that I, WALTER R. ADDICKS, residing in Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Methods of and Apparatus for Producing Water-Gas, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention relates to a novel method for the manufacture of carbureted water-gas and to a novel apparatus by which to practice such method, the apparatus including novel features also particularly well adapted to be used in the manufacture of uncarbureted water-gas.

In the manufacture of carbureted water-gas as now commonly practiced a bed of coal is heated to incandescence in a generator or producer, which is usually effected by a blast of air forced through the coal, and the gases or products of combustion pass from the generator into a structure containing fire-brick or other refractory material and commonly called a "carbureter," and from which the said gases pass into and through a superheater also containing fire-brick or other refractory material. These gases or products of combustion generated in bringing the coal to incandescence are now commonly called "waste" gases and are permitted to pass from the superheater directly to the stack or chimney.

The waste gases are supplied with air in the carbureter and superheater to obtain more perfect combustion of said gases, which heat the refractory material in the carbureter and superheater to a high heat, and when heated to a sufficiently high heat the air-blast is cut off and steam is admitted into the generator, where it combines with the carbon of the incandescent coal and forms water-gas. The water-gas is enriched with carbonaceous gases obtained by admitting oils directly into the highly-heated carbureter, wherein the carbureted water-gas is wholly or partially fixed or rendered permanent, and that portion of the gas which is not fixed in the carbureter is rendered permanent in the superheater. The highly-heated carbureted water-gas usually passes from the superheater to the hydraulic main or water seal, where the said gas, at substantially the temperature it possesses when it leaves the superheater, meets the cooler body of water in the said hydraulic main or seal, which imparts a shock to the carbureted water-gas. This process as commonly practiced is defective and objectionable, owing to the fact that the oil for enriching the water-gas first meets and is mingled with the water-gas in the highly-heated carbureter, which prevents a perfect union of the oil and water-gas and causes the formation and deposition of lampblack and tarry matters, thus reducing the illuminating power of the gas and rapidly clogging up the apparatus; and, furthermore, the sudden cooling of the gas in the hydraulic main produces more or less condensation, which is objectionable for reasons well known to gas-manufacturers.

The present invention is directed mainly to overcoming these defects, and in accordance with this invention the water-gas is subjected to heat by gradual progressive and retrograde steps from the formation of the gas to the point at which it is fixed, and is then reduced in temperature by gradual steps from the point of fixation to the discharge from the apparatus, as will be described, whereby shocks to the carbureted gas are avoided. By subjecting the carbureted water-gas to gradually progressive and retrograde temperatures and then to a reducing temperature, as above referred to, a carbureted gas of superior quality may be obtained at a minimum expense with either heavy or light oils, at the same time avoiding the destructive action of high temperatures upon parts of the apparatus and also obviating the disagreeable effect of overheated tarry matters, as will be described.

The gradual heating of the carbureted gas is effected primarily by means of a mixing-chamber, in which the mixing of the water-gas and hydrocarbons is effected previous to the application of extraneous heat, as will be described, and, secondly, by means of a moderately-heated chamber into which passes the mixture of water-gas and hydrocarbons and from which the said mixture passes to the fixing-chamber.

The reduction of the heat of the carbureted

gas after being fixed is accomplished, as herein shown, by passing the said gas through a boiler and preferably also through a feed-water heater, which may and preferably will be connected to the said boiler and to an auxiliary boiler for purposes as will be described.

The feed-water heater through which the carbureted gas passes may and preferably will be provided with an auxiliary gas-outlet normally closed by a valve, and if desired the boiler above referred to may also be provided with an auxiliary outlet normally closed by a suitable valve.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a side elevation and partial section of a carbureted-water-gas-producing apparatus embodying this invention; Fig. 2, a top or plan view of the apparatus shown in Fig. 1; and Fig. 3, a front elevation of the main portion of the apparatus, looking in the direction of arrow 200 on Fig. 1.

The apparatus herein shown for carrying out the improved process is adapted to be applied in connection with existing apparatus, portions of which may be retained in their existing form and have combined with them novel appliances, as will be hereinafter described, for effecting the novel features of the process.

The apparatus herein shown comprises a generator or producer A, a fixing-chamber G, and intermediate chambers D and E, shown as one structure and separated from each other by a perforated arch *d*, which supports the mixing structure, herein shown as brick checkerwork *d'*. The generator or producer A, which may be of any usual or well-known construction, is provided with the usual fuel-inlet *a*, ash-pit and cleaning door *b*, and is provided at its upper end with two distinct outlets for the products of combustion and the water-gas, one of the said outlets being formed by the pipe C, communicating with the chamber E of the intermediate structure, and the other outlet being formed by preferably two pipes B B', (see Fig. 3,) herein shown as connected, respectively, to the top and bottom of the generator at substantially diametrically opposite points and both leading to the chamber D of the intermediate structure.

The chamber E of the intermediate structure may be the carbureter of the usual form of apparatus, which in the present embodiment of this invention has applied to it the mixing-chamber D, and the connections between the chamber E and the other parts of the apparatus are modified, as will be described, to carry out this invention.

The outlet pipe or passage C is provided with a cut-off valve 3, which may be of any suitable or desired construction, and the pipes B B' are also provided with similar cut-off valves, (marked 4 4' in Fig. 2.) The chamber E is connected at its bottom by a pipe F to the bottom of the fixing-chamber G, (which may be the superheater of the usual form of apparatus,) the latter for the best results being provided with a perforated arch *f*, above which is located the usual checkerwork of fire-brick or other refractory material *g*. The generator or producer A and the fixing-chamber G have connected to them near their bottom or lower portion air-conducting pipes 10 12, communicating with a common supply-pipe 13, the pipes 10 12 being provided with suitable valves 1 2, respectively controlling the admission of air to the generator and to the fixing-chamber G. The fixing-chamber G may and preferably will have connected to it substantially near its center or middle portion a branch air-conducting pipe 14, communicating with the pipe 13 and provided with a suitable controlling-valve 15 for a purpose as will be described.

The fixing-chamber G, in accordance with my invention, has communicating with it a boiler H, which may be of any usual or well-known type and which is herein represented as of the type known as a fire-tube boiler, the said boiler being so connected with the fixing-chamber as to form an outlet-passage for the gases and products of combustion, as will be described.

The boiler H may be of smaller diameter than the diameter of the fixing-chamber, as herein shown, and may be supported on top of the fixing-chamber and practically form a cover for the passage or opening g^{10} in the top of said chamber, but I do not desire to limit my invention to any particular size of boiler, as it is evident the same may be made of any desired diameter and may communicate with the fixing-chamber G in other ways than that shown. The boiler H, for the best results, has connected to it by pipe K a feed-water heater L of any usual or suitable construction, through which the products of combustion and the gases produced in the apparatus may pass.

The boiler H may, if desired, be provided with an auxiliary gas-outlet J, provided with a normally-closed valve 5.

The feed-water heater L has connected to it a gas outlet or delivery pipe M, extended into a water-receptacle N, which receptacle in practice may and preferably will be the hydraulic main, containing sufficient water to seal the lower end of the pipe M.

The pipe M may and preferably will be provided with a branch pipe J', constituting a gas-escape and provided with a normally-closed valve 5'.

The water-main N is connected by pipe O to a condenser P, which may be of any usual or suitable construction and herein represented as a vertical-tube condenser, the vertical tubes of which communicate with a gas-inlet chamber *p* and a gas-outlet chamber *p'*, located, respectively, at the opposite ends of the condenser. The vertical tubes of the condenser P are located in a water-chamber hav-

ing a water-inlet pipe p^2 and a water-outlet pipe p^3. The gas-outlet chamber p' of the condenser P is provided with an outlet-pipe p^4, which in practice leads to the usual scrubbers, purifiers, meters, and holders. (Not herein shown, but which may be the same as now commonly used in gas-works.)

The chamber D has communicating with it an oil-conducting pipe p^6, provided with a valve i to control the admission of oil to the said chamber, the pipe p^6 forming the discharge or outlet pipe of a vaporizer T, preferably of the construction shown in Letters Patent No. 443,214, granted to me December 23, 1890, which vaporizer is connected through an oil-meter Y to a cylinder W and pump V', preferably such as shown in United States Patent No. 428,874, granted to me May 27, 1890, the said pump having its steam-inlet p^7 connected to a steam-outlet p^8, herein shown as from an auxiliary steam-boiler 20 of any usual or suitable construction.

The auxiliary boiler 20 also has its steam-outlet pipe p^8 connected to the steam-inlet pipe p^9 of an engine X, employed to drive a blower X^{10} or other suitable air-forcing apparatus, which blower has its air-discharge port connected to the air-supply pipe 13, common to the generator A and fixing-chamber G. The steam-chambers for the vaporizer T are connected by pipe p^{12} to the boiler H, which also furnishes steam to the generator A through the pipes p^{13} p^{14} p^{15}, the pipes p^{14} p^{15} being provided with steam-controlling valves h h', or steam may be taken from the auxiliary boiler 20, if desired.

The feed-water heater L in the present instance is shown as provided with two water-outlet pipes p^{17} p^{18}, the water-outlet pipe p^{17} being connected to feed the boiler H, and the outlet-pipe p^{18} being connected to feed the auxiliary boiler 20.

The feed-water heater L is preferably supplied with heated water from the condenser P by means of a pump V, to the inlet-port of which the water-outlet pipe p^3 of the condenser is connected, and to the outlet-port of which is connected the inlet-pipe 30 of the feed-water heater, the latter pipe being provided with a valve 31.

The manufacture of carbureted water-gas in accordance with this invention and by means of the apparatus herein described may be considered as involving four successive steps, which will be treated of in their order and which may be classified under the following heads: first, preliminary heating by natural draft; second, heating by air-blast; third, eliminating deleterious gases and products from the apparatus by water-gas, and, fourth, manufacturing carbureted water-gas. Broadly speaking, this succession of steps in the manufacture of carbureted water-gas is not novel, and the present invention consists in certain modifications of the methods heretofore practiced, the nature and purpose of which will be hereinafter explained.

The condition of the apparatus at the moment previous to starting is as follows: The air-blast valves 1, 2, and 15 are closed, the valves 4 and 4' closed, the steam-valves h h' closed, the oil-controlling valve i closed, the valve 5 closed, the valve 5', controlling the branch pipe J', open, and the door b and the valve 3 in pipe C open. Combustion is started within the generator A and is carried on by the natural draft, the products passing from the generator A through the pipe C into the chamber E, and from the chamber E the products pass through the pipe F, fixing-chamber G, through the boiler H, outlet-pipe K, through the feed-water heater L and pipes M J' to the stack J^2. After the coal in the generator or producer A has been brought to an incandescent state and the fire-bricks in the intermediate chamber E and fixing-chamber G have been brought to an appropriate temperature by the natural draft the door b of the generator is closed and the blast-valve 1, supplied with air from the blower X^{10}, is open. The air admitted into the generator A through the pipe 10 causes active, though incomplete, combustion in the bed of coal in the generator, and the products of combustion thus created by the air-blast, which will be hereinafter referred to as "producer-gas," pass from the generator to the outlet-pipe J' and stack J^2, as above described. The said producer-gas heats the fire-brick or other refractory material e in the chamber E by imparting a portion of its specific heat thereto, and with the present form of intermediate structure some heat will also be imparted to the mixing structure in the chamber D both by conduction and radiation, but not enough to produce any appreciable effect therein. The producer-gas referred to passes from the chamber E through the pipe F into the fixing-chamber G, where it meets a supply of air, admitted by opening the air-blast valve 2, to provide for combustion of the said producer-gas, the products of which pass through the refractory material in the fixing-chamber G, thereby highly heating the material in said fixing-chamber.

In practice it may be found desirable to effect the combustion of a portion of the producer-gas within the fixing-chamber, which may be accomplished by admitting air into the said chamber substantially near its middle or center portion through the valve 15 in the branch pipe 14. In apparatus as now commonly constructed and known to me the products of combustion produced by the natural draft and also by the air-blast are permitted to pass from the fixing-chamber of the apparatus directly to the atmosphere. These gases, which are usually termed "waste" gases, are highly heated, and it is one of the objects of this invention to utilize these waste gases, which is accomplished in the apparatus herein shown by passing the same through the boiler H and preferably also through the feed-water heater L, the said gases being greatly reduced

in temperature on their passage through the boiler H and feed-water heater L and escaping through the branch pipe J′ into the stack at a substantially low temperature. The heat from the waste gases, on their passage through the boiler H and feed-water heater L, generates steam in the said boiler, which is utilized for making the water-gas, as will specifically be described, and also for any desired purpose, as, for example, for furnishing the steam to the feed-water pump V, the oil-pump V′, and the engine X for driving the blower X^{10}. The steam generated in the boiler H, if desired, may also be used alone or in conjunction with the exhaust-steam from the pumps V V′ and blower-engine X, together with that from the vaporizer T, for heating a chamber S, through which is extended the air-blast-supply pipe 13.

When the steam from the boiler H is utilized to heat the chamber S, it may be supplied to said chamber through the pipe f', connected to the pipe p^{13} and controlled by a valve f^2. The exhaust-pipes from the pumps V V′, blower-engine X, and vaporizer T may all be connected to a single pipe f^3, forming the steam-inlet pipe for the chamber S, and provided, as shown, with a valve f^4, or they may be separately connected to said chamber. The chamber S may be provided with an outlet-pipe f^5, having a valve f^6. This process of heating the apparatus by the air-blast is continued until the operator considers a proper heat is obtained for decomposing the steam in the generator A, as will be hereinafter described, and for properly fixing hydrocarbons in the chamber G, as will be described. When this point is reached, the following action is taken: The blast-valves 15 2 1 are closed in the order named. The valve 3 is closed and the valve 4 open. The steam-valve h' at the top of the generator A is closed, while the steam-valve h at the bottom of the generator is now open, permitting steam to pass into the generator up through the bed of coal, where it is decomposed and forms water-gas. The water-gas thus produced is employed to clear the apparatus from the deleterious gases and products remaining in the apparatus and which would be objectionable to have present in the carbureted gases. The water-gas passes from the generator A, through the pipe B, chambers D and E, through the outlet F, up through the fixing-chamber G, through the boiler H, feed-water heater L, and pipe J′, to the stack J^2. The water-gas on its passage through the apparatus, as described, forces ahead of it all the deleterious gases and waste products which remain in the apparatus. The heating steps thus far described and which constitute three distinct steps, namely, preliminary heating by natural draft, heating by the air-blast, and heating by the water-gas, may be assembled under one heading, which I prefer to designate as "heating preparatory to manufacturing the carbureted gas."

In some instances it may be found that the natural draft is not sufficiently strong to draw the products of combustion down through the feed-water heater, in which case the said draft may be assisted by an exhaust-fan, (not shown but which may be located in the stack J^2,) or the valve 5′ may be closed and the valve 5 opened. In this latter case the products of combustion would pass directly from the boiler H through the pipe J into the stack. I prefer to have the products of combustion created by the natural draft pass through the feed-water heater, as the heat of such products is thus utilized to the fullest extent.

After the water-gas has been permitted to run through the apparatus a sufficient length of time to thoroughly clean the same from the deleterious gases and waste products the apparatus in now in condition for manufacturing the carbureted water-gas, and the next step in the process is as follows: The operator closes the steam-valve h to permit the outlet-valve 5′ in the pipe J′, leading to the stack, to be easily closed, which is then done. The valve h is again opened, and uncarbureted water-gas, made as above described, passes through the valve 4 and pipe B to the top of the chamber D at a high temperature, where it is met by heated hydrocarbons admitted through the valve i, which is now opened. The hydrocarbons, which are supplied in the present instance from the cylinder W by the pump V′, are heated or vaporized on their passage through the vaporizer T, as described in Letters Patent No. 443,214, above referred to, and the said hydrocarbons on their passage through the vaporizer T are heated to approximately the same temperature as the steam circulating through the chambers of the said vaporizer, so that when admitted to the chamber D the hydrocarbons are in a heated state and have their temperature further raised within the chamber D by the higher heat of the water-gas in said chamber. The mixing structure in the chamber D facilitates and renders perfect the intermingling of the water-gas and the hydrocarbons, which are now more or less vaporized, according to the nature of the oil used. The intermingling of the moderately-heated hydrocarbons and the water-gas lowers somewhat the temperature of the water-gas in the chamber D, as the latter is at a low temperature as compared with that of the chamber in which the gas meets the oil in apparatus of this class as heretofore used. The mixture of the water-gas and hydrocarbons thus produced passes into the chamber E, where the mixture, now at a lower temperature than the water-gas was when it reached the chamber D, is for the first time subjected to extraneous heat, it meeting for the first time moderately-heated refractory material e in the chamber E, and the mixed gases or carbureted water-gas become gradually heated in their passage through the intermediate chamber to its outlet F, where it

comes in contact with the highly-heated refractory material *g* in the fixing-chamber G, which has been previously heated as above described, and where it forms carbureted water-gas finally fixed or rendered permanent at nominal pressures and temperatures.

It will be noticed that in the progress of the manufacture of the fixed carbureted gas from the point of formation of the water-gas in the generator A to the point of fixation of the carbureted gas in the chamber G the water-gas is subjected to progressive and retrograde steps of temperature. To illustrate, the water-gas issuing from the generator A is reduced in temperature in the mixing-chamber D both by reason of the cooler hydrocarbons and also by reason of the fact that the said chamber is comparatively cool, as it has not been previously subjected to any appreciable heating action.

The mixture of water-gas and hydrocarbons is then raised in temperature on its passage through the chamber E and is still further raised in temperature in the fixing-chamber G, which latter is of sufficiently high heat to fix or render permanent the carbureted water-gas. From this point the object of this invention is to reduce the heat of the carbureted water-gas gradually, as it is one of the essentials of perfect gas-making that all shocks to the gas, as by sudden changes in temperature, should be avoided. The fixed carbureted water-gas having reached the top of the fixing-chamber G now passes through the boiler H, where its temperature is materially lowered and the heat abstracted continues the generation of steam, and from the boiler H the said fixed carbureted gas passes through the feed-water heater L, where its heat is still further removed and utilized. After the further cooling of the carbureted water-gas by the feed-water heater L it passes through the delivery-pipe M, (the valve 5′ in the pipe J′ being closed,) and at a comparatively low temperature, for the first time meets a hydraulic seal in the hydraulic main N, from which it passes through the pipe O to the condenser P, where its temperature is reduced to about the atmospheric temperature by cold water admitted into the condenser through the pipe p^2. The now cool gas issues through the outlet-pipe p^4 and thence passes to the usual scrubbers, purifiers, meters, and gas-holders, (not herein shown,) but such as now commonly employed in gas-works. It will be noticed that when the carbureted water-gas meets the water seal in the hydraulic main N it has been reduced in its temperature by its passage through the boiler H and feed-water heater L to such extent as to avoid all shock which would otherwise occur if the gas was permitted to meet the water seal at substantially the temperature it possesses when it leaves the fixing-chamber G, as has been heretofore practiced. By reducing the temperature of the fixed carbureted water-gas, as above described, the condenser P is relieved from the wear and tear incident upon highly-heated gas coming in contact with cool surfaces, and such wear and tear is taken largely upon the feed-water heater, which, being comparatively small, lessens the cost of repairs, if it is found necessary to make the same.

Another advantage resulting from the reduction of temperature of the fixed carbureted gas, as herein described, is that a less quantity of water is required for condensing purposes, which quantity is of such comparatively small volume as to enable it to be employed in connection with the feed-water heater without waste, thereby economizing in the amount of water used, and consequently effecting a reduction in this particular in the cost of manufacturing the gas.

Still another advantage resulting from the reduction of temperature of the carbureted water-gas, as herein described, is that when the said gas meets the water in the hydraulic main its temperature has already been greatly lowered and the water is not overheated, and consequently the nuisance of overheated tarry matters in tar-wells, which in practice are connected with the hydraulic main and are not herein shown, is avoided, and as a result the disagreeable tarry odors now common to gas-works are mitigated. Furthermore, the water in the tar-wells and hydraulic main can be circulated through the hydraulic main and tar-well without the usual attendant wear and tear on the pumps employed to thus circulate the water. The cold water admitted into the condenser P by the pipe p^2 is gradually heated and issues by the pipe p^3, connected to the inlet end of the pump V, and the said water is forced by the said pump, as herein represented, through the feed-water heater L into the boiler H and auxiliary boiler 20, and in the boiler H the said water is transformed into steam, which is used as heretofore described. Carbureted water-gas is thus made for a length of time governed by the gradual cooling of the apparatus and determined by the judgment of the operator, at the expiration of which time the oil-valve *i* is closed, the steam-valve *h* is closed, the stack-valve 5′ is open, the blast-valves 1 and 2 are open, and the conditions of the second step of the preparatory heating-stage are resumed and the process repeated from that point.

By reference to Fig. 3 it will be noticed that the pipe B leads from the top of the generator to the chamber D and the pipe B′ leads from the bottom of the generator below the grate-surface to the mixing-chamber D. By this arrangement the water-gas may be circulated up through the bed of coal in the generator and out through the pipe B, or it may be circulated in the reverse direction down through the bed of coal and up through the pipe B′, the valve 4′ being closed and the valve 4 being open in the first instance, and the valve 4 being closed and the valve 4′ being open in the second instance. When the circulation is downward through the bed of

coal, the steam-valve *h* is closed and the valve *h'* opened to admit steam to the top of the generator.

It will be noticed that the air-blast is admitted directly to the generator A by the pipe 10 and to the fixing-chamber G by the pipe 12, but is not supplied to the chamber E, so that the latter is not heated to an excessively high temperature, and as a result the mixture of water-gas and hydrocarbons admitted into the chamber E from the mixing-chamber D is not immediately subjected to the highest temperature, but, on the other hand, is subjected to what may be termed in gas-making a "moderate" temperature in the chamber E and then to the highest temperature in the fixing-chamber G. The mixture of water-gas and hydrocarbons is thus subjected to a progressive or increasing heat, which permits of the thorough mixing of the water-gas and the hydrocarbon vapors and avoids the formation of a lampblack and tarry matters from the hydrocarbon vapors, which formation of lampblack and tarry matters would take place if the water-gas and hydrocarbon vapors are subjected to a high temperature before being thoroughly mixed. It will also be noticed that the water-gas and hydrocarbons in the mixing-chamber D are not subjected to extraneous heat, but are acted upon solely by their own heat until they are thoroughly commingled. I prefer to heat the hydrocarbons before admitting the same into the chamber D, but I do not desire to limit my invention in this respect, for while superior results may thus be obtained approximate results may be obtained by admitting the hydrocarbons into the chamber D cold or substantially cool.

Believing myself to be the first to effect a mixture of water-gas and hydrocarbons at a moderate temperate prior to subjecting the said mixture to the fixing-temperature in an apparatus of this kind, as may be accomplished by passing the said mixture through the chamber E, into which the air-blast is not admitted, I do not desire to limit this portion of my invention to the use of the mixing-chamber D.

I prefer to employ in the manufacture of carbureted water-gas a mixing-chamber constructed as herein shown, it forming a part, with the chamber E, of an intermediate structure interposed between the generator and the fixing-chamber, but I do not desire to limit myself to any particular form of mixing-chamber, as the latter may be of other forms than that herein shown and may be separate from the chamber E, but connected thereto in suitable manner to permit of the passage of the gases and vapors from it to the chamber E, and so also the chamber E, while herein shown as a separate structure from the fixing-chamber, may be included in one structure with the same, but separated therefrom in suitable manner to preserve its function, which is to moderately heat the mixture of water-gas and hydrocarbons before the said mixture is exposed to the highest heat. I prefer also to provide the outlet-pipe M, leading from the feed-water heater L, with the branch pipe J', provided with a normally-closed valve, but I do not desire to limit my invention in this respect, for while such construction is preferable it may be omitted and advantageous results obtained by the use of the outlet J, leading from the boiler H, which outlet is provided with a normally-closed valve 5.

By locating the mixing-chamber D above and in communication with the chamber E the hydrocarbons in the chamber D are permitted to gravitate into the chamber E, which prevents waste of hydrocarbons and insures the utilization of all the hydrocarbons admitted into the chamber D in the manufacture of the carbureted water-gas.

I claim—

1. In an apparatus for producing carbureted water-gas, the combination with a gas-generator, and a chamber containing refractory material in communication with the said generator for the passage of the products of combustion or blast-gases, of a hydrocarbon-mixing chamber provided with an oil-supply, and connected with the generator for the admission of water-gas, and located above and communicating with the said chamber containing refractory material for the passage of the mixed water-gas and hydrocarbons and for the gravitation into said chamber of the heavier hydrocarbons, for the purpose specified.

2. That improvement in the method of manufacturing water-gas, which consists in the following steps, viz: generating producer-gas, passing the said producer-gas through a chamber containing refractory materials to absorb the specific heat of the said gas, commingling air with the said producer-gas after its specific heat has been absorbed to effect complete combustion of the said producer-gas, passing the gaseous products of complete combustion through a chamber containing refractory material to absorb the heat resulting from said complete combustion, bringing the products of complete combustion into contact with material heated to steam temperatures, that is, at or above the boiling-point of water to absorb further quantities of the specific heat of said gases, and then bringing the products of complete combustion into contact with materials at a temperature below the boiling-point of water to further absorb the specific heat of the said gases, substantially as and for the purpose specified.

3. The improvement in the method of manufacturing carbureted water-gas, which consists in the following steps, viz: generating blast-gas, and internally heating chambers containing refractory material by passing said blast-gases through them; then generating water-gas, enriching said water-gas with oils or hydrocarbons by admitting water-gas into a mixing-chamber containing refractory or

baffling material and into which chamber the said oils or hydrocarbons are admitted, to effect a mixing of water-gas and hydrocarbons and thereby raise the temperature of said hydrocarbons by the specific heat of the water-gas, and form a mixture of water-gas and oils or hydrocarbons and vapors of same, the temperature of which mixture is greater than that of the original oils and less than that of the water-gas previous to the mixing described; passing water-gas admixed with hydrocarbons into one of the internally-heated chambers in communication with the said mixing-chamber and into which internally-heated chamber the heavier hydrocarbons gravitate from said mixing-chamber, thereby further raising the temperature of mixed water-gas and oils or hydrocarbons; and then passing said heated mixture through a second of the internally-heated chambers to still further heat the said mixture and effect a final fixing of the carbureted water-gas, substantially as described.

4. In an apparatus for producing carbureted water-gas, the combination with a water-gas generator, a heated fixing-chamber, and a chamber E, provided with refractory material and intermediate of the said generator and fixing-chamber and communicating therewith, and a hydrocarbon-mixing chamber provided with an oil-supply and connected with the generator for the admission of water-gas, and communicating with the intermediate chamber E for the passage of mixed water-gas and hydrocarbons, substantially as described.

5. In an apparatus for producing carbureted water-gas, the combination with a gas-generator, a fixing-chamber, and a chamber containing refractory material and intermediate of the fixing-chamber and generator, of a hydrocarbon-mixing chamber adapted to communicate with the gas-generator and with the said intermediate chamber, substantially as described.

6. In an apparatus for producing curbureted water-gas, the combination with a gas-generator, a fixing-chamber provided with refractory material, of an intermediate structure consisting of a chamber E communicating with the generator and with the fixing-chamber and containing refractory material, and a mixing-chamber D provided with refractory material and communicating with the chamber E and adapted to communicate with the generator, substantially as described.

7. In an apparatus for producing carbureted water-gas, the combination with a gas-generator and fixing-chamber, and a chamber E provided with refractory material and intermediate of the said generator and fixing-chamber, of a hydrocarbon-mixing chamber communicating with the gas-generator for the admission of water-gas from the said generator into said mixing-chamber and with the said intermediate chamber for the passage from said mixing-chamber of a mixture of water-gas and hydrocarbons, and a boiler communicating with the interior of the fixing-chamber and through which the gas fixed in the said fixing-chamber is passed, substantially as described.

8. In an apparatus for producing carbureted water-gas, the combination with a gas-generator, a fixing-chamber and an intermediate chamber E provided with refractory material, of a hydrocarbon-mixing chamber communicating with the gas-generator and for the admission of water-gas from the said generator into said mixing-chamber and with the said intermediate chamber for the passage from said mixing-chamber of a mixture of water-gas and hydrocarbons, a boiler communicating with the interior of the fixing-chamber, and a feed-water heater L for said boiler connected therewith to afford a passage for the gas from the boiler, substantially as described.

9. In an apparatus for producing carbureted water-gas, the combination with a gas-generator, a fixing-chamber and an intermediate chamber E, of a hydrocarbon-mixing chamber connected to the gas-generator for the admission of water-gas into the said mixing-chamber and with the said intermediate chamber for the passage of water-gas and hydrocarbons into the said intermediate chamber, a boiler communicating with the interior of the fixing-chamber, and a feed-water heater L for said boiler connected therewith to afford a passage for the gas from the boiler, a gas-delivery pipe for said heater, and a branch escape-pipe connected to said gas-delivery pipe, substantially as described.

10. In an apparatus for producing carbureted water-gas, the combination with a water-gas generator, a fixing-chamber provided with refractory material, and a chamber E provided with refractory material and intermediate of the said fixing-chamber and generator and connected thereto for the passage of gas from the generator to the fixing-chamber, and a hydrocarbon-mixing chamber containing refractory mixing material and communicating with the gas-generator and with the intermediate chamber, of air-admission pipes connected to the said generator and fixing-chamber only, substantially as and for the purpose specified.

11. The improvement in the method of manufacturing carbureted water-gas, which consists in the following steps, viz: generating blast-gas, and internally heating chambers containing refractory material by passing said blast-gases through them; then generating water-gas, enriching said water-gas with oils or hydrocarbons by admitting water-gas into a mixing-chamber containing refractory or baffling material and into which chamber the said oils or hydrocarbons are admitted, to effect a mixing of water-gas and hydrocarbons and thereby raise the tempera-

ture of said hydrocarbons by the specific heat of the water-gas, and form a mixture of water-gas and oils or hydrocarbons and vapors of same, the temperature of which mixture is greater than that of the original oils and less than that of the water-gas previous to the mixing described; passing water-gas admixed with hydrocarbons into one of the internally-heated chambers in communication with the said mixing-chamber and into which internally-heated chamber the heavier hydrocarbons gravitate from said mixing-chamber, thereby further raising the temperature of mixed water-gas and oils or hydrocarbons; and then passing said heated mixture through a second of the internally-heated chambers to still further heat the said mixture and obtain a maximum temperature of the mixed water-gas and hydrocarbons; then passing said mixture of water-gas and hydrocarbons into contact with materials heated to the boiling-point of water; thence into contact with materials heated to a temperature below the boiling-point of water, and lastly passing said mixture through water, substantially as and for the purpose specified.

12. The improvement in the method of manufacturing carbureted water-gas, which consists in the following steps, viz: generating blast-gas, and internally heating a chamber containing refractory material by passing said blast-gas through it; then generating water-gas, admixing water-gas and oils or hydrocarbons in a chamber containing baffling or refractory material located above and communicating with said internally-heated chamber for the gravitation of the heavier hydrocarbons from the said mixing-chamber into said internally-heated chamber, substantially as and for the purpose specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WALTER R. ADDICKS.

Witnesses:
JAS. H. CHURCHILL,
J. MURPHY.