No. 682,038. Patented Sept. 3, 1901.

E. B. CORNELL.

PROCESS OF MAKING GAS.

(Application filed Oct. 24, 1900.)

(No Model.) 2 Sheets—Sheet 1.

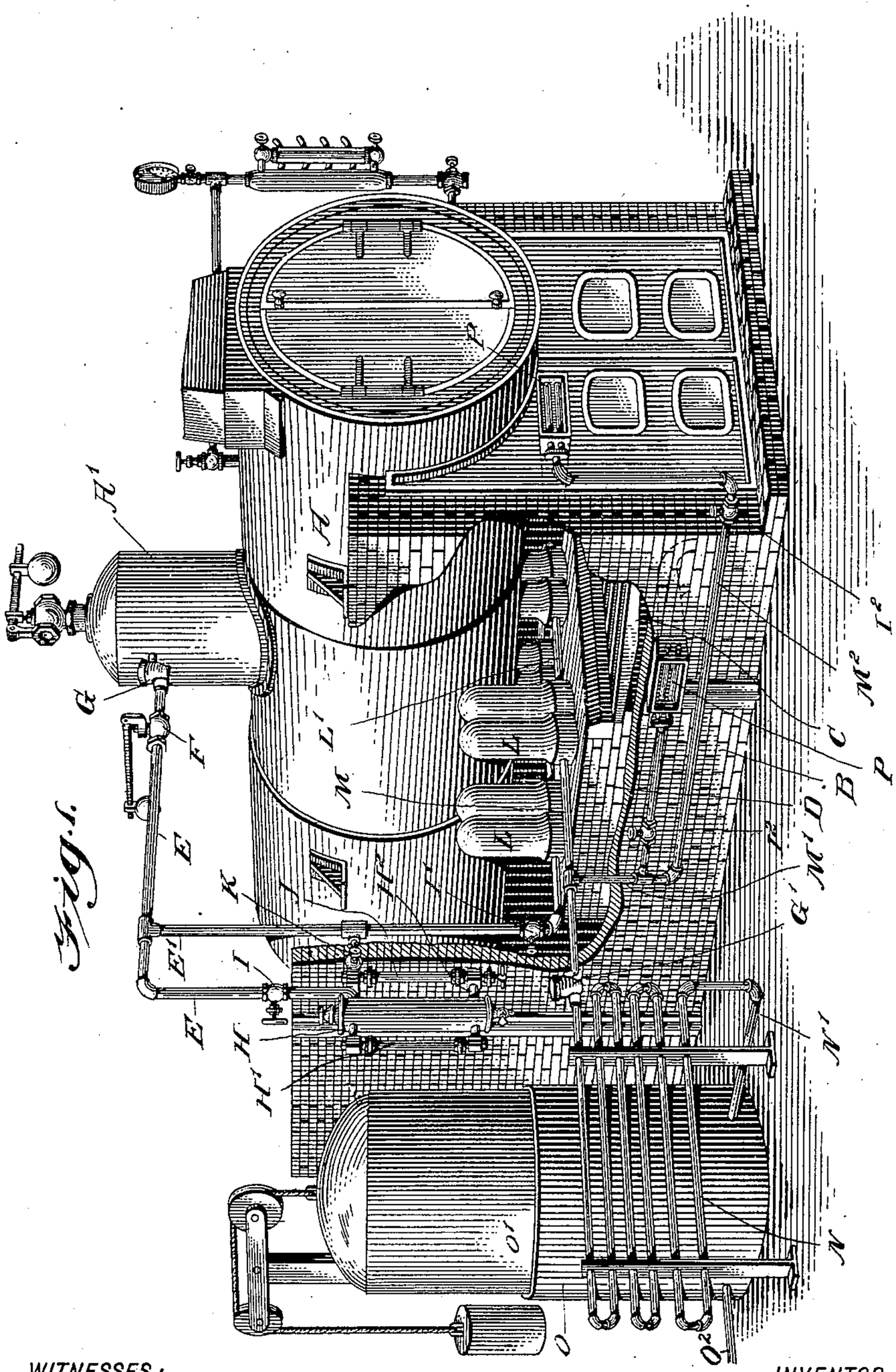

Fig. 1.

WITNESSES:

H. G. Dieterich

John Lotka

INVENTOR

Elijah B. Cornell

BY Munn & Co.

ATTORNEYS

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Fig. 2.

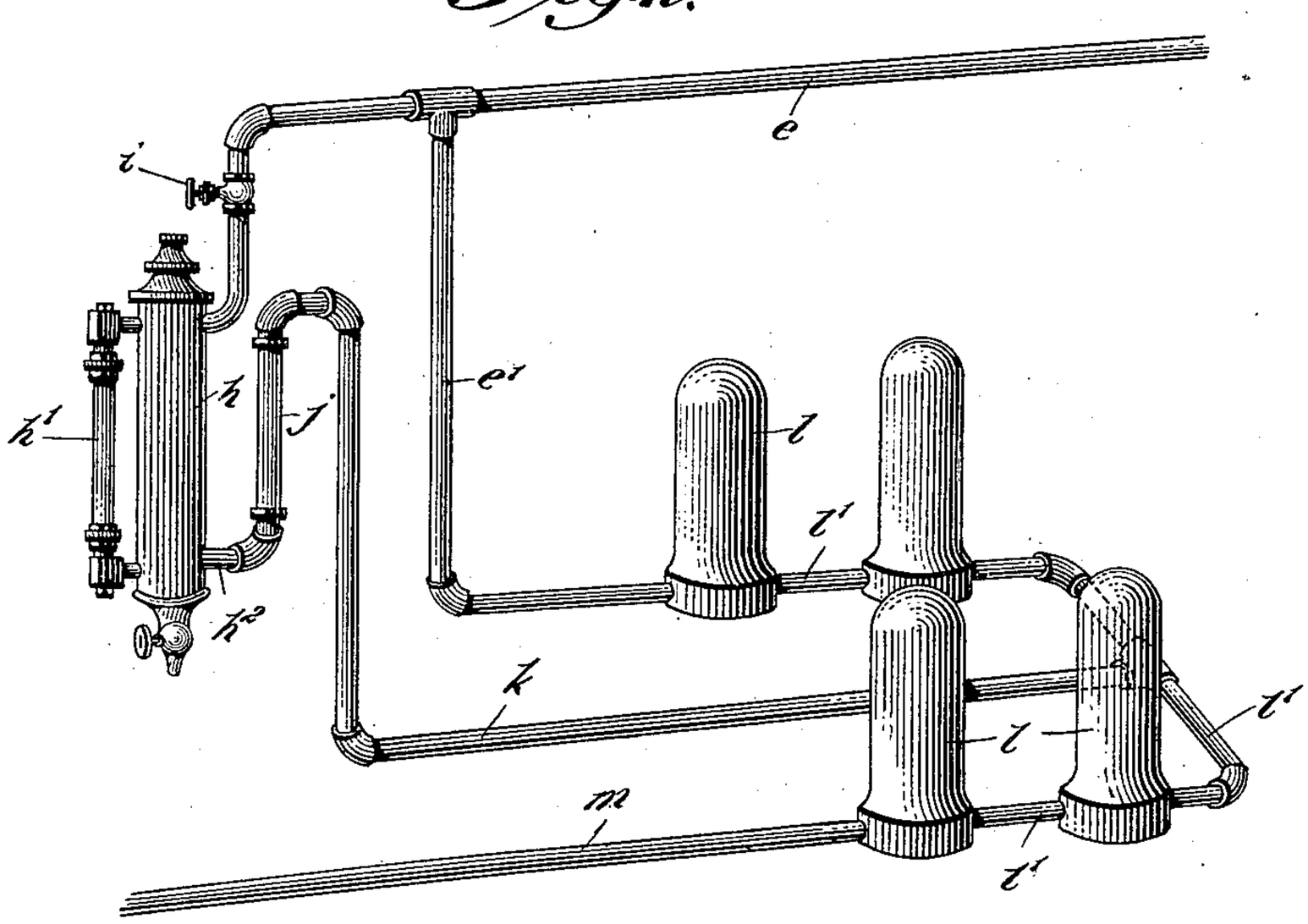
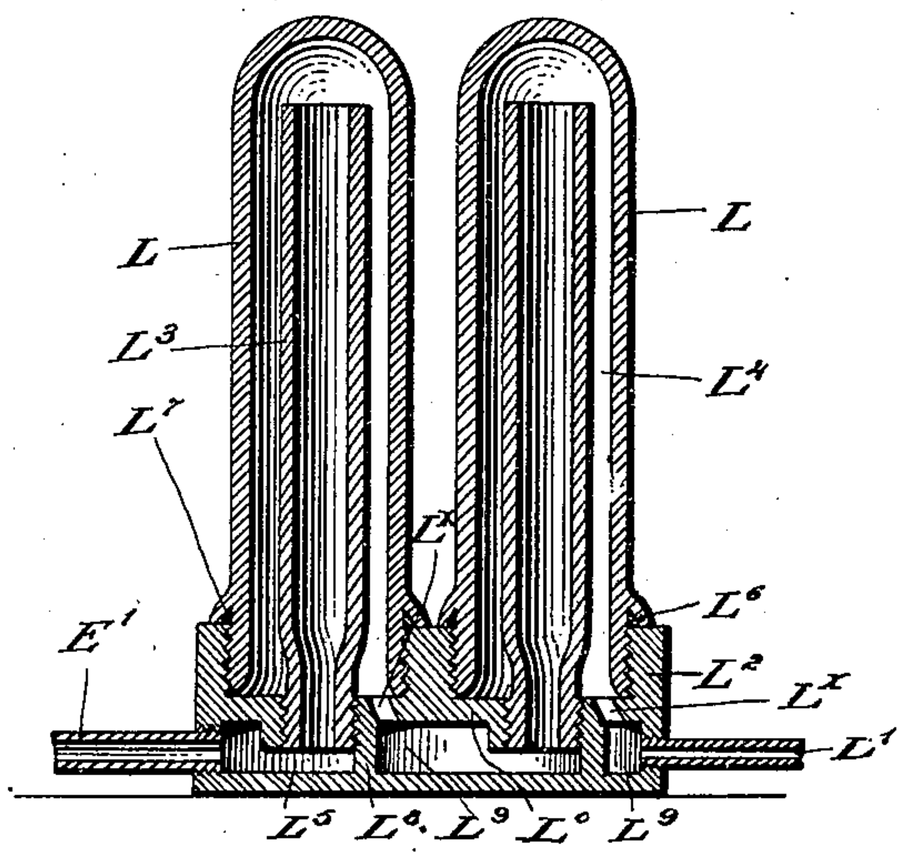


Fig. 3.



WITNESSES:

H. G. Peterich

John Lotka

INVENTOR

Elijah B. Cornell

BY Munn & Co.

ATTORNEYS

UNITED STATES PATENT OFFICE.

ELIJAH BEANS CORNELL, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO WILLIAM C. ALDERSON, OF SAME PLACE.

PROCESS OF MAKING GAS.

SPECIFICATION forming part of Letters Patent No. 682,038, dated September 3, 1901.

Application filed October 24, 1900. Serial No. 34,157. (No specimens.)

To all whom it may concern:

Be it known that I, ELIJAH BEANS CORNELL, a citizen of the United States, and a resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and Improved Process of Making Fixed Gases, of which the following is a full, clear, and exact description.

My invention relates to the manufacture of gas from steam and hydrocarbons, and more particularly to a process in which the production of a fixed gas is insured—that is, of a gas which can be stored and conveyed through pipes at ordinary temperatures, like ordinary illuminating-gas.

I will first describe the invention in detail and then point out its novel features in the appended claim.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a perspective view of an apparatus suitable for carrying out my improved process with parts broken away. Fig. 2 is a perspective view of a portion of the apparatus, showing a different arrangement of certain parts; and Fig. 3 is a sectional elevation of a set or bench of retorts forming part of said apparatus.

The apparatus shown comprises a boiler A, provided with a steam-dome A′ and supported by a setting B, within which is located a grate C in front of the bridge-wall D. From the dome A′ a pipe E, provided with a safety-valve F and a pressure-reducing valve G, leads to the top of a reservoir H, which is filled with a suitable oil or hydrocarbon—such as, for instance, crude petroleum. This reservoir is constructed after the fashion of a sight-feed lubricator and has a gage-glass H′ and an outlet-nipple H^2, leading to an upright transparent sight-feed tube J, which connects by a pipe K with a branch pipe E′, leading from the pipe E to retorts L, arranged within the furnace or setting B. The retorts, as shown in Fig. 3, are arranged in sets of two, with their shells L screwing into a common base L^2, which also receives tubular cores L^3, opening at their upper ends into the chambers L^4, which surround the cores, and at their lower ends into the inlet-chambers L^5. The shells L have flanges L^6, with packing-rings L^7 to secure a tight joint at the base L^2. A vertical partition L^8 separates the inlet-chamber L^5 from the outlet-chamber L^9, and a horizontal partition L^0, provided with a passage $L^\times$, separates the chamber L^4 from the outlet-chamber L^9. The several sets of retorts are connected by pipes L′, which should be protected from the hot combustion products by being embedded in fire-brick. This has been omitted from Fig. 1 for the sake of clearness. By the above-described construction the steam and hydrocarbon in their passage through the several retorts will be subjected to a series of successive contractions and expansions, thus retarding them, so that the steam will be decomposed and the hydrocarbon completely broken up and thoroughly mixed with the decomposed steam. The bore of the pipes L′ is smaller than that of the pipe E′. From the last retort of the set a pipe M leads to the condenser or cooler N, the connection being controlled by a pressure-reducing valve G′. The cooler is generally set within a tank, (not shown,) as is well known. The outlet N′ of the cooler connects with a gas-holder O, having a movable bell O′ and an outlet-pipe or service-pipe O^2. A branch pipe M′ leads to burner-pipes M^2, having burners P, suitably located for heating the boiler A and the retorts L.

I is a cock or valve controlling the connection of the pipe E with the reservoir H. The valve I′ controls the connection of the pipe E′ with the retorts L and the valves I^2 that of the branch pipe M′ with the burners P.

The retorts should be lined interiorly with a non-oxidizable substance, such as carbid of iron.

In the construction illustrated by Fig. 2 the steam-pipe *e* leads from the boiler-dome to the reservoir *h*, as before; but the nipple h^2, sight-feed tube *j*, and connecting-pipe *k* do not lead to the pipe *e′*, entering the first retort *l*, but to one of the connections *l′*, so that steam alone passes through some of the retorts and the hydrocarbon, together with steam, through the remainder of the retorts.

The operation is as follows in the case illustrated by Fig. 1: The apparatus is started

by burning fuel on the grate C until steam is generated. The heat should be sufficient to make the retorts L—that is, their shells—red-hot, or practically the temperature should not be less than 1,800° Fahrenheit. The steam from the dome A′ passes through the pipe E in part directly to the retorts L by way of the branch pipe E′ and in part to the hydrocarbon-reservoir H. From the latter a certain amount of hydrocarbon, depending on the admission and condensation of steam as regulated by the position of the valve I, passes through the nipple H^2 and the sight-feed tube J to the pipes K and E′ to finally reach the retorts L in finely-divided or globular form, together with the steam passing directly through the pipe E′. While the proportion of steam and hydrocarbon may be varied with, in certain limits, I would say that satisfactory results are obtained by employing one and three-fourths pounds of crude petroleum (of a specific gravity of 0.875) for every pound of steam. The amount of hydrocarbon should be just sufficient to fix the dissociated steam. The steam and hydrocarbon pass first through the hollow core L^3 and then spread in a thin film within the chamber L^4, so that every particle of steam and of hydrocarbon is subjected to the intense heat of the red-hot retort-shell. This causes the decomposition of the steam into oxygen and hydrogen and the formation of a fixed gas consisting mainly of carbon monoxid and of gaseous hydrocarbons rich in hydrogen. By the term "fixed gas" I mean a gas which does not change its constitution or its gaseous state upon cooling to ordinary temperatures.

When produced from steam and crude petroleum, (for which no generally-accepted formula is known, but I believe the group formula C_nH_{2n} is at least a satisfactory approximation,) the fixed gas obtained by my process consists of carbon monoxid, (CO,) ethane, (C_2H_6,) and methane (CH_4) in about the proportions given by the following equation, which represents the probable reaction:

$$C_nH_{2n}+2H_2O=2CO+C_2H_6+3CH_4.$$

Crude petroleum. Steam. Carbon monoxid. Ethane. Methane.

The gas produced according to my method is suitable for the lighting of buildings, for heating purposes, (by mixing it with air, as in burners of the Bunsen type,) and for any other purpose for which gas is ordinarily used. The gas may be stored in a holder, as O, after the customary purification, if such should be necessary. A portion of the gas may be used for heating the retorts and the boiler or other apparatus, so that after the operation has been started the plant will supply its own fuel continuously. My fixed gas when burned with air (oxygen) will yield a practically smokeless combustion, since the combustion products consist almost exclusively of carbon dioxid (CO_2) and steam, (H_2O.) The length of the path of the steam and hydrocarbon in the retorts, or, in other words, the length of time necessary to produce the gas, depends partly on the kind of hydrocarbon treated and partly on the temperature obtained in the furnace. It will be readily understood that the reaction generally cannot be completed in one retort, (unless a very long retort should be employed,) but in passing through several retorts successively any steam remaining as such will be decomposed, so that a fixed gas leaves the apparatus at the outlet-pipe M. The contraction of the connections L′ relatively to the inlet-pipe E′ retards the flow of the gas-generating mixture, and thus affords more time for the reaction. I find it advisable to heat the steam to the temperature (about 1,800°, as stated) at which it will become decomposed when in contact with hydrocarbon before such hydrocarbon is introduced. When hydrocarbon is brought in contact with steam of a lower temperature, the hydrocarbon instead of giving up part of its carbon to combine with the oxygen of the steam will form a deposit of carbon on the walls of the retorts, clogging them and interfering with the regular working of the plant. To prevent this, I first heat the steam alone up to the temperature at which the introduction of hydrocarbon will bring about the desired reaction. For this purpose the steam is passed through all of the retorts and the hydrocarbon only through a portion of them—that is to say, the steam passes through the first sets of retorts and is decomposed, forming hydrogen gas, and then the hydrocarbon is introduced into the said gas as it passes from the retorts, and both the gas and hydrocarbon will enter the second set of retorts together, forming carbureted hydrogen gas, and in their passage through the several retorts being subjected to a series of successive contractions and expansions while highly heated will pass from the said retorts as a fixed illuminating-gas. The reaction will be complete and no deposit will be formed on the walls of these retorts. It will, however, be understood that the first set of retorts will become foul, owing to decomposition, and will occasionally require cleaning. By varying the relative time during which the steam and the hydrocarbon are subjected to the action of heat I can within certain limits control the illuminating power of the gas obtained.

Modifications as long as they remain within the scope of the appended claim will constitute no departure from the nature of my invention.

It will be seen that in my process I employ a conventional type of horizontal boiler with its furnace and bridge-wall such as is ordinarily used for supplying steam for motive power. I also employ a gas-making apparatus in which its retorts are located on the bridge-wall and within the influence of the same heat that raises steam and an external gas-cooling device and gasometer, and my

invention involves a subprocess in which the steps work in a cycle and are correlated to produce the new results of economical steam generation, economical light production, and also fuel economy, thus greatly extending the scope and utility of ordinary steam-boilers and making it practical with one plant to have light, heat, and power.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

The process of making gas, which consists in forming hydrogen gas, injecting the hydrogen thus formed together with a hydrocarbon oil into a highly-heated retort, thereby forming carbureted hydrogen gas and at the same time subjecting the gas to a series of successive contractions and expansions while highly heated thereby forming a fixed illuminating-gas.

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

ELIJAH BEANS CORNELL.

Witnesses:
JOHN LOTKA,
EVERARD BOLTON MARSHALL.