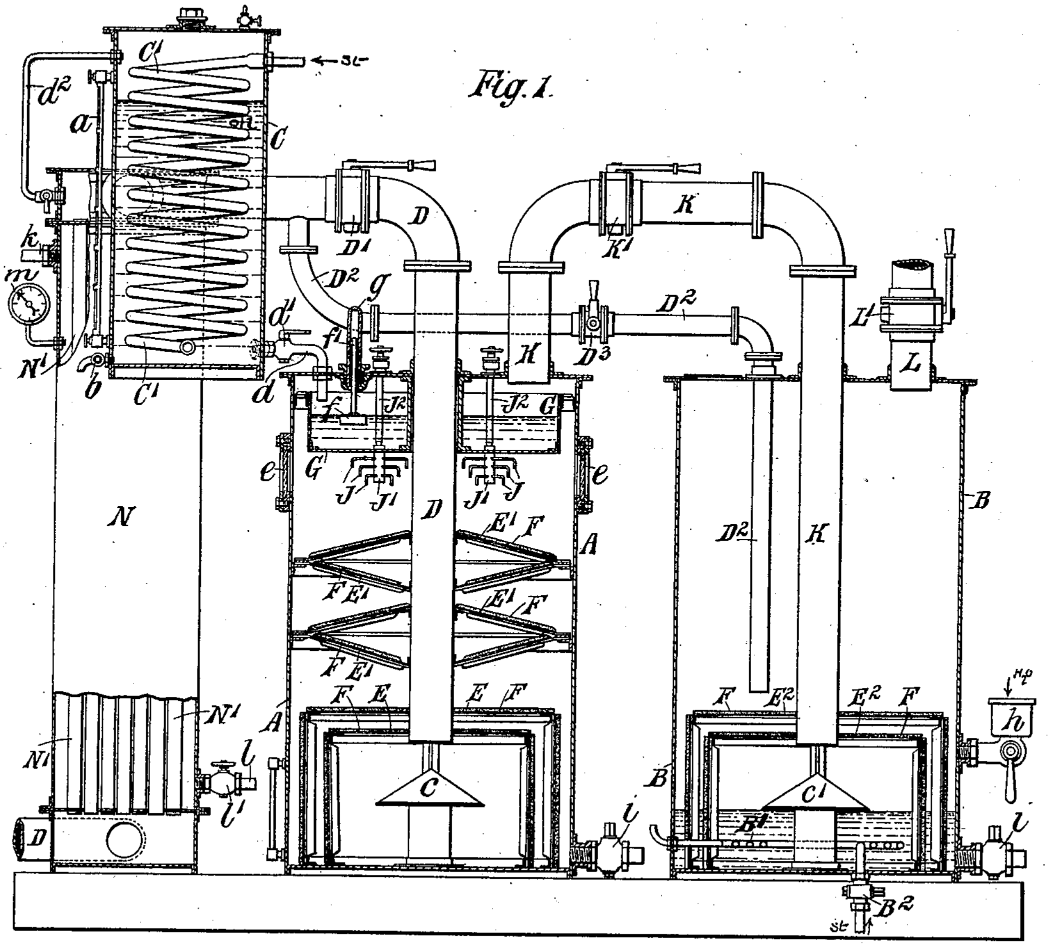
(No Model.)

2 Sheets—Sheet 1.

J. H. LADD.

METHOD OF AND APPARATUS FOR MANUFACTURING GAS.

No. 590,893. Patented Sept. 28, 1897.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

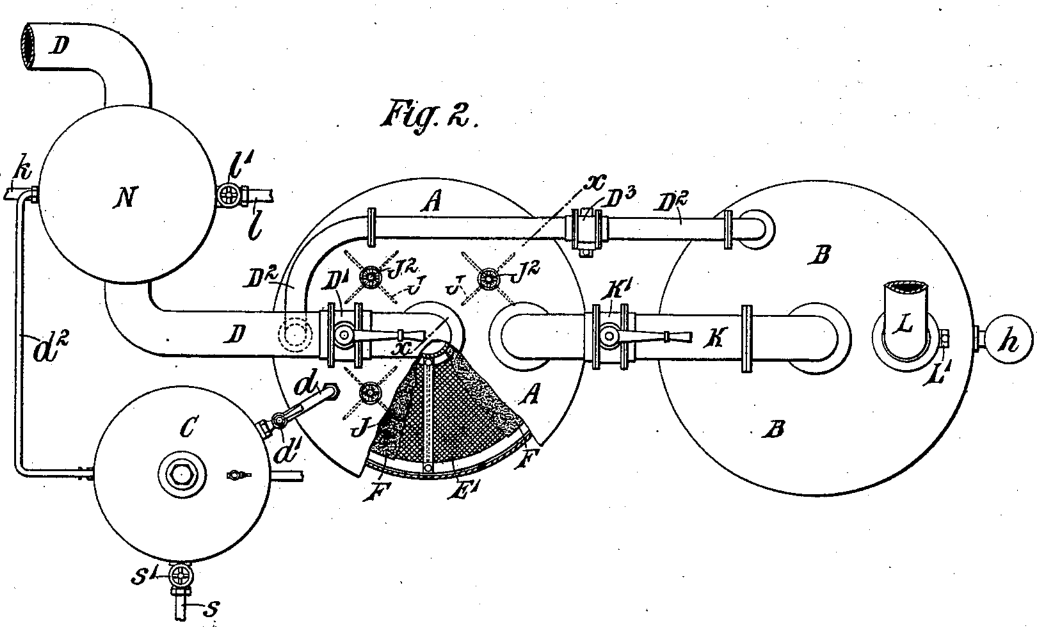
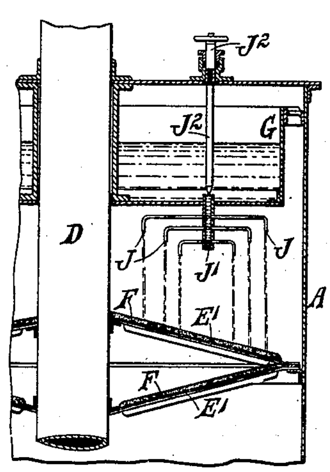


Fig. 3.



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UNITED STATES PATENT OFFICE.

JOHN HASKINS LADD, OF LONDON, ENGLAND.

METHOD OF AND APPARATUS FOR MANUFACTURING GAS.

SPECIFICATION forming part of Letters Patent No. 590,893, dated September 28, 1897.

Application filed July 13, 1895. Serial No. 555,866. (No model.) Patented in England May 27, 1895, No. 10,477.

To all whom it may concern:

Be it known that I, JOHN HASKINS LADD, engineer, a citizen of the United States of America, residing at London, England, have invented new and useful Improvements in Methods of and Apparatus for the Manufacture of Fixed Hydrocarbon Gas, (in relation to which British Letters Patent No. 10,477 were granted me on May 27, 1895,) of which the following is a specification, reference being had to the accompanying drawings.

Figure 1 is a side elevation, partly in vertical section, and Fig. 2 a plan, with parts broken away, showing my improved apparatus. Fig. 3 is a section on the line *x x*, Fig. 2, drawn to an enlarged scale, illustrating a detail of construction.

Like letters indicate corresponding parts throughout the drawings.

My invention relates to a new method of and to an improved apparatus for the manufacture of fixed hydrocarbon gas suitable for various purposes, more especially where great heat is required and for incandescent lighting.

My invention consists in carbureting hot air with a hot hydrocarbon vapor and charging the hot carbureted air with vapor of water at a temperature between the freezing-point and the steam-generating point.

The hot carbureted air previous to its contact with the water particles is not a fixed gas, but if imprisoned in a retort, pipe, or gasometer will separate, the liquid hydrocarbon falling to the bottom of the receptacle. I find it to be a fact, however, that by causing a carbureted hot-air blast to take up vapor of water a permanently-fixed gas is formed and that this gas can be stored a great length of time or conveyed in mains or pipes great distances without disintegration or any deterioration in its heating or lighting properties.

It is a fact known to me by long experience with the Stringfellow process and apparatus hereinafter mentioned that the use of an air-blast of "normal" temperature (when such air-blast is of great volume and of great velocity) prevents that proper vaporization of the liquid hydrocarbon which is essential to the production in large quantities of a fixed hydrocarbon gas.

I have discovered the fact that to produce the best results on a large scale it is essential in carbureting an air-blast of great volume and of great velocity to heat both the air and the liquid hydrocarbon and to bring them both together in a chamber wherein the temperature is constantly above the temperature at which the liquid hydrocarbon congeals.

I attribute the marked practical success of my improved method not merely to the mere application of heat in a loose sense to the air-blast and liquid hydrocarbon, but rather to the interaction of the rapidly-moving molecules of hydrocarbon and hot air, whereby, physically at least, an intimate association of the hydrocarbon and atmospheric molecules is obtained, and I am inclined to think that a new chemical action or effect is produced by the subjection of the hydrocarbon molecules to the rapidly-moving atmospheric molecules, and my theory also is that the carbureted hot-air blast has a radically-different physicochemical effect on the water particles from that of an air-blast at normal temperature.

In the specifications of the United States Letters Patent No. 457,484, granted August 11, 1891, and No. 467,266, granted January 19, 1892, to Stringfellow, there are described a process and apparatus for the manufacture of a new gas, which consists of atmospheric air, hydrocarbon, and the vapor of water, and is adapted for heating and incandescent lighting. In the process and apparatus described in the said specifications atmospheric air at its ordinary or normal temperature is first caused to pass through absorbent material saturated with liquid hydrocarbon at the ordinary or atmospheric temperature, so that the air will take up some of the vapor of the hydrocarbon, and the carbureted air is then caused to pass through absorbent porous material saturated with water at its normal temperature. The Stringfellow process is based on the discovery that carbureted air at normal temperature can be charged with vapor of water to produce a gas for heating and incandescent lighting. In actual practice under the Stringfellow patents I found first that there was some deposit of oily or greasy matter in the chamber where the carbureted-air blast of normal temperature was brought into intimate contact with the vapor of water at normal temperature. While the results—the gas—which I have obtained were pronounced impossible by experts with whom I consulted, yet the results are facts heretofore fully and completely demonstrated at my works in London and are now admitted as actualities by the experts. I mention this because I do not know exactly what chemical or physicochemical action occurs; but I discovered several important facts in the course of my experiments, and those facts are:

First. By heating the air-blast the refrigeration that occurred in the Stringfellow carbureting-chamber, (wherein the air-blast was of normal temperature,) when the Stringfellow process was continually worked under the considerable pressure or exhaust necessary on a large scale, was absolutely prevented, and constant vaporization of the liquid hydrocarbon effected without producing a "snow-storm" or congealing the liquid hydrocarbon in the carbureting-chamber. I found, however, that the use of the hot-air blast alone did not prevent the deposit of oily or greasy matter in the water-chamber and that the gas produced was still lacking in absolute fixity.

Second. I discovered it to be a fact that by heating the liquid hydrocarbon and subjecting it to the action of the hot-air blast while dispersed or suspended on the screens no deposit whatever of oily or greasy matter is preceptible in the water-chamber and that the gas produced is an absolutely permanently-fixed gas according to the severest tests known to my expert advisers.

Third. It was also discovered by chemists under my direction that the products of combustion of my improved gas revealed not the faintest trace of carbon monoxid and not the faintest trace of hydrocarbon.

The analysis of the products of combustion of my new gas is as follows:

Nitrogen	72.6
Carbon dioxid	14.9
Oxygen	12.5
Carbon monoxid	0.
Hydrocarbons	0.
	100.

Just what the scientific reasons of this improvement are I do not know, but my theory is that the rapid molecular action of this heated carbureted-air blast on the vapor of water produces a physicochemical change that instantaneously contributes to the permanent fixity of the gas produced. By "air-blast" I mean to include a current of air produced by either a blower or by an exhaust. The effect of the decomposition of the water in the gas at the point of burning gives a perfection of combustion, and thus produces with a certain expenditure of hydrocarbon, combined with the hot air and water, a maximum degree of heat obtainable from the combination, and it is a fact that better results are obtained by directing the carbureted hot-air blast against and past particles of water suspended or spread on screens than are obtained by directing the carbureted hot-air blast directly against the surface of a body of water.

The value of the water treatment was observed in connection with the Stringfellow process under the following conditions: Two parallel experiments were conducted with a small Stringfellow apparatus, one with and the other without the water. Exactly the same amount of benzin was used in both tests and all the conditions were precisely the same, excepting as above noted in regard to the water and also in regard to the pressure under which the gas was delivered to the burners, it being considerably greater, for unavoidable reasons, with the dry gas than with the wet gas. The amount of heat practically generated by both kinds of gas was then observed, and it was found that with the use of water upward of ten per cent. more heat was produced than without it. With the exception of the water the only condition not rigorously the same in the two tests was the difference in the pressure of the gas, but this, in my opinion, would not account for more than a part, if for any, of the difference in heat obtained. Warming of the water with the vapor of which the carbureted hot air is charged is essential at low temperatures of the atmosphere, for the temperatures of the hot carbureted air and of the water-vapor should always be about the same. It has also been found that by reason in the Stringfellow apparatus of the refrigeration due to the evaporation of the liquid hydrocarbon the temperature in the carbureting-chamber is reduced to such a low degree that the liquid hydrocarbon is congealed and the process cannot be effectively carried on continuously on a large commercial scale.

My present invention is chiefly designed to overcome the practical objection to the Stringfellow process and apparatus and to provide for the manufacture of an absolutely permanent or fixed gas, according to the present technical standard, in a more rapid, efficient, and reliable manner than has been heretofore practicable. To this end I force a blast of heated atmospheric air against and past particles of heated liquid hydrocarbon, feeding heated liquid hydrocarbon continuously into a carbureting-chamber and allowing it to fall upon absorbent porous material, so that the liquid hydrocarbon is divided up and placed in the most favorable condition for vaporization in said chamber, saturating absorbent porous material in another chamber with water, so that the water is divided up and placed in the most favorable condition for absorption by the carbureted hot air, passing the heated air first through the absorbent porous material saturated with the heated liquid hydrocarbon, and then passing this heated carbureted air through the porous material saturated with water. In some instances I also warm the water with which the said absorbent material is saturated, but in some instances the water is sufficiently raised in temperature by the heat of the carbureted air.

In practice I have heretofore heated the air to about 176° Fahrenheit and the liquid hydrocarbon to about the same temperature, but at the time the hot carbureted-air blast comes into contact with the vapor of water or water particles its temperature will be found to be considerably decreased, usually to about 65° Fahrenheit, and if the temperature of the outside atmosphere be lower the water should be warmed to about 65° Fahrenheit.

The foregoing temperatures are fair averages of those observed by me in actual practice, but I do not mean to limit my invention to them.

Any and all effective temperatures of the air, hydrocarbon, and water I consider within the scope of my invention.

Other features of my invention relate to a form of apparatus suitable for use in carrying out my new process.

Referring to the drawings, A is the carbureting vessel or chamber.

B is the vessel in which the carbureted air is charged with vapor or water.

C is the reservoir for the carbureting fluid, which reservoir is provided with a gage-glass *a* and with a drain-cock *b*.

To provide for raising and regulating the temperature of the liquid hydrocarbon as required, I arrange in the reservoir C a coil C′, through which steam, hot water, hot air, or any other suitable heating medium may be circulated; or I can, if desired, provide the said reservoir with a casing or jacket through which the heating medium is caused to circulate. I provide the outlet-pipe *s* or the steam or other heating medium with a cock or valve *s*′, so that the temperature of the liquid hydrocarbon can be easily regulated as desired. The fluid hydrocarbon can thus be heated more or less, according to its specific gravity and according to the atmospheric temperature, so as to insure the requisite rate of evaporation of the said hydrocarbon.

The carbureter A is provided with an inlet-pipe D, controlled by a cock or valve D′, for the admission of the air to be carbureted, which air is previously heated, as hereinafter described. The pipe D extends downward in the vessel A and discharges the air over a conical deflector or distributer *c* into a space inclosed by dome-shaped screens or frames E, covered with absorbent porous material F, which is kept saturated with liquid hydrocarbon. Above the domes or screens E, I provide conical or dished frames or screens E′, also covered with absorbent porous material, which are arranged one above another and which extend between the air-pipe D and the wall of the vessel A, every alternate frame or screen E′ being inverted.

The hot liquid hydrocarbon is fed continually from the reservoir C upon the screens or frames E, preferably, but not necessarily, by means of the tank G in the upper part of the carbureter A through a pipe *d*, controlled by a cock *d*′. The tank G, if used, is provided with a series of nozzles J, formed on pipes radiating from tubes or barrels J′, which are secured in the under side of the said tank and are closed at their lower end. The flow of the liquid hydrocarbon through these tubes is controlled by screw-down valves J^2, the stems of which extend through stuffing-boxes in the cover of the carbureter A, so that they may be operated from the exterior thereof. From the nozzles J the liquid hydrocarbon drops on the surface of the uppermost screens E′ and runs down through and over its surface, any liquid which does not percolate through the absorbent material flowing toward the periphery of the vessel, whence it runs inward over and percolates through the second screen and then outward over and through the third screen, and so on. I also provide a float *f* on the liquid in the tank G, having an index rod or stem *f*′ passing up through the cover of the vessel and working in a glass tube *g*, so that the depth of liquid in said tank may be readily ascertained at any time.

The vessel A is provided at the top with an outlet-pipe K, controlled by a cock or valve K′, for conducting the carbureted air into the water-chamber B. This pipe extends nearly to the bottom of the said chamber, where it opens over a conical deflector or distributer *c*′ into a space inclosed by domes or screens E^2, covered with absorbent porous material F. This absorbent material is kept saturated with water by capillary attraction from a supply of water which is maintained in the bottom of the vessel B for this purpose. For raising the temperature of this water when necessary a coil B′ is arranged in the lower part of the said vessel B and is provided with a cock or valve b^2 to permit of regulating the temperature of the water as required; or I provide a heating-jacket around the lower part of the vessel B for the purpose of raising the temperature of the water. The vessel or chamber B is provided with an outlet-pipe L for the gas, controlled by a cock or valve L′, also with a filling funnel and valve *h* for the introduction of the water and with a drain-cock *i*, whereby it may be emptied when required.

For the purpose of heating the air entering through the pipe D, I provide a suitable air receiver and connections, consisting in this instance of an air-receiver N, comprising a series of tubes N′, through which the air passes and which are heated externally by steam or any other suitable heating medium circulated through an outer vessel or casing having inlet and outlet openings k l and provided on the outlet l to permit of regulating the temperature of the air as required.

The space above the screens E^2 in the water-chamber B is preferably connected with pipe D^2, controlled by a cock or valve D^3, with the air-supply pipe D or with the air-receiver, so that uncarbureted air may when desired be mixed with the gas to dilute the same.

I find that it is not necessary to pass the air used for diluting the gas through the screens or vaporizers in the water-chamber, as in the apparatus described in the said former patent, No. 457,484, and that better results are obtained by the arrangement above described.

Atmospheric air is either forced into the air-reservoir N or is drawn into the apparatus by means of a pump inserted in the outlet or delivery tube L, as may be found most desirable, so as to permit of the gas being used under pressure. The air is heated on its way through the receiver N and enters the space below the screens E in the vessel A, and passing through the absorbent porous material F on the screens E E′ takes up a proportion of hydrocarbon vapor from the liquid hydrocarbon with which the said porous material is saturated, this liquid hydrocarbon having been previously heated to a suitable temperature by means of the coil C′ in the reservoir C. The carbureted air is then conducted through the pipe K into the space beneath the screens E^2 in the vessel B, and passing through the absorbent material on the said screens, which are saturated with water at a suitable temperature, takes up more or less of the vapor of the water. From the vessel B the gas passes out through the pipe L.

Should it be found that the gas is too rich in hydrocarbon vapor and vapor of water, I provide an additional supply of air from the pipe D through the by-pass D^2, this air mixing with the gas in the space above the screens E^2 in the chamber B and diluting it as required.

By the means above described I am enabled to very accurately regulate the temperature of the air and liquid hydrocarbon supplied to the apparatus and also the temperature of the water according to the degree of volatility of the hydrocarbon employed or according to the atmospheric temperature, as may be required. It is desirable to have the air, the hydrocarbon, and the water all at about the same temperature, which will vary somewhat according to the grade of the hydrocarbon employed and other conditions. The water, however, should in no case be converted into steam, but should only be warmed, so as to facilitate to some extent its vaporization when absorbed by the screens or domes.

It will be found most advantageous to heat the air, the liquid hydrocarbon, and the water to such temperatures that the liquid hydrocarbon on the domes or screens of absorbent porous material in the carbureting-chamber A will be at about the same degree of temperature as the air passing through such domes or screens, and the water on the domes or screens of absorbent porous material in the water-chamber B will be at about the same degree of temperature as the carbureted air passing through the domes or screens. The effect of applying the heat to the air, liquid hydrocarbon, and water in this manner is that no deposit of hydrocarbon from the carbureted air will be caused by reduction of the temperature of the carbureted air while the same is taking up the vapor of water. Subsequent cooling of the gas cannot cause condensation of the hydrocarbon vapor for the reason that the mixture of the water-vapor with the carbureted air produces a fixed gas.

In heating the air previous to its passing into the carbureting-chamber regard should be had to the raising of the temperature of the air by compression of the same when it is forced under pressure into the air-receiver, and the temperature of the air and of the liquid hydrocarbon should be maintained at such a degree as to overcome the refrigerating effect of the rapid evaporation in the carbureting-chamber.

To insure the proper flow of the liquid hydrocarbon to the screens through tank G when that is used, I connect the supply tank or reservoir C at its upper end with the air-receiver N or with the air-inlet pipe D by means of the pipe d^2, so that the pressure above the liquid hydrocarbon in the supply tank or receiver C corresponds to that in the carbureting-chamber A.

The gas produced in this manner is useful for a great variety of industrial purposes, more especially those in which great heat is required. It is also useful for lighting purposes in conjunction with mantles or other bodies which can be rendered incandescent by the heat without destroying them.

In lieu of tank G, nozzles J, tubes J′, and valve J^2 any other suitable distributing devices may be employed.

My apparatus may be altered, if desired, in many other respects without departure from my invention.

What I claim is—

1. The improved method herein described of making a fixed gas from air, hydrocarbon and water, said method consisting in carbureting hot air with a hot hydrocarbon vapor and charging the carbureted air with vapor of water below the steam-generating point.

2. The improved method herein described of making a fixed gas from air, hydrocarbon and water, said method consisting in directing a hot-air blast against and past hot particles of hydrocarbon and then directing the hot carbureted air against and past particles of water below the steam-generating point.

3. As a new article of manufacture, a fixed gas made from air, hydrocarbon, and water

by hot carburization of hot air and charging the carbureted air with vapor of water below the steam-generating point.

4. In an apparatus for the manufacture of gas which consists of atmospheric air, hydrocarbon and the vapor of water the combination with the carbureting-chamber A and the water-chamber B connected therewith, of an air-heater N connected with the air-inlet pipe D of said carbureting-chamber, a distributing-tank G in the upper part of said carbureting-chamber, having separately-controlled discharge-pipes J′, an oil-reservoir C, provided with means for heating the oil therein, a pipe *d* provided with a controlling valve or cock *d′* connecting said reservoir with said distributing-tank, and a heater B′ in the lower part of said water-chamber, substantially as and for the purposes above specified.

5. In an apparatus for the manufacture of gas which consists of atmospheric air, hydrocarbon and the vapor of water, the combination with the carbureting-chamber A and the water-chamber B, of an air-heater N connected with the air-inlet pipe D of said carbureting-chamber, a distributing-tank G in the upper part of said carbureting-chamber, an oil-reservoir C, a pipe *d* provided with a controlling valve or cock *d′* connecting said reservoir with said distributing-tank, a pipe d^2 connecting the air-space of said heater with the upper part of said reservoir, and means for heating said reservoir, substantially as and for the purposes specified.

6. In an apparatus for making gas which consists of atmospheric air, hydrocarbon and the vapor of water, the combination, with the screens or domes of absorbent porous material and the distributing-tank for the liquid hydrocarbon arranged above the same in the carbureting-chamber, of the conical or dished screens of absorbent porous material arranged one above another in said chamber between said domes and the distributing-tank, every alternate conical or dished screen being inverted, substantially as and for the purposes set forth.

7. In an apparatus for the manufacture of gas which consists of atmospheric air, hydrocarbon and the vapor of water, the combination with a carbureting-chamber having a screen of absorbent porous material arranged therein; and a water-chamber connected therewith and also provided internally with a screen of absorbent porous material; of an air-heater connected with the air-inlet pipe of said carbureting-chamber; a sprinkling-distributer in the upper part of said carbureting-chamber for sprinkling the oil upon said screens; an oil-reservoir exterior to the carbureting-chamber and provided with means for heating the oil therein; and a pipe provided with a controlling valve or cock connecting said reservoir with said distributer; and a pressure-forming apparatus which produces pressure in the air-carbureting and water chambers.

JOHN HASKINS LADD.

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