(No Model.) 4 Sheets—Sheet 1.

# W. D. & S. PRIESTMAN.

## MOTOR ENGINE OPERATED BY THE COMBUSTION OF LIQUID HYDROCARBON.

No. 386,029. Patented July 10, 1888.

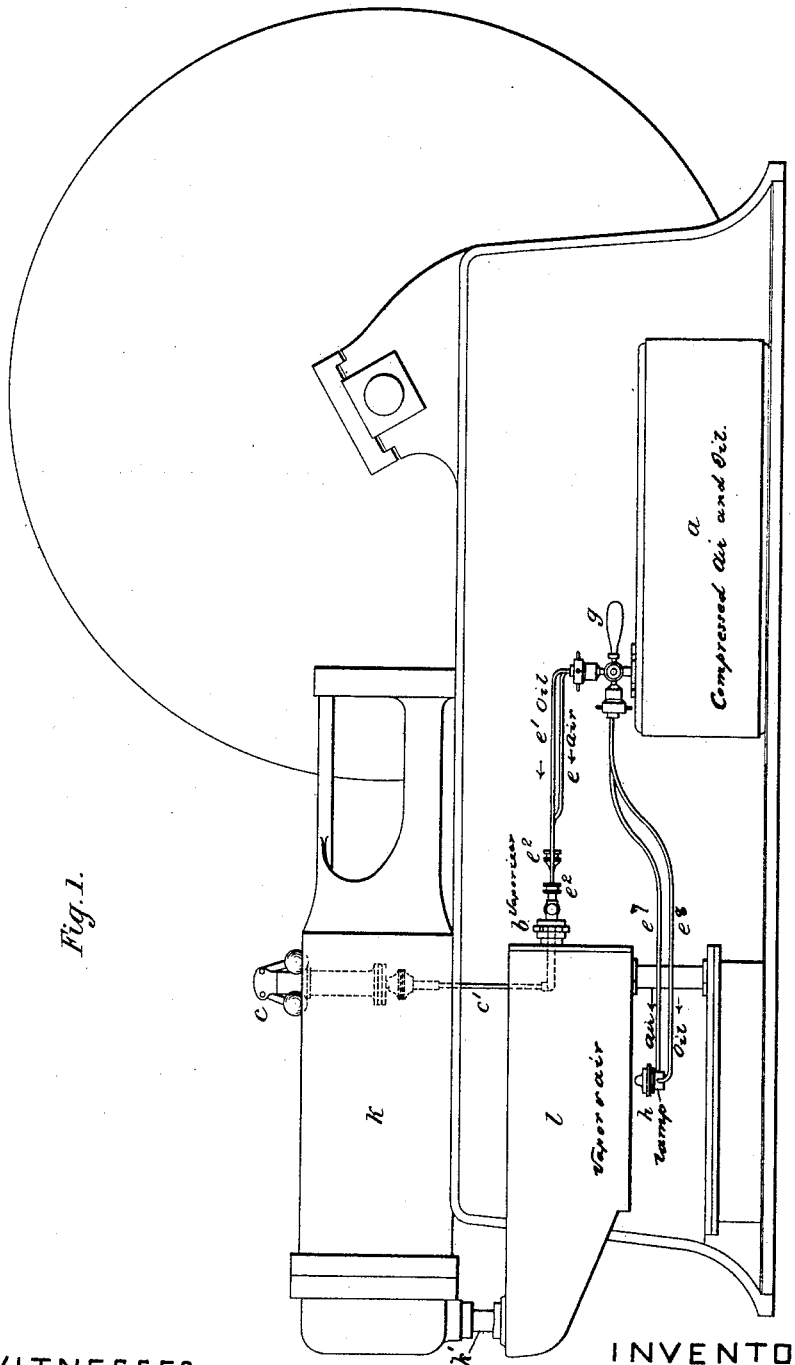


Fig. 1.

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## MOTOR ENGINE OPERATED BY THE COMBUSTION OF LIQUID HYDROCARBON.

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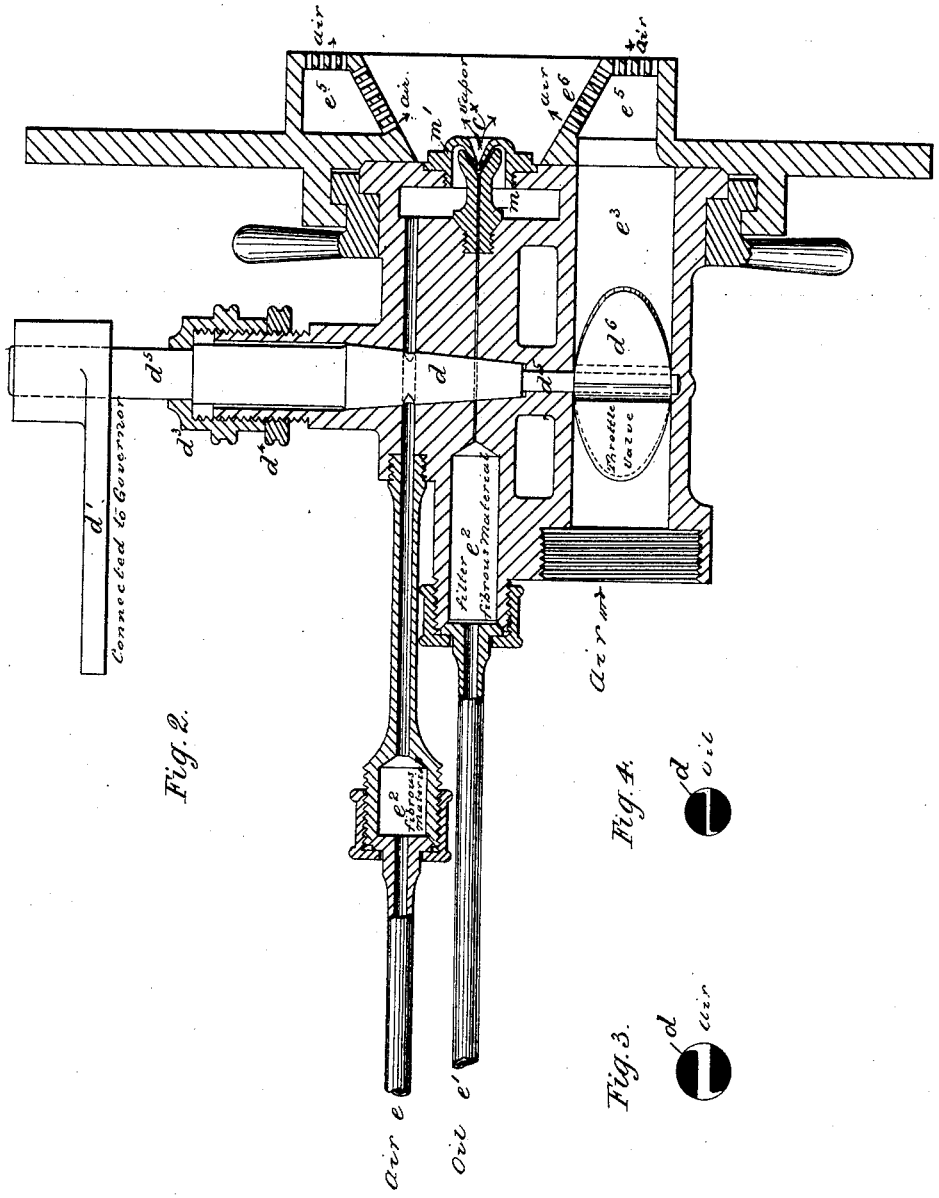


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## MOTOR ENGINE OPERATED BY THE COMBUSTION OF LIQUID HYDROCARBON.

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Fig. 6.

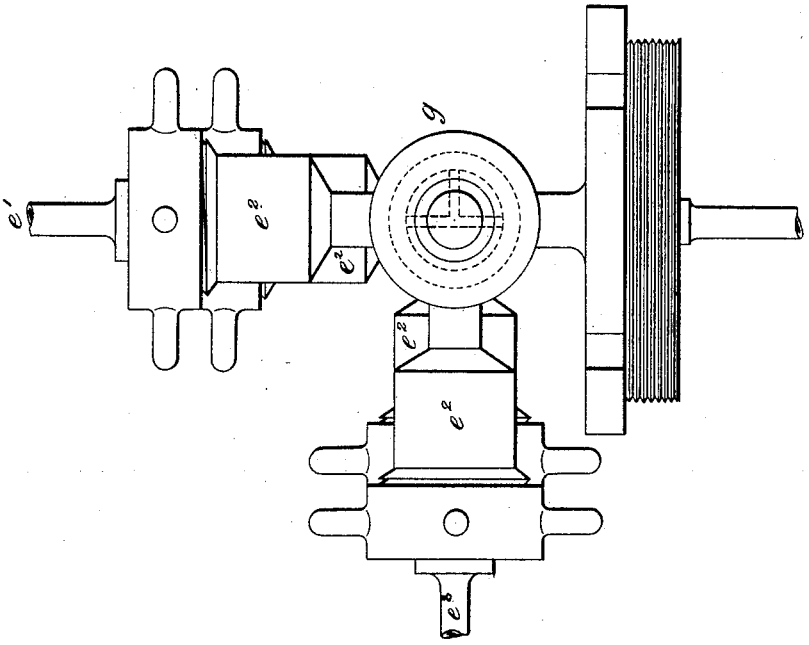
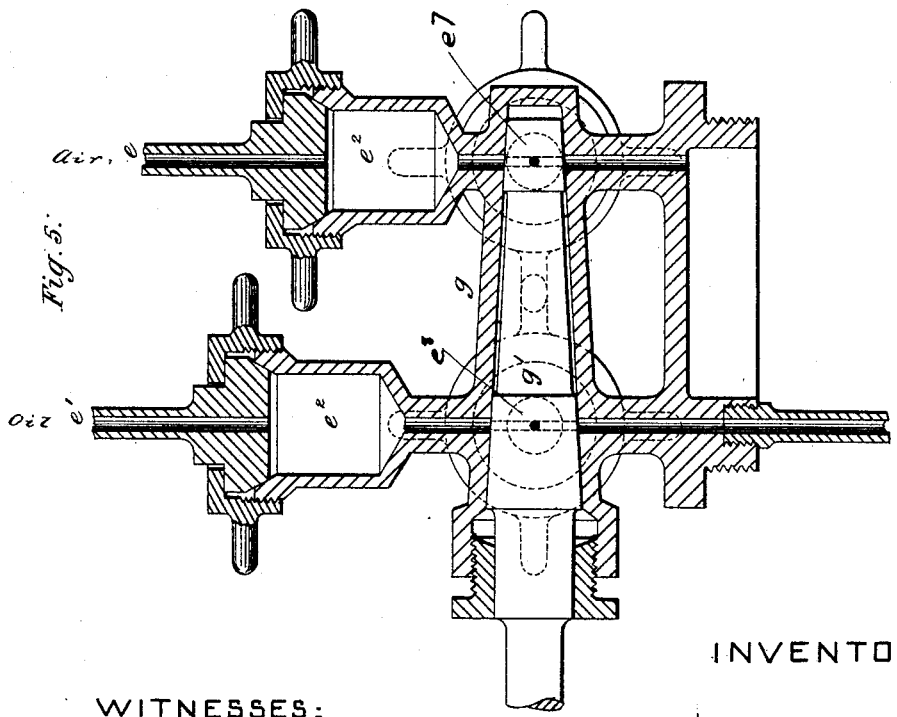



Fig. 5.

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(No Model.) 4 Sheets—Sheet 4.

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## MOTOR ENGINE OPERATED BY THE COMBUSTION OF LIQUID HYDROCARBON.

No. 386,029. Patented July 10, 1888.

*Fig. 7.*

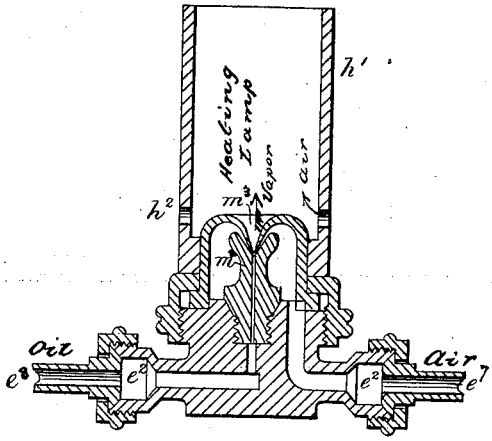



*Fig. 8.*

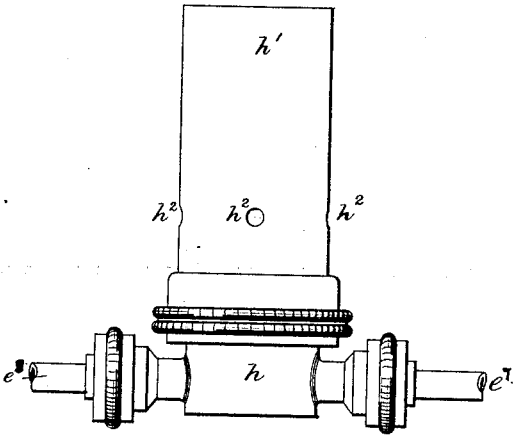
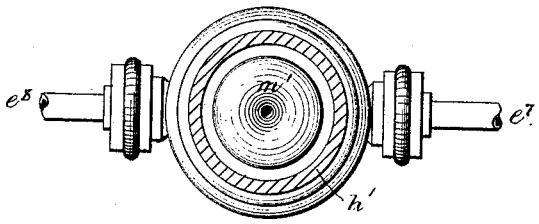



*Fig. 9.*

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# UNITED STATES PATENT OFFICE.

WILLIAM DENT PRIESTMAN AND SAMUEL PRIESTMAN, OF HOLDERNESS FOUNDRY, HULL, COUNTY OF YORK, ENGLAND.

## MOTOR-ENGINE OPERATED BY THE COMBUSTION OF LIQUID HYDROCARBON.

SPECIFICATION forming part of Letters Patent No. 386,029, dated July 10, 1888.

Application filed July 20, 1887. Serial No. 244,892. (No model.) Patented in England December 21, 1886, No. 16,779; in Germany June 8, 1887, No. 43,273; in France June 25, 1887, No. 184,436; in Belgium June 28, 1887, No. 57,833; in Norway July 2, 1887, No. 695; in Italy July 7, 1887, XLIV, 421, and May 22, 1888, XLV, 270; in Cape Colony July 12, 1887, No. 401; in Victoria July 19, 1887, No. 5,188; in Queensland July 22, 1887, No. 298; in New Zealand July 27, 1887, No. 2,449; in South Australia July 29, 1887, No. 848; in New South Wales August 2, 1887, No. 37; in India August 15, 1887, No. 1,073; in Spain August 24, 1887, No. 7,137; in Brazil August 30, 1887, No. 504; in Tasmania September 22, 1887, No. 492/9; in Austria-Hungary December 3, 1887, No. 24,081 and No. 56,741; in Argentine Republic January 4, 1888, No. 634, and in Portugal March 8, 1888, No. 1,223.

*To all whom it may concern:*

Be it known that we, WILLIAM DENT PRIESTMAN and SAMUEL PRIESTMAN, subjects of the Queen of Great Britain and Ireland, of Holderness Foundry, Hull, in the county of York, England, have invented new and useful Improvements in Motor-Engines Operated by the Combustion of Liquid Hydrocarbon, (for which patents have been granted in Great Britain December 21, 1886, No. 16,779; in Germany June 8, 1887, No. 43,273; in France June 25, 1887, No. 184,436; in Belgium June 28, 1887, No. 57,833; in Norway July 2, 1887, No. 695; in Italy July 7, 1887, Vol. XLIV, No. 421, (prolongation May 22, 1888, Vol. XLV, No. 270;) in Cape Colony July 12, 1887, Register Folio 401; in Victoria July 19, 1887, No. 5,188; in Queensland July 22, 1887, No. 298; in New Zealand July 27, 1887, No. 2,449; in South Australia July 29, 1887, No. 848; in New South Wales August 2, 1887, No. 37; in India August 15, 1887, No. 1,073; in Spain August 24, 1887, No. 7,137; in Brazil August 30, 1887, No. 504; in Tasmania September 22, 1887, No. 492/9; in Austria-Hungary December 3, 1887, No. 24,081 and No. 56,741; in Argentine Republic January 4, 1888, No. 634, and in Portugal March 8, 1888, No. 1,223,) of which the following is a specification.

This invention relates to motor-engines operated by the combustion of liquid hydrocarbon mixed with air; and it consists in improved means for mixing the said fluids in regulated quantities and proportions and for heating the inflammable vapor so produced before admission to the motor-cylinder or other combustion-chamber.

In order that our invention may be fully understood, we will proceed to describe the same with reference to the accompanying drawings, whereof Figure 1 represents, partly in longitudinal section, a hydrocarbon-engine embodying our invention. Fig. 2 is a detail sectional view on a large scale of the vaporizer and the valve mechanism for supplying the fluid and liquid thereto in proportionately-regulated quantities. Figs. 3 and 4 are cross-sections of the valve *d* seen in Fig. 2. Figs. 5 and 6 are detail views on a large scale of the valve mechanism controlling the supply of fluid and liquid from the reservoir to the vaporizer or mixing apparatus. Figs. 7, 8, and 9 are detail views on a large scale illustrating the construction of a burner or lamp for heating the vapor in the vaporizing-chamber.

The type of engine employed to illustrate our present improvements corresponds in many respects with that described in the specification to Letters Patent of the United States granted to John Joseph Reveley Humes, and dated October 5, 1886, No. 350,200. The present specification is accordingly directed and, so far as may be, confined to the particular parts or appurtenances to which our improvements appertain.

For regulating the supply of air and liquid hydrocarbon from the reservoir *a* (containing compressed air and petroleum or other liquid hydrocarbon) to the vaporizer or mixing apparatus *b*, we employ valve mechanism controlled by the action of the governor *c*, such valve mechanism being shown to an enlarged scale in Fig. 2, which is a longitudinal mid-section of the device.

*d* is a cock or regulating-valve connected with the governor-spindle *c'*, Fig. 1, by means of the lever *d'*, and serving to control the air and hydrocarbon passages *e* and *e'*. Each of the latter is provided with a chamber, *e²*, packed with cotton wool, or other suitable filtering material, through which the fluids are respectively strained on their passage to the mixing-nozzle *c*.

The valve *d* is retained within its seating and adjusted by means of the screw-cap $d^2$, the latter bearing on a shoulder formed on the valve-spindle $d^3$, and being secured in place by the lock-nut $d^4$. The orifices through the

valve *d*, corresponding, respectively, with the air and hydrocarbon passages *e* and *e'*, are of the shape indicated in Figs. 3 and 4, which are cross-sections of valve *d* taken through the ports or orifices therein, whereby increased facility for regulating the flow of the fluids is afforded. The valve-spindle $d^5$ is prolonged and furnished with a throttle-valve, $d^6$, arranged to work within and to regulate the effective area of the passage $e^3$, through which the supplementary air supply is admitted to the vapor-chamber *l*, Fig. 1. The said supplementary air supply is led from the passage $e^3$ into the annular chamber $e^4$ surrounding the mixing-nozzle $e^\times$, and before entering the vapor-chamber is dispersed through a perforated baffle plate, $e^6$.

The action of the governor causes the inflammable charge drawn into the motor-cylinder *k*, Fig. 1, from the vapor-chamber *l* to become attenuated upon the normal speed of the engine being exceeded, the potency of the inflammable charge being thereby regulated to suit the varying requirements of the work to be performed. As the air-supply valve $d^6$ is on the same stem with the valve *d*, it will readily be seen that the supply controlled by these valves will always be regulated proportionately.

The apparatus we employ for controlling the air and hydrocarbon supply pipes or passages *e e'*, leading from the petroleum-reservoir *a*, Fig. 1, to the vapor-making device *b*, and also for controlling the corresponding passages, $e^7$ $e^8$, to the vapor-heating lamp *h*, is marked *g* in Fig. 1, and is shown to an enlarged scale in vertical section in Fig. 5 and in side elevation in Fig. 6. It comprises a four-way valve, *g'*, arranged in such a manner in relation to the air and hydrocarbon pipes or passages leading from the petroleum-reservoir that in one position of the valve air and oil are conveyed to the vapor-burning lamp *h* through the pipes $e^7$ $e^8$, but are shut off from the vapor-making apparatus *b*. In another position of the valve the supply of air and oil to the lamp is closed and communication through the pipes *e e'* to the vaporizer *b* is opened. In a third position of the valve the supply of air and oil is shut off both to the vapor-making apparatus and to the heating-lamp. Escape from the petroleum-reservoir being under the last-mentioned conditions prevented, pressure may be generated therein either by means of a small hand-pump or by turning the engine by hand and so operating the pump, which serves in regular working for supplying the petroleum-reservoir with compressed air. The valve *g'* is furnished with a lever or hand-wheel, which works against an indicator, showing the positions respectively appropriate, first, for generating pressure in the petroleum-reservoir preliminary to starting the engine, (corresponding with the third position above referred to;) secondly, for heating the vapor-chamber immediately before the engine is started, (corresponding with the first position,) and, thirdly, during regular working, (corresponding with the second position,) when the heat conveyed by the exhaust-gases is available for raising to a suitable temperature the vapor stored in the chamber whence the working-charge is drawn. The apparatus may be mounted upon the petroleum-reservoir, the pipe *e'* extending downward into the liquid.

In the specification to the aforesaid Letters Patent granted to John Joseph Reveley Humes, dated October 5, 1886, there is described and illustrated a device for mixing liquid hydrocarbon with air in the preparation of hydrocarbon vapor, such means including a mixing-nozzle in which two concentric tubes are employed for conveying the liquid and air, respectively, the extremity of the passage for the latter being so formed as to direct the gas obliquely forward against the stream of liquid as it issues from the extremity of the inclosed pipe conveying the same, the two streams meeting at an acute angle and the gas acting to accelerate the fluid of the liquid.

According to our improved construction of vaporized or mixing apparatus, we employ two nozzle-tubes, *m* and *m'*, Fig. 2, connected, respectively, with the two passages *e* and *e'*. The nozzle-tube *m* is embraced or inclosed by the nozzle-tube *m'*, and the current of fluid from passage *e*, flowing through the annular space between tubes *m* and *m'*, is deflected inward and impinges from all sides on the current flowing out through tube *m* in such a manner as to oppose and measurably retard the flow of the latter, and thus effect a more intimate mixing of the fluids. As illustrated in Fig. 2, the deflecting portion of the nozzle-tube *m'* is in the form of a backwardly-directed cone which fits concentrically into a conical recess in the end of the tube *m*, but so as to leave a conical passage for the fluid arriving through passage *e*; but the angle at which the outer current is made to impinge upon the inner may be varied so long as it is not arranged to assist the motion of the latter, but rather to obstruct and retard it. The current arriving through passage *e'* has its own impelling force, and the current through passage *e* is not required to impel it.

By the use of a mixing-nozzle constructed as above described the liquid is more minutely subdivided and dispersed in the gaseous medium, the resultant vapor being more readily ignited and the combustion rendered more perfect.

In Fig. 1, *k'* represents the exhaust-pipe from cylinder *k*, which enters the chamber *l* and connects with a coil therein. The object of this is to heat the vapor in said chamber by means of the waste gases. We do not claim this mode of heating in itself, and therefore have not shown the heating-coil.

For heating the vapor contained in the chamber *l*, besides utilizing the waste gases discharged from the cylinder, we apply a heating-lamp constructed to generate hydrocarbon vapor for its own consumption. This de-

vice (*h*, Fig. 1) is represented to an enlarged scale in the vertical section, Fig. 7, side elevation, Fig. 8, and plan, Fig. 9. It comprises two tubes, $m^2$ $m^3$, one inclosed within the other and shaped and arranged substantially as described with reference to the mixing-nozzle illustrated in Fig. 2, these two tubes being supplied from the petroleum-reservoir *a* with air and liquid hydrocarbon, respectively, by means of the pipes $e^7$ $e^8$. For convenience of manufacture, the straining-chambers $e^2$ are placed on opposite sides of the device. The lamp is provided with a metal chimney, *h'*, perforated with holes $h^2$ for the admission of air, such chimney or tube acting not only as a wind-guard, but serving to heat the vapor and promote its combustion.

For convenience, we call the vessel *a* the "petroleum-reservoir," although it contains an aeriform fluid as well as a liquid, and it may contain any suitable liquid hydrocarbon.

We have employed $e^2$ to represent throughout the straining-chambers, as these are all alike or may be alike.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. A motor-engine operated by the combustion of hydrocarbon vapor, having valves, as *d* and $d^6$, controlling proportionately the supply of air and liquid hydrocarbon, a heater that heats the vapor, and a three-way valve, as *g*, which controls the supply of air and liquid hydrocarbon from the petroleum-reservoir, all arranged to operate substantially as described.

2. In a hydrocarbon-engine, the combination, with the vapor-chamber, as *l*, the petroleum-reservoir, as *a*, a vapor-burner, as *h*, for heating the vapor in chamber *l*, and a mixer, as *b*, for preparing the vapor, of pipes, as *e* and *e'*, which supply air and liquid hydrocarbon to the mixer *b* from the reservoir *a*, pipes, as $e^7$ and $e^8$, which supply air and liquid hydrocarbon to the vapor-burner *h* from said reservoir, and a three-way cock, as *g*, controlling the passage of air and liquid hydrocarbon through said pipes, substantially as set forth.

3. In a hydrocarbon-engine, the combination, with a valve, as *d*, controlling an air-passage, as *e*, and a hydrocarbon-passage, as *e'*, of a valve, as $d^6$, connected with valve *d* and moving therewith, said valve $d^6$ controlling an air-passage, as $e^3$, whereby the flow of air through passage $e^3$ is regulated proportionately to the flow of air and liquid through passages *e* and *e'*, substantially as set forth.

4. In a valve mechanism for regulating the supply of air and liquid hydrocarbon to a hydrocarbon-vapor engine, the combination, with the two passages, as *e* and *e'*, for the aeriform fluid and liquid hydrocarbon, respectively, and each provided with a straining-chamber, as $e^2$, of the valve, as *d*, controlling said passages, substantially as set forth.

5. In a hydrocarbon-engine, the construction of vaporizer for mixing a liquid hydrocarbon with a gas capable of supporting combustion, and comprising two nozzle-tubes, one arranged within the other, the outer one being formed, as set forth, to cause the fluid conveyed thereby to be deflected inward against the stream of fluid issuing from the inner nozzle-tube and to measurably retard or obstruct the same, substantially as and for the purpose set forth.

6. In a hydrocarbon-engine, the combination, with the vessel for the liquid hydrocarbon, the heating-lamp, as *h*, and a vaporizer, as *b*, of the pipes for conveying air and liquid hydrocarbon to said lamp and vaporizer, and a three-way valve controlling said pipes, whereby the air and liquid hydrocarbon may be supplied to either the lamp or vaporizer at will, or be cut off from both, as set forth.

7. In combination with a vapor-chamber, such as *l*, to which a supplementary air-supply is admitted, the annular passage $e^5$, and perforated baffle-plate $e^6$, surrounding the vapor-inlet and serving to equally distribute the additional air among the vapor in the preparation of the working-charge.

8. In a valve mechanism for regulating the supply of air and hydrocarbon to a hydrocarbureted-air engine, the combination, with the two passages, as *e* and *e'*, for the air and hydrocarbon, respectively, of a valve, as *d*, provided with passages, whereof the extremities are formed with enlargements which vanish in a circumferential direction, substantially as and for the purposes set forth.

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