G. L. CROOK.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED SEPT. 24, 1908.

931,389. Patented Aug. 17, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

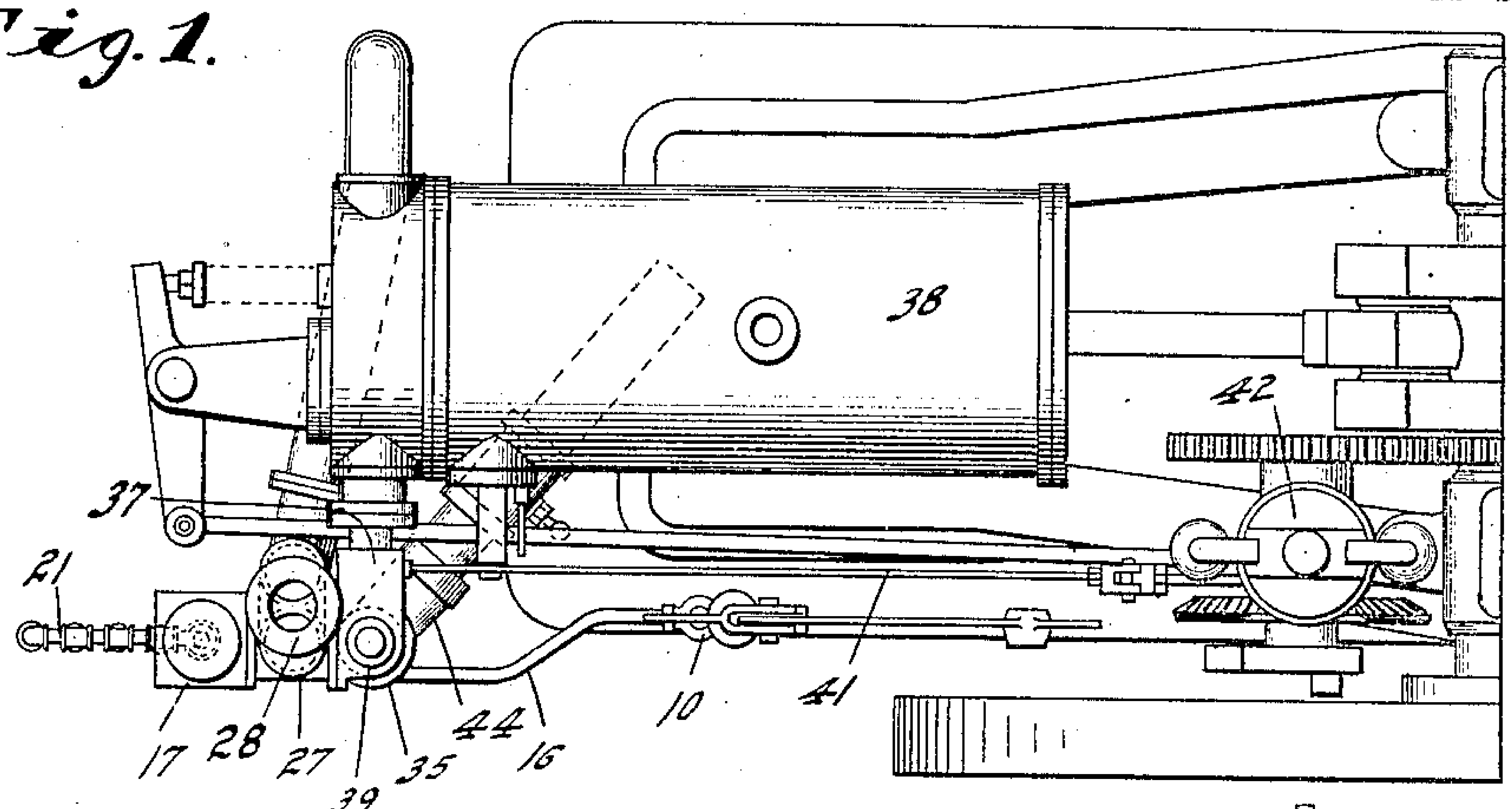


Fig. 2.

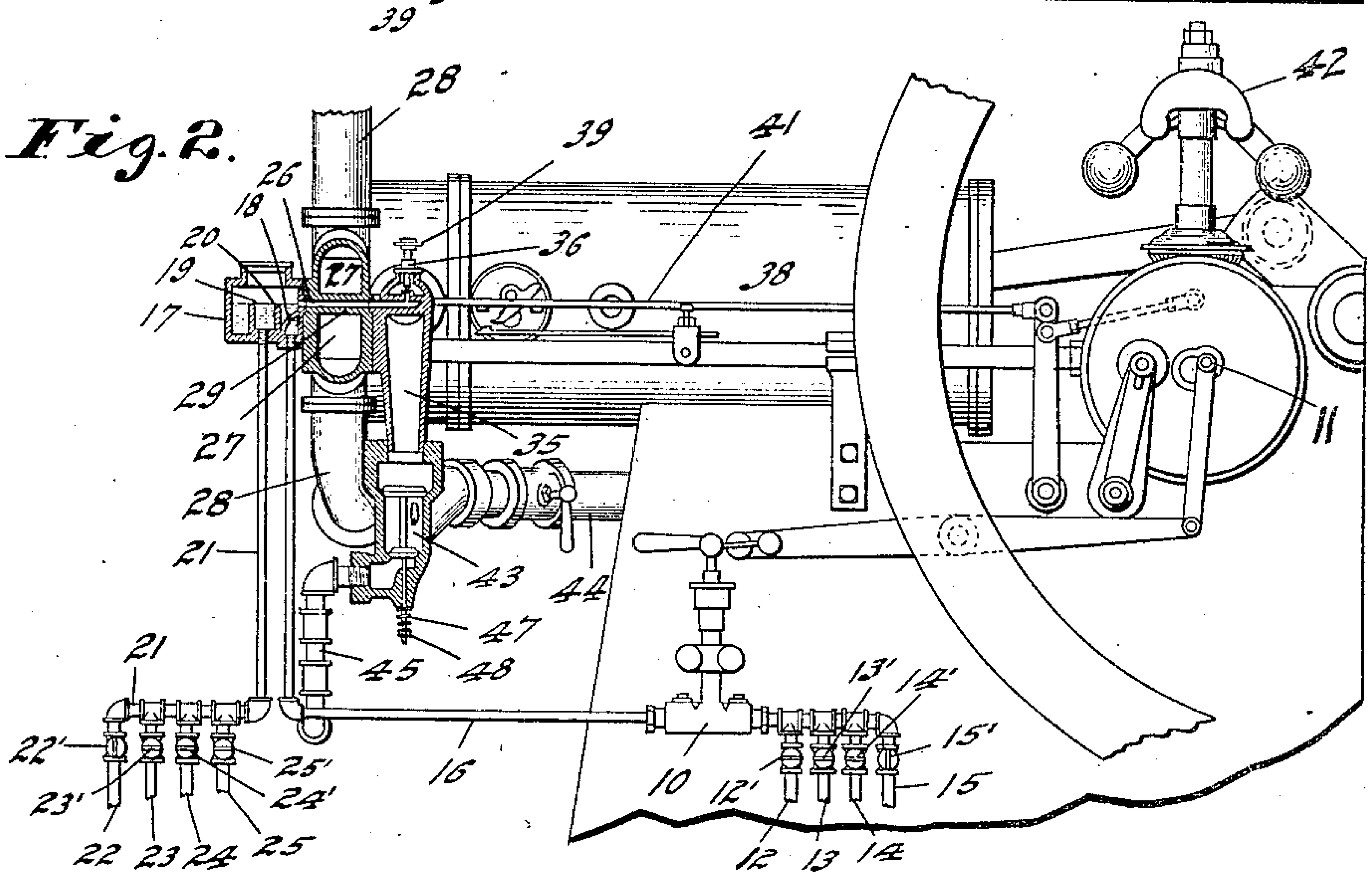
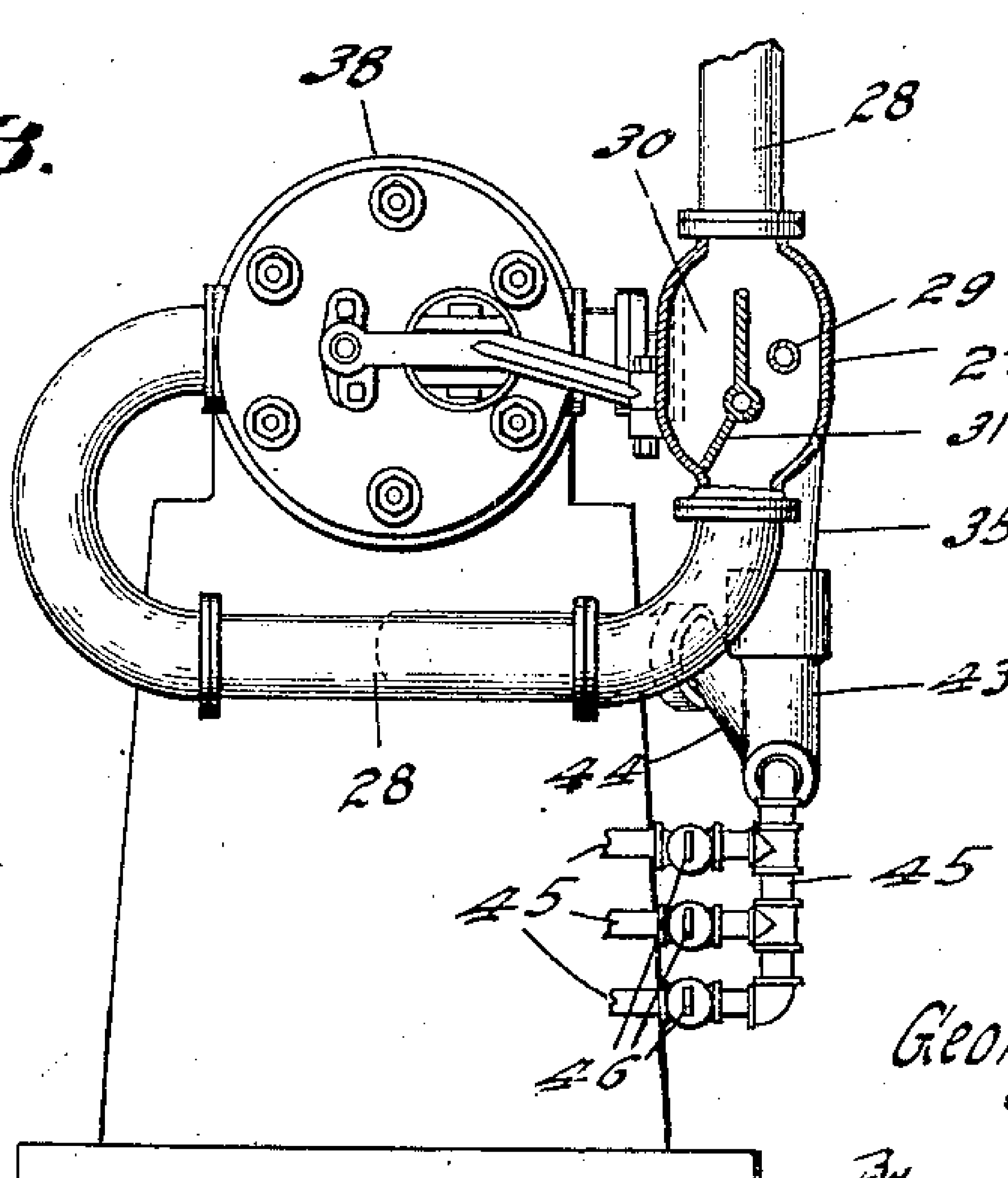


Fig. 3.



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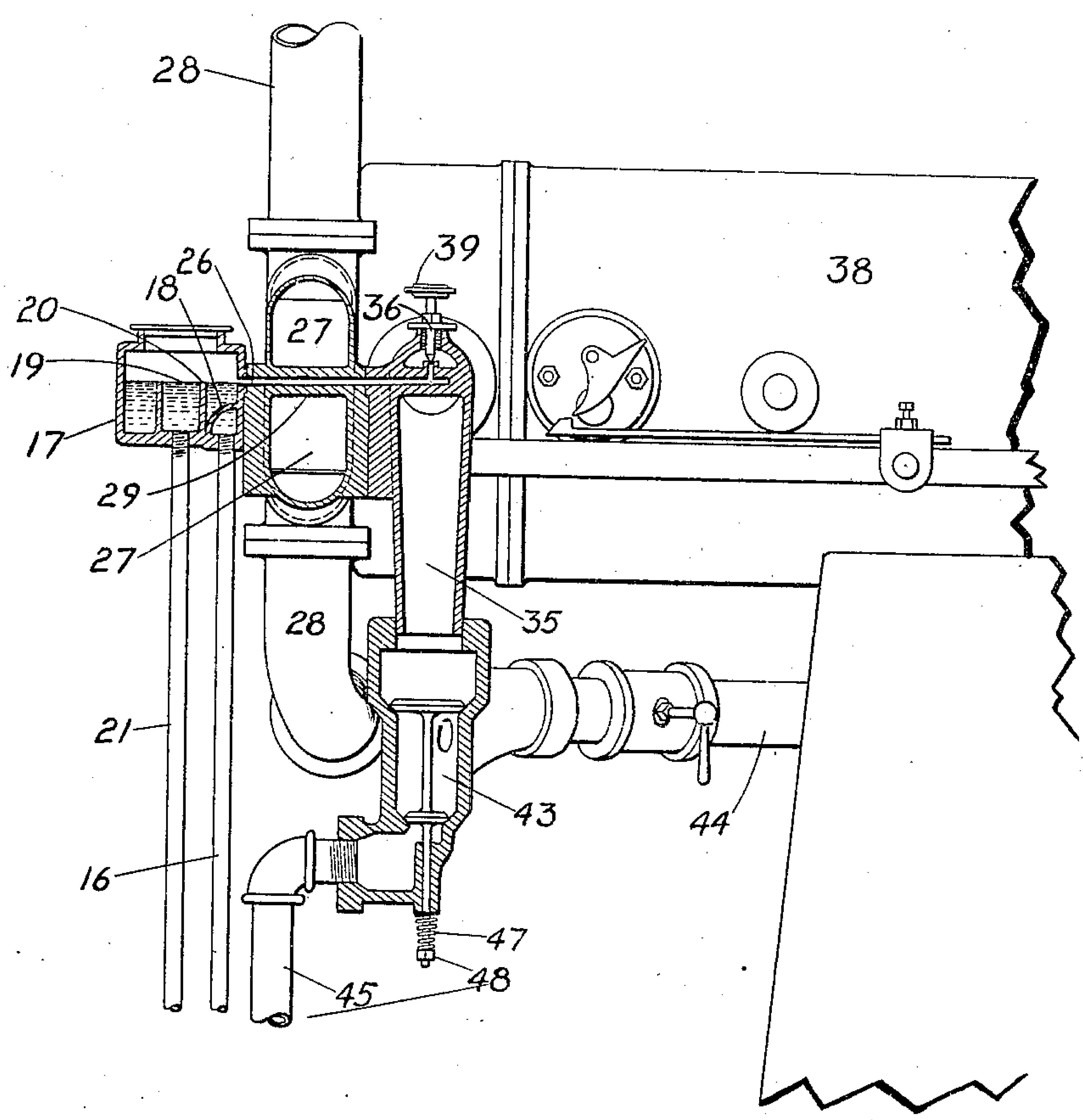
2 SHEETS—SHEET 2.

Fig. 4.



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UNITED STATES PATENT OFFICE.

GEORGE LOUIS CROOK, OF INDIANAPOLIS, INDIANA, ASSIGNOR TO ATLAS ENGINE WORKS, TRUSTEE, OF INDIANAPOLIS, INDIANA, A CORPORATION OF INDIANA.

INTERNAL-COMBUSTION ENGINE.

No. 931,389. Specification of Letters Patent. Patented Aug. 17, 1909.

Application filed September 24, 1908. Serial No. 454,660.

To all whom it may concern:

Be it known that I, George Louis Crook, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention has relation to that class of machines wherein, by means of the combustion, within a cylinder, of a mixture of atmospheric air with a liquid, vaporous or gaseous fuel, heat and pressure against a piston are produced, which by suitable mechanism, is transformed into motive power. Such a piece of machinery is known as "an internal combustion engine." Many different kinds of fuel, such as mineral oil, crude petroleum, naphtha, petrol, coal oil distillate, gasolene, kerosene, methol, alcohol, natural gas, illuminating gas, producer gas, etc., have been utilized in such engines. But as each kind of fuel requires peculiar treatment with regard to the conditions of introduction into the cylinder, proportionate admixture of air, etc., it has been the practice hitherto to build each engine with particular reference to the kind of fuel intended to be used, as it has been found impracticable with any apparatus hitherto devised to change from one kind of fuel to another without such modifications in the construction of the engine as rendered the change inconvenient, expensive and unsatisfactory. The demand for a cheaper and more convenient motor than the steam engine has, for this reason, called into the market a bewildering variety of gas engines, vapor engines, gasolene engines, oil engines and alcohol engines, which has greatly complicated the business of engine building. I have discovered, however, that with a properly designed and adjustable fuel supplying apparatus, the conditions of the introduction of the fuel and the proportioning of its admixture with air may be so controlled that any variety of gaseous or liquid fuel may be successfully used in any internal combustion engine of proper construction, without the removal or substitution of any part, or any change other than the proper manipulation of the adjustments provided. Such an apparatus would, of course, be novel, and obviously useful. To provide it is the object of my invention.

Investigation has shown me that in order to burn with sufficient speed for practical use in an internal combustion engine, all fuels must be introduced into the cylinder in a gaseous state, or at least in such state of fine division as approximates that condition, and properly mixed in the required proportions with air. Permanent gases, such as natural, illuminating and producer gas, require only the proper admixture of air in the proportions indicated by their chemical constitution, compression and ignition, to secure perfect combustion. The required proportion of air is such that at the moment of ignition each particle of combustible will find itself in contact with a quantity of atmospheric oxygen slightly in excess of that necessary for its perfect combustion. Then the energy developed by the combustion will be directly proportional to the thermic efficiency of the gas consumed. Very volatile liquids, such as gasolene, are converted into an inflammable vapor by a current of air drawn through or over them, and this mixture of air and vapor may be treated as a gas in the further proportionate admixture of air before introduction into the cylinder. The dynamic result, upon ignition, will be, as with a permanent gas, in proportion to the thermic content of the mixture, considered as a gas. Less volatile fluids, such as kerosene, "distillate," alcohol, crude oil, etc., to be reduced by the current of air to a state of sufficiently fine division to insure their burning with sufficient speed for perfect combustion, require to be heated in proportion to their lack of volatility.

Internal combustion engines must operate at the highest practicable speed, in order to insure the conversion of the greatest possible percentage of the thermic efficiency of the fuel into mechanical energy. The slower this conversion is effected, the greater will be the proportion of the heat diffused through the cylinder and lost in the water-jacket which is necessary to preserve the lubrication of the rubbing surfaces of cylinder and piston. If the rate of combustion be too slow, there will not be sufficient time for perfect combustion during the working stroke of the piston, and a portion of the fuel will be discharged with the exhaust from the engine, unburned. Nor must the fuel be heated so highly as to convert it into a hot vapor. That will not only cause the fuel to occupy an undue amount of space, but will heat and expand the air it mixes with, and so lessen the development of power by diminishing the density of the charge. It will also tend to preignition, or "backfiring." The degree of heating allowed must be just enough to secure the best result. This demands an effective heating apparatus with ready means of adjustment. The fuel thus vaporized, or atomized, should pass at once through a mixer having the required means of adjustment so as to insure its admixture with the proper proportion of air due to the character of the fuel; and before any separation or segregation can take place it should pass on through a throttle valve, which determines the quantity of the charge to be admitted, and so on into the engine cylinder, to be compressed and ignited. The charge will thus always be of uniform proportions, as required by the kind of fuel and determined by the adjustments. The quantity of each charge necessary, to carry the engine's load and maintain its speed, will be determined by the throttle valve, which will be under the control of the governor.

In most engines heretofore devised employing liquid fuel, much trouble has been experienced from the tendency of such fluids to decompose and form a carbonaceous deposit within the cylinder and upon the valves of the engine. This arises from overheating the charge in the presence of air insufficient for perfect combustion. The more volatile component of the liquid (hydrogen) having a greater affinity for oxygen than the less volatile (carbon) burns and leaves a portion of the latter nothing to combine with, so, being in its uncombined state a solid, nothing else can occur but a deposit. But if the supply be so regulated that an excess of oxygen is always present, combustion will be complete and no such deposit can occur.

The accompanying drawings illustrate my invention.

Figure 1 is a plan of an engine cylinder equipped with my improved fuel supplying apparatus; Fig. 2 a side elevation in partial section; Fig. 3 an end elevation in partial section, and Fig. 4 a detail on a larger scale, of parts shown in Fig. 2.

The cylinder and all other details of the engine proper may be of any suitable construction, having an automatic inlet valve, a positively operated exhaust valve and a centrifugal governor. With the particular construction and arrangement of these details, my invention has nothing to do, requiring in this respect only what may be considered good engineering practice. My invention relates solely to the method and apparatus for supplying fuel; which I will now proceed to describe.

For supplying liquid fuels, I provide a pump 10 of suitable construction, having the necessary suction and delivery valves and piping to draw the fuel from a tank or reservoir (not shown), located in any safe and convenient place. This pump is supported by attachment to some part of the engine bedplate or foundation where it may conveniently be driven from a wrist 11 on the cam gear, or by attachment to some other moving part of the engine. A rotary, or any other sort of pump might serve equally well.

It is obvious that, if it be desired to have choice of two or more kinds of liquid fuel, as for instance, gasolene, which does not require to be heated and is convenient to start the engine with when cold, and kerosene, petroleum distillate or alcohol, for use after the engine is warmed up, the pump suction may be divided into as many branches 12, 13 14, 15 as may be desired, each controlled by its proper valve or cock 12′, 13′, 14′, 15′ and connected with a separate tank or reservoir for each kind of fuel. The change from one to another will then require only the manipulation of the proper cocks and the regulation of the feed and air valves. The delivery pipe 16 of the pump 10 discharges into a "constant level" basin 17. This is a receiver of any convenient size and shape which will serve the purpose. The liquid is delivered under a kind of baffle 18 designed to quell any disturbance of the level of the liquid in the basin due to the current in the delivery pipe. The stream striking this baffle is directed downward where it enters the main compartment of the basin through a wide but shallow opening. In the center of the basin is an overflow opening 19 surrounded by a ledge 20 which rises to about mid-height of the receiver. The relative sizes of the delivery and overflow orifices are such that the liquid flowing over the ledge will escape through the overflow so freely that the level of the liquid will remain practically constant, notwithstanding any variation of the speed of the pump. From the overflow opening leads a pipe 21 which may be divided into a number of branches 22, 23, 24, 25, each controlled by a cock or valve 22′, 23′, 24′, 25′. These branch pipes carry back to their respective tanks or reservoirs the excess of whatever kind of liquid fuel the supply pump is serving. In the side of the basin 17 so placed that about one-fourth of its area is always beneath the level of the liquid, is an opening 26 through which a spray of the liquid fuel, mingled with air, is drawn by the suction of the engine's piston. The side of the basin containing this opening is flanged and provided with bolts whereby it is fastened to a heater 27 which is essentially a part or branch of the engine's exhaust pipe 28. Passing through the heater in such a position as to constitute a continuation of the opening 26 is a heater pipe 29 the farther end of which is higher than the one connecting with the basin 17, through the opening 26, so that the liquid can not flow by gravity through the pipe, but can only be drawn through it by the current of air sucked through by the engine. The pipe 29 being surrounded by the more or less hot exhaust passing through the heater, the spray of liquid drawn through it is heated to the required degree. This is regulated by providing the heater 27 with a by-pass 30 and a switch valve, 31 whereby more or less of the exhaust from the engine may be diverted into either channel. The side of the heater 27 which is opposite from the basin 17 is also furnished with a flange and bolts, whereby it is fastened to a mixer 35 the heater pipe 29 connecting within the mixer through a passage controlled by a needle valve 36 through which the fuel spray is drawn into the body of the mixer.

Air entering through the bottom of the mixer mingles with the fuel spray and the mixture passes onward through the butterfly throttle valve 37 into the engine's cylinder 38. The proper admixture of spray and air is regulated by adjusting the opening of the needle valve 36 by means of its handwheel 39. The rod 41 of the valve 37 is connected to the centrifugal governor 42 the motion of which, derived from the engine, determines the amount of the mixture drawn into the cylinder for each charge. Attached to the bottom of the mixer 35 is a gas valve 43 to which is connected one air supply pipe 44 and several gas pipes 45 each with its proper cock or valve 46 and connection with the main or gas holder supplying a particular kind of gas. The proportions of gas and air are regulated by adjusting the tension of the spring 47 by means of the nut 48.

To change from the use of one kind of fuel to another, simply shut off the supply of that which is being used, by means of the cock in its supply pipe, and open the cock which controls the supply of the fuel desired. Then make such adjustment in the heater, mixer and air valves as may be required. This can be done without stopping the engine or more than momentarily interfering with its economical performance.

Of course it is not to be supposed that any one engine will, in practice, be equipped for every kind of fuel. The object of so showing this engine is merely to demonstrate how readily a change may be made from one kind of fuel to another if the proper means of adjustment be provided, and to show that in view of my invention, it is not necessary to provide a different engine for each different kind of fuel, nor even to make any material change in the construction of an engine to adapt it to the use of any particular kind of fuel, if it be provided with the means of adjustment described, which constitute my invention. The kind of fuel which will be used in an engine is generally known at the time of its installation, and the pipe connections for that alone need be made, the orifices for the supply of other kinds being simply plugged up. Thus, a dealer receiving an order for an internal combustion engine may select from his stock one of suitable dimensions and equip it for the particular fuel mentioned in the order. If it is to burn liquid fuel exclusively, he may leave off the gas valve 43. Or, if gas only is to be used, he may disconnect the parts, 10 and 17 close the needle valve 36 and connect the supply pipes of the gas to be used, plugging up other orifices.

It will be noted that the heater structure 27 is arranged between the inlet structure and the liquid-fuel container and in practice I find it desirable to finish the opposed faces of this heater structure and the coöperating faces of the liquid-fuel container and the inlet structure in the same way so that the parts may be associated as shown in Fig. 2 or the heater structure may be eliminated and the liquid fuel container attached directly to the inlet structure. By this arrangement it becomes possible to immediately furnish a customer either with the structure as shown in Fig. 2, and capable of handling the heavier liquid-fuels, or to furnish a customer with a structure intended only for the use of those lighter liquid-fuels which do not require preliminary heating.

I claim as my invention:—

1. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a valved main gas passage communicating therewith, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, and a liquid-fuel container communicating with said fuel passage.

2. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a plurality of independent valved gas passages communicating with said main gas passage beyond the valve thereof, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, and a liquid-fuel container communicating with said fuel passage.

3. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a valved main gas passage communicating therewith, a plurality of independent valved gas passages

communicating with said main gas passage beyond the valve thereof, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, and a liquid-fuel container communicating with said fuel passage.

4. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, a liquid-fuel container communicating with said fuel passage, and a plurality of independent valved feed-pipes for said liquid-fuel container.

5. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a valved main gas passage communicating therewith, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, a liquid-fuel container communicating with said fuel passage, and a plurality of independent valved feed-pipes for said liquid-fuel container.

6. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a plurality of independent valved gas passages communicating with said main gas passage beyond the valve thereof, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, a liquid-fuel container communicating with said fuel passage, and a plurality of independent valved feed-pipes for said liquid-fuel container.

7. The combination, with an internal combustion engine, of an inlet structure therefor comprising an air passage, a valved main gas passage communicating therewith, a plurality of independent valved gas passages communicating with said main gas passage beyond the valve thereof, a heating structure comprising a main chamber in communication with the exhaust passage of the engine, a fuel tube extending through said chamber, said fuel tube communicating with the interior of the inlet structure, a liquid-fuel container communicating with said fuel passage, and a plurality of independent valved feed-pipes for said liquid-fuel container.

8. The combination, with an internal combustion engine, of an inlet structure therefor comprising a main gas passage and a fuel passage leading into said main passage from one side, a heating structure comprising a main passage and a fuel tube passing therethrough, the said heating structure having at each end of the fuel passage a finished surface adapted to coöperate with the liquid fuel container at one end and the inlet structure at the other end, and a damper structure arranged within said chamber to regulate the flow of exhaust through said chamber relative to the fuel tube.

9. The combination, with an internal combustion engine, of an inlet structure therefor comprising a main gas passage and a fuel passage leading into said main passage from one side, a liquid fuel container having a face adapted to coöperate with the fuel tube of the inlet structure, a heating structure comprising a main passage and a fuel tube passing therethrough, the said heating structure having at each end of the fuel passage a finished surface adapted to coöperate with the liquid fuel container at one end and the inlet structure at the other end, and a damper structure arranged within said chamber to regulate the flow of exhaust through said chamber relative to the fuel tube.

In witness whereof, I, have hereunto set my hand and seal at Indianapolis, Indiana, this 17th day of September, A. D. one thousand nine hundred and eight.

GEORGE LOUIS CROOK. [L. S.]

Witnesses:

ARTHUR M. HOOD,

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