C. R. RADCLIFFE.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 30, 1909.

975,796. Patented Nov. 15, 1910.

Fig. 1

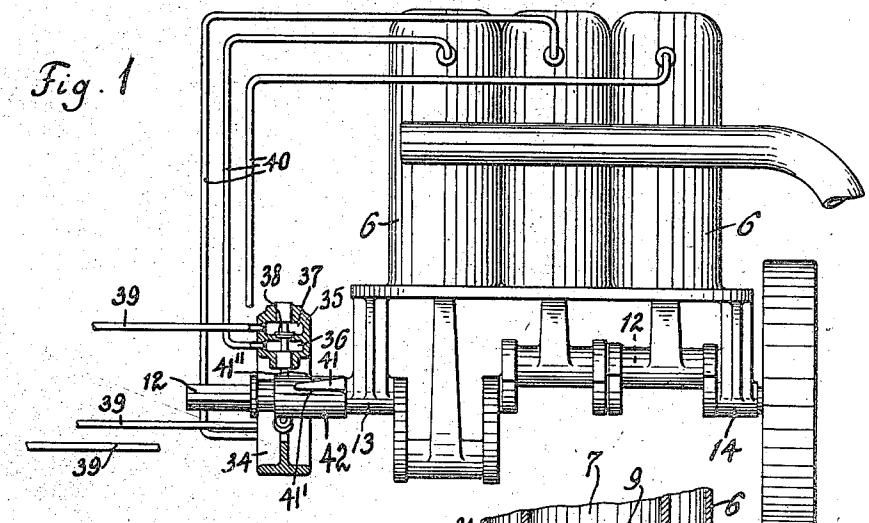

Fig. 3

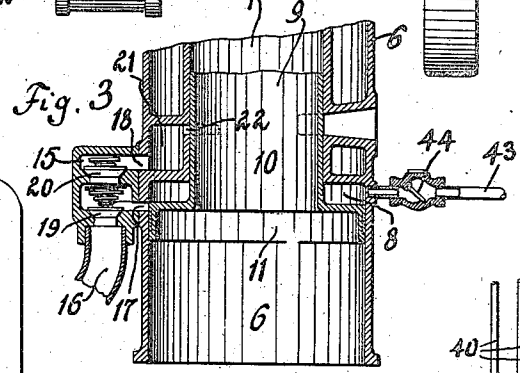

Fig. 2

Fig. 4

Fig. 5

WITNESSES

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INTERNAL-COMBUSTION ENGINE.

975,796. Specification of Letters Patent. Patented Nov. 15, 1910.

Application filed June 30, 1909. Serial No. 505,203.

To all whom it may concern:

Be it known that I, CARLTON R. RADCLIFFE, a citizen of the United States, and resident of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

The present invention relates to improvements in internal combustion engines, into the combustion chambers of which is introduced either a liquid or gaseous fuel or combustible, and mixed therein with a supply of air to produce a complete combustion of the fuel.

Heretofore there have been used variable stroke pumps for injecting the liquid fuel into the cylinders of the engine, and more particularly an individual pump for each cylinder of the engine. As the stroke of these pumps is only a very small fraction of an inch, it is almost impossible to properly adjust the stroke in order to vary the quantity of the fuel to be injected.

One of the objects of the present invention is to obviate the defect, mentioned, of the devices heretofore in use, and to provide a single means for controlling the quality and the flow of the fuel to all of the cylinders of the engine.

A further object is to provide a single means for controlling the quantity of the liquid or gaseous hydrocarbon injected into the cylinders of the engine.

Other objects of the invention will be apparent from a reading of the specification and an examination of the drawings, forming part of the present application for Letters Patent.

To attain these ends, the invention consists, essentially, in the combination and arrangement with an internal combustion engine of a suitable mixing chamber, wherein a predetermined quantity of liquid fuel, or in other words, liquid hydrocarbon, is mixed with air enough to carry the hydrocarbon in a vaporized or partially vaporized state to the cylinders of the engine; this mixing chamber is combined with a single means, controlling the flow of the overrich combustible mixture to the said cylinders.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a sectional elevation of an internal combustion engine embodying the invention, Fig. 2 shows a diagrammatic arrangement of the invention, Fig. 3 a vertical section taken through one of the cylinders of the engine, Fig. 4 a detail of construction, and Fig. 5 a section taken on line 5, 5 of Fig. 4.

In the drawings, the numeral 6 indicates the cylinders of the engine, which may be of any desired number and type. In the particular case illustrated, double diameter cylinders are shown, comprising the working chambers 7 and pump chambers 8, in which work the pistons 9, consisting of the working portions 10 and the pump portions 11. The pistons are connected in the usual manner with the crank-shaft 12, journaled in the bearings 13 and 14, arranged upon the frame of the engine.

Upon the down stroke of the pistons, pure air is drawn into the pump cylinders which is, upon the upstroke, transferred into the working chambers of the same. For this purpose a common transfer passage 15 is provided, to which lead supply pipes 16. This transfer passage comprises a port 17 for each pump cylinder and ports 18 for the distributing chamber 21. A supply valve 19 and a transfer valve 20 is provided for each cylinder, controlling the communications between the atmosphere and the pump cylinders and the pump cylinders and working chambers, respectively.

In operation, a valve 19 is lifted from its seat on the down stroke of its corresponding piston, whereby air is drawn through the pipe 16 and passage 17 into the corresponding pump cylinder, which is then forced upon the up stroke of the piston, in lifting the valve 20, into the distributing chamber 21, wherefrom it will flow into a working chamber when its corresponding inlet 22 is uncovered by the working portion 10 of the piston.

The mechanism, thus far described, operates in a well known manner, and does not form an essential part of the invention, as the same could be used in connection with internal combustion engines of any type, in which pure air is drawn and compressed.

A supply of liquid hydrocarbon is stored in a reservoir 23, connected by means of a pipe 24 to a float chamber 25, which in turn is connected to a valve casing 26, terminating in a nozzle 27, controlled by a needle

valve 28, or its equivalent. The float 29 of the float chamber is adjusted so as to close the pipe 24, leading thereto, as soon as the level of liquid reaches a height slightly below the nozzle 27, mentioned.

A mixing chamber 30 is provided, which is connected by means of a pipe 31 to a supply of fluid pressure, such as, for instance, compressed air, and into which pipe leads the nozzle 27, hereinbefore described. This nozzle should terminate in the pipe 31, preferably, near to the mixing chamber, or the nozzle may lead into the said mixing chamber itself. The pipe 31 is connected by means of pipes 32 and 33 to the liquid fuel reservoir 23 and the float chamber 25, respectively, so as to equalize the pressure on the liquid fuel.

The liquid being vaporized or partially vaporized, passes as an overrich gas mixture from the mixing chamber 30 into the distributer 34. This distributer consists of a stationary casing, supported in any suitable manner concentrically with and upon the crankshaft 12, and comprises a plurality of valve chambers 35, 35, equal in number to the number of cylinders of the engine. Each valve casing is divided into two compartments 36 and 37, the communication between which is controlled by a valve 38, in each casing. The compartments 37 of the valve casings are connected by pipes 39, 39, to the mixing chamber 30, while each of the compartments 36 is connected by an individual pipe 40, 40 to its corresponding cylinder.

The valves 38 are operated by a single cam 41, mounted, preferably, upon a sleeve 42, shiftably arranged upon the crankshaft 12, in the rotation of which it participates. The valves are arranged in the distributer 34 at the angular distances of the cranks, and the angular position of the cam relative to the cranks is fixed upon the crankshaft in such a manner that the valves will open a communication between the mixing chamber 30 and a cylinder for a predetermined time between the end of the exhaust and the point of ignition in either two- or in four-cycle engines. The communication remains open, as mentioned, for a predetermined time, depending upon the position of the cam 41 upon the crankshaft 12. The cam is shown, in Fig. 1 of the drawings, as a variable stroke cam, the edge 41′ of which is arranged in a horizontal line, whereby the valves are closed always at the same time irrespective of the position of the cam upon the crankshaft, while the edge 41″ is tapered, lifting thereby the valves at a predetermined time, which depends upon the position of the cam upon the crankshaft.

The supply of fluid pressure may be carried along with the engine, or a pump, operated by the engine, may supply the same, or, finally, the fluid pressure tank may be connected by means of a pipe or pipes 43 to one or more of the pump cylinders 8, and more particularly at or near the upper ends of the same. A check valve 44, opening toward the tank, may be inserted in the pipes 43. Obviously upon the up stroke of the pistons, and after the ports 17 thereof are closed by said pistons, the air, still remaining in the pump cylinders, will be further compressed and forced into the tank, mentioned.

The operation of the engine is as follows: A charge of pure air is forced into the working cylinders of the engine and in the manner above described; the cam 41 of the distributer, being in the desired position relative to the valves, will open communications between the mixing chamber 30 and the cylinders in succession and in an order in which the cylinders are firing. As soon as a valve is lifted from its seat, compressed air will rush into the mixing chamber and, passing by the nozzle 27, vaporize a certain quantity of liquid fuel, and carry the same through the valve chamber and the corresponding pipe into the corresponding cylinder. The quantity of the liquid fuel fed to a cylinder depends, of course, upon the angular distance of the cam through which the valve remains open, and can be varied therefore by the setting of the variable lift cam. Another way to vary the quantity and quality of the gaseous mixture, fed to the cylinders, would be to vary by means of the needle valve the nozzle mouth 27. In other words, the device described, may be provided with a fixed nozzle mouth and with a variable lift cam, or with a needle valve and a cam which lifts the valves always through the same angular distance, or with the combination of both devices.

It is obvious, that the pressure in the fluid pressure tank must be always above the compression pressure in the cylinders of the engine at a point where the supply of fuel is cut off by the valves 38 of the distributer. The charge is, preferably, injected at or near the top of the combustion chambers, so that when a very small amount of fuel is injected, corresponding, for instance, to a throttle condition of the engine, the charge will be characterized or localized, and a positive ignition insured, while if the same amount of fuel was entirely diffused throughout the working chamber, the resultant mixture would be, as a whole, too lean or too weak to be readily ignited, and consequently the running of the engine would be irregular. The ignition plugs of the engine are, preferably, placed so that the sparking points of the same are located at or near to the center of the characterized or localized injected charge.

As mentioned hereinbefore, the invention may be applied also to four cycle engines, in which case, of course, the distributer is operated by a cam mounted upon the cam-shaft of such engine. When used in connection with a convertible four and two cycle engine, the arrangement shown in Figs. 4 and 5 may be made use of, in which the numeral 45 indicates the crank shaft of the engine, operating the cam-shaft 46 in the usual manner at the ratio of two revolutions of the crankshaft to one revolution of the camshaft. Upon the camshaft 46 is mounted a sleeve 47, adapted to be shifted in the direction of the longitudinal axis of said shaft. This sleeve carries thereon a cam 48, extending almost through the whole length of the sleeve, and a cam 49, arranged at a diametrically opposite point to the cam 48, and extending through a distance which corresponds about to one-half the length of the cam 48. If the sleeve is shifted so that both cams 48 and 49 act upon the valves of the distributer, fuel will be injected into the combustion chambers upon each up stroke of the pistons, while when the sleeve is shifted so that only cam 48 acts upon the valves, fuel will be admitted upon every second upward stroke of the pistons.

It will be observed that the mixing chamber and the distributer may be made use of when, instead of the liquid hydrocarbon, hydrocarbon gas is fed to the cylinders, which are charged with pure air in the manner hereinbefore described. Obviously such hydrocarbon gas must be compressed to a point above the pressure existing in the engine cylinders at that point of the compression stroke where the fuel admission ceases. In such case, of course, the float chamber and needle valve is not needed, and only a single pipe will lead from the compressed hydrocarbon gas container to the mixing chamber, in which pipe may be inserted a regulating valve for obvious reasons. The operation of the engine in such case would be exactly the same as with liquid hydrocarbon fuel and compressed air.

What I claim is:

1. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a single means for forming an overrich mixture of air and hydrocarbon under pressure, and means common to all of the cylinders of the engine adapted to direct the flow of said mixture to said cylinders during a predetermined time between the end of the exhaust stroke and the point of ignition.

2. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a single means for forming an overrich mixture of air and hydrocarbon under pressure, and means common to all of the cylinders of the engine adapted to direct the flow of said mixture to said cylinders in an order in which the same are firing.

3. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, and means adapted to control said communications between said chamber and said cylinders.

4. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and means for operating said valves.

5. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and a cam for operating said valves.

6. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and a single means for operating said valves.

7. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and means for operating said valves so as to open a communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

8. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to

said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and a cam for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

9. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and a single means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

10. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and means for operating said valves so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means to vary the length of time during which said communications are open.

11. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, a cam for operating said valves so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means to vary the length of time during which said communications are open.

12. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, a single means for operating said valves so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means to vary the length of time during which said communications are open.

13. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, and means for operating said valves so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for varying the relative positions between said valve operating means and valves, whereby the length of time during which the communications between said chamber and said cylinders are open is varied.

14. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, a cam for operating said valve so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for varying the relative positions between said cam and valves, whereby the length of time during which the communications between said chamber and said cylinders are open is varied.

15. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, means for furnishing an overrich mixture of air and hydrocarbon under pressure to said mixing chamber, a communication between each cylinder and said chamber, a valve in each communication, a single means for operating said valves so as to open the communication between each cylinder and said chamber some time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for varying the relative positions between said valve operating means and valves, whereby the length of time during which the communications between said chamber and said cylinders are open is varied.

16. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is sup-

plied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and means for operating said valves.

17. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and a cam for operating said valves.

18. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and a single means for operating said valves.

19. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

20. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and a cam for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

21. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, and a single means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder.

22. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, means for operating said valve, and means for adjusting the mouth of said nozzle.

23. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a cam for operating said valves, and means for adjusting the mouth of said nozzle.

24. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a single means for operating said valves, and means for adjusting the mouth of said nozzle.

25. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for adjusting the mouth of said nozzle.

26. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a cam for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for adjusting the mouth of said nozzle.

27. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a single means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and means for adjusting the mouth of said nozzle.

28. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, means for operating said valves, and a needle-valve for regulating the mouth of said nozzle.

29. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a cam for operating said valves, and a needle-valve for regulating the mouth of said nozzle.

30. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a single means for operating said valves, and a needle-valve for regulating the mouth of said nozzle.

31. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and a needle-valve for regulating the mouth of said nozzle.

32. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, a cam for operating said

valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and a needle-valve for regulating the mouth of said nozzle.

33. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a mixing chamber, a tank containing a fluid pressure, a pipe leading from said tank to said mixing chamber, a container for a supply of liquid hydrocarbon, a connection leading from said container to said pipe and terminating in a nozzle therein, a communication between each cylinder and said mixing chamber, a valve in each communication, single means for operating said valves so as to open the communication between each cylinder and said chamber during a predetermined time between the end of the exhaust stroke and the point of ignition in the respective cylinder, and a needle-valve for regulating the mouth of said nozzle.

34. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a single means for forming an overrich mixture of air and hydrocarbon under pressure, and means adapted to direct the flow of said mixture to said cylinders during a predetermined time between the end of the exhaust stroke and the point of ignition.

35. In an internal combustion engine, the combination with the cylinders of an engine having inlets through which pure air is supplied to the same, of a single means for forming an overrich mixture of air and hydrocarbon under pressure, and means adapted to direct the flow of said mixture to said cylinders in an order in which the same are firing.

Signed at New York, in the county of New York and State of New York, this 3rd day of June, A. D. 1909.

CARLTON R. RADCLIFFE.

Witnesses:
SIGMUND HERZOG,
S. BIRNBAUM.