This invention relates to a device for obtaining an intimate contact between a liquid in a vaporous state and a gas, and particularly to such a device which may serve as a carburettor for internal combustion engines.

Carburettors commonly used for supplying a combustible mixture of air and liquid fuel to internal combustion engines, comprise a bowl in which a supply of the fuel is maintained in the liquid phase and a fuel jet which extends from the liquid fuel into a passage through which air is drawn by the suction of the engine cylinders. On the suction, or intake stroke of the cylinders, air is drawn over and around the fuel jet and a charge of liquid fuel is drawn in, broken up and partially vaporised during its passage to the engine cylinders. However, I have found that in such carburettors, a relatively large amount of the atomised liquid fuel is not vapourised and enters the engine cylinder in the form of microscopic droplets. When such a charge is ignited in the engine cylinder, only that portion of the liquid fuel which has been converted into the vaporous (molecular) state, combines with the air to give an explosive mixture. The remaining portion of the liquid fuel which is drawn into the engine cylinders and remains in the form of small droplets, does not explode and impart power to the engine, but burns with a flame and raises the temperature of the engine above that at which the engine operates most efficiently, i.e. 160° to 180°F.

According to this invention, a carburettor for internal combustion engines is provided in which substantially all of the liquid fuel entering the engine cylinder will be in the vapour phase and consequently, capable of combining with the air to form a mixture which will explode and impart a maximum amount of power to the engine, and which will not burn and unduly raise the temperature of the engine.

A mixture of air and liquid fuel in truly vapour phase in the engine cylinder is obtained by vaporising all, or a large portion of the liquid fuel before it is introduced into the intake manifold of the engine. This is preferably done in a vaporising chamber, and the “dry” vaporous fuel is drawn from the top of this chamber into the intake manifold on the intake or suction stroke of the engine. The term “dry” used here refers to the fuel in the vaporous phase which is at least substantially free from droplets of the fuel in the liquid phase, which on ignition would burn rather than explode.

More particularly, the invention comprises a carburettor embodying a vaporising chamber in the bottom of which, a constant body of liquid fuel is maintained, and in the top of which there is always maintained a supply of “dry” vaporised fuel, ready for admission into the intake manifold of the engine. The supply of vaporised liquid fuel is maintained by drawing air through the supply of liquid fuel in the bottom of the vaporising chamber, and by constantly atomising a portion of the liquid fuel so that it may more readily pass into the vapour phase. This is preferably accomplished by a double-acting suction pump operated from the intake manifold, which forces a mixture of the liquid fuel and air against a plate located within the chamber. To obtain a more complete vaporisation of the liquid fuel, the vaporising chamber and the incoming air are preferably heated by the exhaust gasses from the engine. The carburettor also includes means for initially supplying a mixture of air and vaporised fuel so that starting the engine will not be dependent on the existence of a supply of fuel vapours in the vaporising chamber.

The invention will be further described in connection with the accompanying drawings, but this further disclosure and description is to be taken as an exemplification of the invention and the same is not limited thereby except as is pointed out in the claims.
Fig. 1 is an elevational view of a carburettor embodying my invention.

Fig. 2 is a vertical cross-sectional view through the centre of Fig. 1.

Fig. 3 is a horizontal sectional view on line 3--3 of Fig. 2.
Fig. 4 is an enlarged vertical sectional view through one of the pump cylinders and adjacent parts of the carburettor.

Fig. 5 is an enlarged view through the complete double-acting pump and showing the associated distributing valve.
Fig. 6 is an enlarged vertical sectional view through the atomising nozzle for supplying a starting charge for the engine.

Fig. 7 and Fig. 8 are detail sectional views of parts 16 and 22 of Fig. 6.

Fig. 9 and Fig. 10 are detail sectional views showing the inlet and outlet to the cylinders of the atomising pump.
Referring to the drawings, the numeral 1 indicates a combined vaporising chamber and fuel bowl in which liquid fuel is maintained at the level indicated in Fig. 1 by a float-valve 2 controlling the flow of liquid fuel through pipe 3 which leads from the vacuum tank or other liquid fuel reservoir.

The vaporising chamber 1 is surrounded by a chamber 4 through which hot exhaust gasses from the engine, enter through pipe 5 located at the bottom of the chamber. These gasses pass around the vaporising chamber 1 and heat the chamber, which accelerates the vaporisation of the liquid fuel. The gasses then pass out through the upper outlet pipe 6.

Chamber 4 for the hot exhaust gasses, is in turn surrounded by chamber 7 into which air for vaporising part of the liquid fuel in chamber 1 enters through a lower intake pipe 8. This air passes upwards through chamber 4 through which the hot exhaust gasses pass, and so the air becomes heated. A portion of the heated air then passes though pipe 9 into an aerator 10, located in the bottom of the vaporising chamber 1 and submerged in the liquid fuel in it. The aerator 10 is comprised of a relatively flat chamber which extends over a substantial portion of the bottom of the chamber and has a large number of small orifices 11 in its upper wall. The heated air entering the aerator passes through the orifices 11 as small bubbles which then pass upwards through the liquid fuel. These bubbles, together with the heat imparted to the vaporising chamber by the hot exhaust gasses, cause a vaporisation of a portion of the liquid fuel.

Another portion of the air from chamber 7 passes through a connection 12 into passage 13, through which air is drawn directly from the atmosphere into the intake manifold. Passage 13 is provided with a valve 14 which is normally held closed by spring 14a, the tension of which may be adjusted by means of the threaded plug 14b. Passage 13 has an upward extension 13a, in which is located a choke valve 13b for assisting in starting the engine. Passage 13 passes through the vaporising chamber 1 and has its inner end communicating with passage 15 via connector 15a which is secured to the intake manifold of the engine. Passage 15 is provided with the usual butterfly valve 16 which controls the amount of fuel admitted to the engine cylinders, and consequently, regulates the speed of the engine.

The portion of passage 13 which passes through the vaporising chamber has an opening 17 normally closed by valve 17a which is held against its seat by spring 17b, the tension of which may be adjusted by a threaded plug 17c. As air is drawn past valve 14 and through passage 13 on the intake or suction stroke of the engine, valve 17a will be lifted from its seat and a portion of the dry fuel vapour from the upper portion of the vaporising chamber will be sucked into passage 13 through opening 17 and mingle with the air in it before entering passage 15.
In order to regulate the amount of air passing from chamber 7 to aerator 10 and into passage 13, pipe 9 and connection 12 are provided with suitable valves 18 and 19 respectively. Valve 18 in pipe 9 is synchronised with butterfly valve 16 in passage 15. Valve 19 is adjustable and preferably synchronised with butterfly valve 16 as shown, but this is not essential.

The bottom of passage 15 is made in the form of a venturi 20 and a nozzle 21 for atomised liquid fuel and air is located at or adjacent to the point of greatest restriction. Nozzle 21 is preferably supplied with fuel from the supply of liquid fuel in the bottom of the vaporising chamber, and to that end, a member 22 is secured within the vaporising chamber by a removable threaded plug 23 having a flanged lower end 24. Plug 22 extends through an opening in the bottom of chamber 1, and is threaded into the bottom of member 22. This causes the bottom wall of chamber 1 to be securely clamped between the lower end of member 22 and flange 24, thus securely retaining member 22 in place.

Plug 23 is provided with a sediment bowl 24 and extending from bowl 24 are several small passages 25 extending laterally, and a central vertical passage 26. The lateral passages 25 register with corresponding passages 27 located in the lower end of member 22 at a level lower than that at which fuel stands in chamber 1, whereby liquid fuel is free to pass into bowl 24.

Vertical passage 26 communicates with a vertical nozzle 28 which terminates within the flaring lower end of nozzle 21. The external diameter of nozzle 26 is less than the interior diameter of the nozzle 21 so that a space is provided between them for the passage of air or and vapour mixtures. Nozzle 26 is also provided with a series of inlets 29, for air or air and vapour mixtures, and a fuel inlet 30. Fuel inlet 30 communicates with a chamber 31 located in the member 22 and surrounding the nozzle 28. Chamber 30 is supplied with liquid fuel by means of a passage 32 which is controlled by a needle valve 33, the stem of which, extends to the outside of the carburettor and is provided with a knurled nut 34 for adjusting purposes.

The upper end of member 22 is made hollow to provide a space 35 surrounding the nozzles 21 and 28. The lower wall of the passage 13 is provided with a series of openings 35a, to allow vapours to enter space 35 through them. The vapours may then pass through inlets 29 into the nozzle 28, and around the upper end of the nozzle 28 into the lower end of nozzle 21.

Extending from chamber 31 at the side opposite passage 32, is a passage 36 which communicates with a conduit 37 which extends upwards through passage 13, and connects through a lateral extension 39, with passage 15 just above the butterfly valve 16. The portion of conduit 37 which extends through passage 13 is provided with an orifice 39 through which air or air and fuel vapour may be drawn into the conduit 37 mingle with and atomise the liquid fuel being drawn through the conduit. To further assist in this atomisation of the liquid fuel passing through conduit 37, the conduit is restricted at 40 just below orifice 39.

The upper end of conduit 37 is in communication with the atmosphere through opening 41 through which air may be drawn directly into the upper portion of the conduit. The proportion of air to combustible vapours coming through conduit 37 is controlled by needle valve 42.

As nozzle 21 enters directly into the lower end of passage 15, suction in the inlet manifold will, in turn, create a suction on nozzle 21 which will cause a mixture of atomised fuel and air to be drawn directly into the intake manifold. This is found to be desirable when starting the engine, particularly in cold weather, when there might not be an adequate supply of vapour in the vaporising chamber, or the mixture of air and vapour passing through passage 13 might be to “lean” to cause a prompt starting of the engine. At such times, closing the choke valve 13b will cause the maximum suction to be exerted on nozzle 21 and the maximum amount of air and atomised fuel to be drawn directly into the intake manifold. After the engine has been started, only a small portion of the combustible air and vapour mixture necessary for proper operation of the engine is drawn through nozzle 21 as the choke valve will then be open to a greater extent and substantially all of the air and vapour mixture necessary for operation of the engine will be drawn through the lower end 20 of passage 15, around nozzle 21.

Conduit 37 extending from fuel chamber 31 to a point above butterfly valve 16 provides an adequate supply of fuel when the engine is idling with vale 16 closed or nearly closed.

The casings forming chambers 1, 4 and 7, will be provided with the necessary openings, to subsequently be closed, so that the various parts may be assembled, and subsequently adjusted or repaired.

The intake stroke of the engine creates a suction in the intake manifold, which in turn causes air to be drawn past spring valve 14 into passage 13 and simultaneously a portion of the dry fuel vapour from the top of vaporising chamber 1 is drawn through opening 17 past valve 17a to mix with the air moving through the passage. This mixture then passes through passage 15 to the intake manifold and engine cylinders.
The drawing of the dry fuel vapour into passage 13 creates a partial vacuum in chamber 1 which causes air to be drawn into chamber 7 around heated chamber 4 from where it passes through connection 12 and valve 19, into passage 13 and through pipe 9 and valve 18 into aerator 10, from which it bubbles up through the liquid fuel in the bottom of chamber 1 to vaporise more liquid fuel.

To assist in maintaining a supply of dry fuel vapour in the upper portion of vaporising chamber 1, the carburettor is provided with means for atomising a portion of the liquid fuel in vaporising chamber 1. This atomising means preferably is comprised of a double-acting pump which is operated by the suction existing in the intake manifold of the engine.

The double-acting pump is comprised of a pair of cylinders 43 which have their lower ends located in the vaporising chamber 1, and each of which has a reciprocating pump piston 44 mounted in it. Pistons 44 have rods 45 extending from their upper ends, passing through cylinders 46 and have pistons 47 mounted on them within the cylinders 46.

Cylinders 46 are connected at each end to a distributing valve V which connects the cylinders alternately to the intake manifold so that the suction in the manifold will cause the two pistons 44 to operate as a double-acting suction pump.

The distributing valve V is comprised of a pair of discs 48 and 49 between which is located a hollow oscillatable chamber 50 which is constantly subjected to the suction existing in the intake manifold through connection 51 having a valve 52 in it. Chamber 50 has a pair of upper openings and a pair of lower openings. These openings are so arranged with respect to the conduits leading to the opposite ends of cylinders 46 that the suction of the engine simultaneously forces one piston 47 upwards while forcing the other one downwards.

The oscillatable chamber 50 has a T-shaped extension 53. The arms of this extension are engaged alternately by the upper ends of the piston rods 45, so as to cause valve V to connect cylinders 46 in sequence to the intake manifold.

Spring 54 causes a quick opening and closing of the ports leading to the cylinders 46 so that at no time will the suction of the engine be exerted on both of the pistons 47. The tension between discs 48 and 49 and the oscillatable chamber 50 may be regulated by screw 55.

The particular form of the distributing valve V is not claimed here so a further description of operation is not necessary. As far as the present invention is concerned, any form of means for imparting movement to pistons 47 may be substituted for the valve V and its associated parts.

The cylinders 43 are each provided with inlets and outlets 56 and 57, each located below the fuel level in chamber 1. The inlets 56 are connected to horizontally and upwardly extending conduits 58 which pass through the carburettor to the outside. The upper ends of these conduits are enlarged at 59 and are provided with a vertically extending slot 60. The enlarged ends 59 are threaded on the inside to accept plugs 61. The position of these plugs with respect to slots 60 determines the amount of air which may pass through the slots 60 and into cylinder 43 on the suction stroke of the pistons 44.

The upper walls of the horizontal portions of conduits 58 have an opening 62 for the passage of liquid fuel from chamber 1. The extent to which liquid fuel may pass through these openings is controlled by needle valves 63, whose stems 64 pass up through and out of the carburettor and terminate in knurled adjusting nuts 65.

The horizontal portion of each conduit 58 is also provided with a check valve 66 (shown in Fig.10) which allows air to be drawn into the cylinders through conduits 58 but prevents liquid fuel from being forced upwards through the conduits on the down stroke of pistons 44.

Outlets 57 connect with horizontal pipes 67 which merge into a single open-ended pipe 68 which extends upwards. The upper open end of this pipe terminates about half way up the height of the vaporising chamber 1 and is provided with a bail 69 which carries a deflecting plate 70 positioned directly over the open end of pipe 68.

The horizontal pipes 67 are provided with check valves 71 which permit the mingled air and fuel to be forced from cylinders 43 by the pistons 44, but which prevent fuel vapour from being drawn from chamber 1 into cylinders 43.

When operating, pistons 44 on the ‘up’ strokes, draw a charge of air and liquid fuel into cylinders 43, and on the ‘down’ stroke, discharge the charge in an atomised condition through pipes 67 and 68, against deflecting plate 70 which further atomises the particles of liquid fuel so that they will readily vaporise. Any portions of the liquid fuel which do not vaporise, drop down into the supply of liquid fuel in the bottom of the vaporising chamber where they
are subjected to the vaporising influence of the bubbles of heated air coming from the aerator 10, and may again pass into the cylinders 43.

As previously stated, the vaporised fuel for introduction into the intake manifold of the engine, is taken from the upper portion of the vaporising chamber 1. To ensure that the vapour in this portion of the chamber shall contain no, or substantially no, entrained droplets of liquid fuel, chamber 1 is divided into upper and lower portions by the walls 71 and 72 which converge from all directions to form a central opening 73. With the vaporising chamber thus divided into upper and lower portions which are connected only by the relatively small opening 73, any droplets entrained by the bubbles rising from the aerator 10, will come into contact with the sloping wall 72 and be deflected back into the main body of liquid fuel in the bottom of the chamber. Likewise, the droplets of atomised fuel being forced from the upper end of pipe 68 will, on striking plate 70, be deflected back into the body of liquid fuel and not pass into the upper portion of the chamber.

In order that the speed of operation of the atomising pump may be governed by the speed at which the engine is running, and further, that the amount of air admitted from chamber 7 to the aerator 10, and to passage 13 through connection 12, may be increased as the speed of the engine increases, the valves 18, 19 and 52 and butterfly valve 16 are all connected by a suitable linkage L so that as butterfly valve 16 is opened to increase the speed of the engine, valves 18, 19 and 52 will also be opened.

As shown in Fig.2, the passage of the exhaust gasses from the engine to the heating chamber 4, located between the vaporising chamber and the air chamber 7, is controlled by valve 74. The opening and closing of valve 74 is controlled by a thermostat in accordance with the temperature inside chamber 4, by means of an adjustable metal rod 75 having a high coefficient of expansion, whereby the optimum temperature may be maintained in the vaporising chamber, irrespective of the surrounding temperature.

From the foregoing description, it will be understood that the present invention provides a carburettor for supplying to internal combustion engines, a comiled mixture of air and liquid fuel vapour free from microscopic droplets of liquid fuel which would burn rather than explode in the cylinders and that a supply of such dry vaporised fuel is constantly maintained in the carburettor.

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