

July 21, 1959

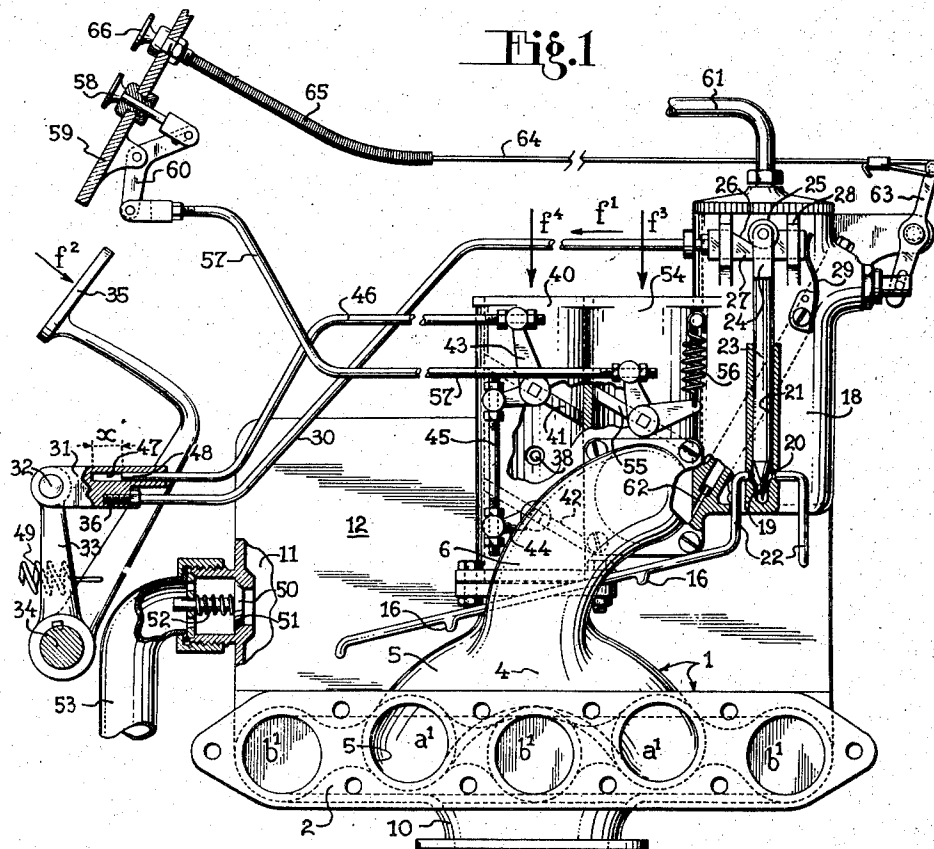
M. CHAMP

2,895,462

FEED DEVICE FOR AN INTERNAL COMBUSTION ENGINE

Filed Dec. 11, 1957

3 Sheets-Sheet 1



INVENTOR
MARCEL CHAMP
BY *Diggins & LeBlanc*
ATTORNEYS

July 21, 1959

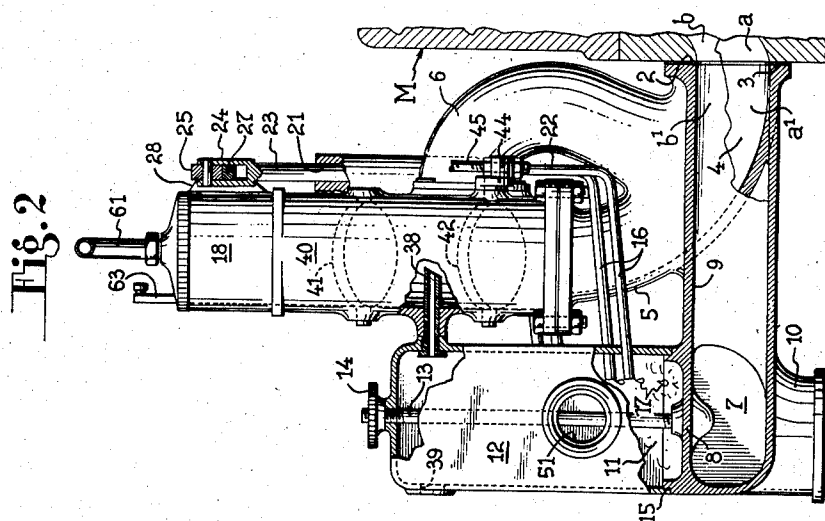
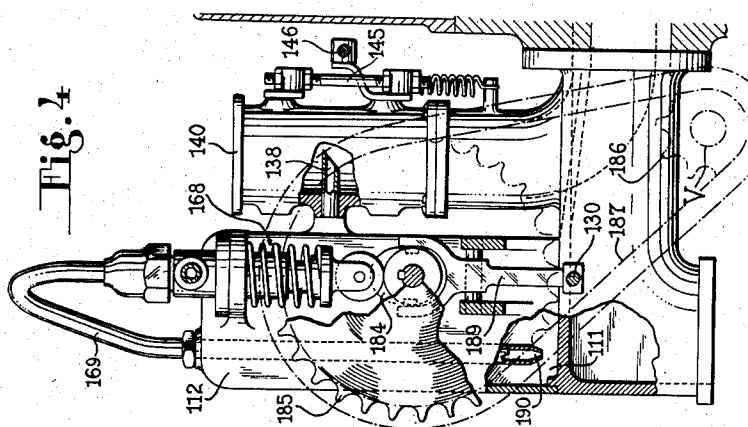
M. CHAMP

2,895,462

FEED DEVICE FOR AN INTERNAL COMBUSTION ENGINE

Filed Dec. 11, 1957

3 Sheets-Sheet 2



INVENTOR
MARCEL CHAMP
BY *Diggins & de Sane*
ATTORNEYS

July 21, 1959

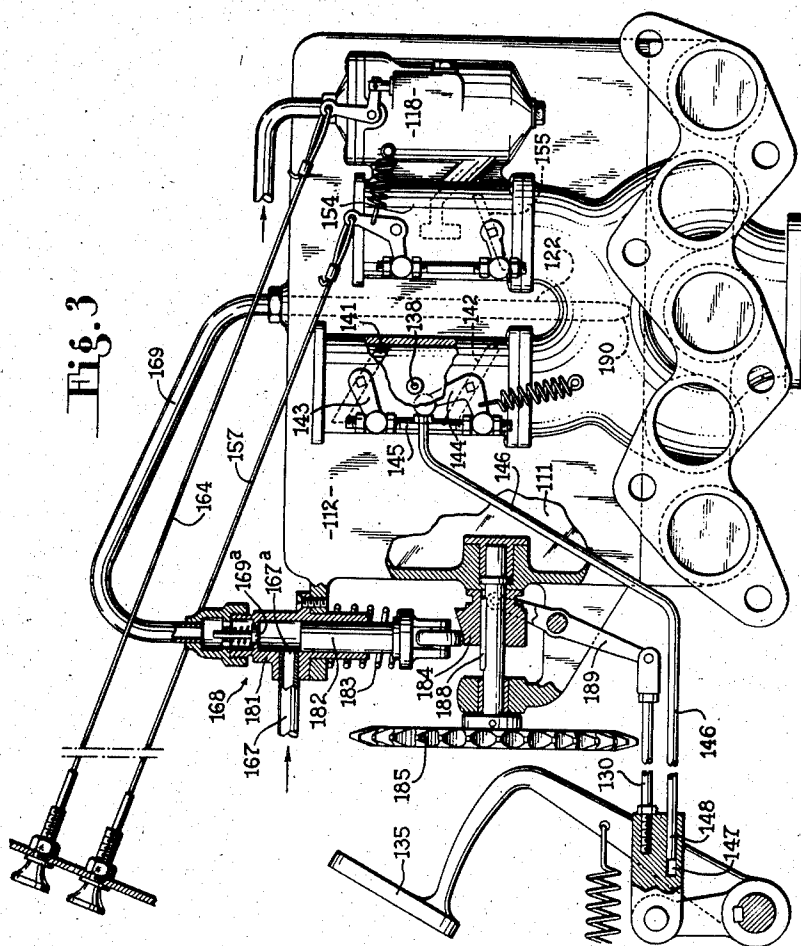
M. CHAMP

2,895,462

FEED DEVICE FOR AN INTERNAL COMBUSTION ENGINE

Filed Dec. 11, 1957

3 Sheets-Sheet 3



INVENTOR
MARCEL CHAMP
BY *Diggins & LeBlanc*
ATTORNEYS

1

2,895,462

FEED DEVICE FOR AN INTERNAL COMBUSTION ENGINE

Marcel Champ, Vire, France

Application December 11, 1957, Serial No. 702,130

Claims priority, application France December 17, 1956

16 Claims. (Cl. 123—133)

The present invention relates to feeding fuel to internal combustion engines of the explosion type and the object of the invention is to obtain a considerable saving in fuel, that is, petrol or the like.

In engines of current type, the cylinders receive fuel which is mixed with air by means of a carburetor to ensure a vaporization of the petrol in the air, but this is more theoretical than real and in actual fact a large proportion of the fuel passing through the jet of the carburetor reaches the cylinders in a merely pulverized state this proportion being moreover the greater as the air drawn in is colder. For example, in an engine running at 3600 r.p.m., the time between ignition and the end of the explosion (opening of the exhaust valve) corresponds to $\frac{1}{120}$ second. During this very short period of time, only the gaseous part of the mixture of air and petrol has had time to explode and the rest, which is a not at all negligible part of the fuel, is discharged in the form of flames into the exhaust manifold, without having had time to generate the energy it was capable of generating.

Thus, to obtain a given power with conventional carburetor feed devices, it is necessary to feed to the cylinders an amount of fuel greater than that theoretically necessary and this naturally results in loss of fuel.

It has already been proposed to effect a prior vaporization of the fuel before it is introduced into the cylinders and to this end it was arranged to reheat by means of the exhaust manifold the mixture of air and fuel furnished by the carburetor. The improvement is appreciable but corresponds to only a fraction of the increased efficiency that a complete vaporization of the fuel would afford.

It has also been proposed to vaporize the fuel before it is mixed with the comburent air, but the solutions proposed were either complicated and had to be abandoned or only partially solved the problem, and in particular did not permit the engine to be started or to idle in a satisfactory manner, since at these engine speeds the heat supplied by the exhaust gases was insufficient.

The object of the invention is to provide an improved feed device for explosion engines which permits a considerable saving in fuel relative to that obtained with conventional devices. This device is characterized in that it comprises an auxiliary feed device connected in parallel to a single induction manifold, having a carburetor for starting the engine and running the latter at idling speed, and a main feed device employing a prior vaporization of the fuel by means of the heat of the exhaust gases for normal engine speeds, said two feed devices being combined with control means permitting changing over from one of the feed devices to the other.

Owing to the combination of these two feed devices, it is possible to start or run the engine at idling speed with the usual feed through the carburetor and then, when the exhaust gases have sufficiently heated the main feed device, to utilize a prior vaporization of the petrol,

2

this device can be brought into action thus affording a very economical running of the engine.

In one embodiment, there are provided two air induction tubes which are connected in parallel to the induction manifold of the engine and with which communicate respectively a nozzle supplying vapours produced in the vaporization chamber adapted to be heated by the burnt gases issuing from the exhaust manifold of the engine, and the jet of a carburetor.

According to another feature of the invention, there is provided for controlling the prior-vaporization feed to the engine, a device regulating the feed of fuel to the vaporization chamber and, moreover, a device regulating the opening of the corresponding air induction tube, these two devices being connected to the pedal or other accelerating means, the first device being connected positively and the second device through the medium of a lost-motion connection, whereby, when said pedal is actuated, it causes, firstly, admission of fuel in the vaporization chamber and then a short time after, the opening of the air induction tube.

In a modification of the invention, the feed to the main feed device utilizing prior vaporization of fuel is effected by means of a pump which injects the fuel into the prior vaporization chamber.

This injection is effected under pressure by means of a cylinder and piston type of pump which injects the fuel in the space adjacent the heated wall, the fuel being pulverized by means of jets in this space.

In this way, there is obtained an indirect injection of fuel. It is known that in the usual method utilizing injection of light fuels into explosion engines, an important difficulty resides in the fact that, on the one hand, the injection pump is driven at high speed and, on the other hand, one element of the piston and cylinder type pump must effect an injection every two revolutions of the crankshaft, if this pump element only supplies a single cylinder of the engine, or two injections per revolution of the crankshaft if this pump element is, for example, used for feeding a four cylinder engine.

Another important difficulty is that the amount of fuel injected for every stroke of the piston of the pump is very small and a precise metering thereof is therefore difficult.

The indirect injection device according to this embodiment of the invention permits overcoming these difficulties. To this end, according to the invention, the dimensions of the pump are such that in the case of a four-stroke engine having n cylinders, in which each cylinder of the engine consumes for each cycle a mass u of fuel and the engine necessitates therefore for each revolution of the crankshaft a mass

$$\frac{n}{2}u$$

of fuel, a cylinder of said pump delivers for each injection a mass

$$\frac{n}{2}u \times N$$

of fuel, where N is an integer greater than 1, the pump being driven by the crankshaft through a transmission having an appropriate speed reduction.

In particular, if the pump comprises a single cylinder, the speed reduction ratio is N ; in the case of a four-stroke engine having four cylinders, the single cylinder pump delivers, for each injection, a mass $2u \times N$ of fuel.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings to which the invention is in no way restricted.

In the drawings:

Fig. 1 is a side elevational view, with parts cut away, of a feed device embodying the invention;

Fig. 2 is a corresponding end elevational view with parts cut away;

Fig. 3 is a side elevational view of a modification of the device, and

Fig. 4 is an end elevational view of the device shown in Fig. 3.

In the embodiment shown in Figs. 1 and 2, the feed device feeds an explosion engine M (Fig. 2) provided with induction and exhaust ports *a* and *b* in a common wall.

The device embodying the invention is put into the communication with these ports.

This device comprises a cast body 1. This body has a flat face 2 adapted to be clamped, with interposition of a gasket 3, against the wall of the engine M in which the ports *a* and *b* are provided.

This body 1 constitutes an induction and exhaust manifold.

The induction manifold is formed by a pipe 4 which has openings *a*¹ in the face 3 in alignment with the inlet ports *a* of the engine M. In the presently-described embodiment, the engine has two inlet ports *a* and the pipe 4 has therefore an arcuate shape. Two pipes 5 and 6, corresponding to the main and auxiliary feed respectively, are connected to the pipe 4.

The flat-shaped exhaust manifold 7 has a flat upper wall 8. It has passageways 9 leading to a number of openings *b*¹ in the face 2 corresponding to the number of exhaust ports of the engine. In the presently-described embodiment, the engine M has three exhaust ports *b* and there are therefore three openings *b*¹.

The ports *a* and *b* of the engine are arranged in alternate relation in the known manner and the same is true of the openings *a*¹ and *b*¹ of the body 1.

The exhaust manifold 7 also comprises a pipe 10 which is secured to the vehicle exhaust pipe.

The body 1 supports said main and auxiliary fuel feed devices.

The main fuel feed device comprises a vaporization chamber 11 provided above the flat wall 8 of the exhaust manifold 7 in an inverted housing 12 fixed to the wall 8, for example by means of studs 13 connected to this wall and nuts 14. A recess 15 or any other means ensures that the vaporization chamber 12 is fluid-tight.

A plurality of liquid fuel feed nozzles or pipes 16 communicate with the chamber 11, the liquid therefrom falling in the form of droplets 17 (Fig. 2) on the wall 8, which is heated by the hot exhaust gases circulating through the manifold 7, and the fuel is immediately vaporized.

The petrol or gasolene is fed to the nozzles 16 from the float chamber of a conventional carburetor 18. This chamber communicates through a small orifice 19 with the lower end of a vertical cylindrical bore of small diameter 20 which is extended upwardly by a bore or well 21 connected to the bore 20 by a conical shoulder forming a seat.

Connected to the upper part of this seat are one or more pipes 22 adapted to feed fuel to the nozzles 16. The flow of fuel from the orifice 19 to the pipes 22 is regulated by means of closing means formed by a needle valve 23 slidably mounted in the bore 21 and downwardly extended by a point having a decreasing cross-section. The position of this point relative to the bore 20 determines in the latter the size of the section of the passageway for the fuel. Above this point, the needle valve 23 comprises a shoulder which by bearing against said seat completely stops the flow of fuel.

The needle valve 23 extends above the bore 21 and terminates in the form of a fork 24 carrying a freely rotative roller 25. The latter bears against the ramp 26 of a cam 27 slidably mounted in fixed guides 28. This ramp is biased in the direction of arrow *f*¹ (Fig. 1) by a resili-

ently yieldable device, such as a spring 29 and is connected to a rigid rod 30 which permits moving this cam toward the right (as seen in Fig. 1) in opposition to the action of the spring 29 so as to raise the roller 25 and in consequence the needle 23 and permit the end of the latter to withdraw from the small end 20 of the bore 21 and permit flow of fuel to the nozzles 16. This rod 30 may be moved in opposition to the action of the spring 29 through the medium of a push member 31 pivoted at 32 to a crank 33 keyed on a shaft 34. Also keyed to the latter is a pedal or other accelerating means 35. The end of the rod 30 is rendered rigid with the member 31 by means of a screw-threaded connection 36.

The vaporization chamber 12 carries at its upper part a preferably detachable nozzle 38 screwed in one of its walls. The nozzle can be thus screwed in position owing to the provision of an aperture in the opposite wall which is in alignment with this nozzle and is closed by a plug 39. The nozzle 38 communicates with the interior of a main air induction tube 40 connected to the pipe 5 of the induction manifold 4.

Conjugate throttles 41 and 42 which are capable of being actuated simultaneously are provided on either side of the nozzle 38. These two throttles are interconnected by two arms 43 and 44 and a rod 45. The arm 43 has two branches and its other branch is connected to the member 31 by a rod 46. This rod 46 is engaged in an aperture 47 in the member 31 and there is a clearance *x* in the inoperative position of the member 31 between the end of the aperture 47 and the end 48 of the rod. Thus, any action on the pedal 35 immediately raises the needle valve 23, whereas it opens the throttles 41 and 42 after a slight delay when the lost-motion travel *x* has been effected.

The accelerator pedal 35 is biased toward its inoperative position by a resiliently yieldable device diagrammatically represented by a spring 49 (Fig. 1).

The main feed device is completed by a safety valve 50 (Fig. 1) provided on the housing 12 for the purpose of avoiding an overpressure in the chamber 11. This valve 50 normally closes an aperture 51 provided in the wall of the housing 12. It is urged against its seat in the direction inwardly of the housing by a spring 52 (Fig. 1), and the petrol vapours, when they are in a state of overpressure, raise this valve off its seat and escape through a pipe 53 which communicates with the exhaust pipe of the engine.

The auxiliary feed device for the starting and idling speed of the engine comprises an auxiliary air induction tube 54. It is connected to the main tube 40 and to the induction manifold 4 by the additional branch 6 of this manifold.

The carburetor 18 is of conventional type. Its float chamber feeds the bore 21 of the main feed device and also feeds, in the usual manner, the normal and slow speed jets (not shown in the drawing) disposed in the tube 54 on the output side of the throttle 55 relative to the direction of fuel flow. This throttle is normally urged toward its closing position by the spring 56 and is capable of being moved away from this position for starting up the engine and a possible accelerated performance with direct feed through the carburetor by means of rod 57 connected to control means 58 constituted by, for example, a pull knob carried by the dashboard 59 and connected by a bell crank 60 to said rod 57.

Preferably, the carburetor 18, which receives its fuel through the usual pipe 61, is provided with a starting jet 62 which is fed with fuel in the usual manner, for example by actuating a lever 63 connected by a cable 64 enclosed in a flexible sheath 65 connected to a knob 66 also carried by the dashboard 59.

The mixed-feed device operates in the following manner:

For starting the engine, and for idling speed, that is,

when the body 1 and in particular its exhaust manifold 7 are cold, the engine is fed with fuel by way of the carburetor 18, the mixture of air and fuel being produced in the tube 54 in which air enters in the direction of arrow f^3 . The mixture of air and fuel, partially vaporized and partially in the state of fine particles, passes through the pipe 6, the induction manifold 4, the openings a^1 and a^2 and the inductions ports a and fills the cylinders of the engine where it explodes and provides the energy necessary for starting the vehicle or for driving the vehicle at slow speeds.

After running the engine under these conditions for a period of time, when it is considered that the exhaust gases flowing through the manifold 7 have sufficiently heated the upper wall 8, the accelerator pedal 35 is depressed and, through the medium of the arm 33 and the member 31, this pedal moves the cam 27 in the direction opposite that of the arrow f^1 in opposition to the action of the spring 29. The cam 27 progressively raises the needle valve 23 and permits a progressive supply of fuel directly from the float chamber of the carburetor 18 through the pipes 22 and the nozzles 16 into the vaporization chamber 11 where the droplets 17 fall on the hot wall 8 and are immediately vaporized.

In continuing to depress the pedal 35 and after the lost motion travel x has been effected, the member 31, through the medium of the rod 46, progressively opens the throttles 41 and 42 in the main tube 40 and the air drawn in by the engine enters this tube in the direction of arrow f^4 and automatically draws the fuel vapours through the nozzle 38 and these vapours fill the chamber 11 at a pressure which can never become dangerous owing to the provision of the safety valve 50.

Thenceforth, fuel is fed to the engine according to the prior-vaporization method and, as mentioned hereinbefore, there results a particularly economical engine performance.

The usual accelerations or decelerations are obtained by actuating the pedal 35 beyond the position corresponding to the take-up of the lost-motion travel x , that is, by opening or closing the conjugate throttles 41 and 42 to varying extents. The throttle 41 alone would be sufficient for this purpose, but the throttle 42 improves the fluid-tightness of the tube 40 when, for any reason, it is desired to return to idle speed with direct feed through the carburetor 18. This fluid-tightness prevents the petrol vapours, which filled the chamber 12 at the moment of changing the feed method, from escaping into the atmosphere.

According to a modification of the invention, the vaporization chamber 11 instead of being fed from the float chamber of the carburetor 18 could be fed by injection by means of the arrangement diagrammatically shown in Figs. 3 and 4. In these figures, most of the elements are identical to those of the device shown in Figs. 1 and 2 and are designated by the same reference numbers increased by 100. A brief reference will be made to the main elements of this device. The latter comprises in particular a housing 112 defining a vaporization chamber 111 into which extends a fuel feed pipe 122, a main tube 140, with which communicates a nozzle 138 connected to the vaporization chamber 111, and conjugate throttles 141, 142 which are capable of being actuated simultaneously and are interconnected by two arms 143, 144 coupled by a rod 145. This device also comprises an auxiliary feed device 154 whose throttle 155 may be controlled by means of a rod 157, the carburetor being controlled by a rod 164.

The fuel feed pipe 122 is supplied with fuel by way of a pipe 169 by means of an injection pump 163 which is connected to a fuel tank by a pipe 167. This pump is of the usual type comprising a cylinder body 181 and a piston or plunger 182 which may be actuated, in opposition to the action of a spring 183, by a cam 184 which is driven by a sprocket 185 or other driving de-

vice. A valve 169^a, which opens in the direction of circulation of the fuel toward the engine, is provided at the output end of the pump. A valve, which opens in the direction of intake of fuel, may be provided at the input side of the pump or, in a simpler arrangement as shown in Fig. 3, the aperture 167^a of the pipe 167 could be located in the vicinity of the lower dead centre position of the plunger 182 so as to be covered by the latter at the start of the delivery stroke.

The driving device of this pump is connected to the crankshaft or to any other mechanism connected to the latter by a speed reducing device which has been shown in Fig. 4 in the form of a sprocket 185, which has a large diameter and is connected to a small diameter sprocket 186, mounted on the crankshaft by means of a chain 187. It will be understood that this speed reduction could be obtained by any other means, such as a direct gearing, worm and worm wheel arrangement or any other slip-free driving device. The cam 184 is slidably keyed on its shaft by means of a key 188 so as to permit varying the volume of fuel injected for each revolution of the crankshaft between an initial value which is zero, the pump being then inoperative, and a maximum value obtained when the cam is pushed to its extreme position toward the left as viewed in Fig. 3. This regulation device is well known and is connected to the accelerator pedal 135 by means of a shifting-fork lever 189 and a rod 130. The arm 145 controlling the throttles 143 and 144 is connected to this pedal by a rod 146 through the medium of a lost-motion device 147, 148 as in the first embodiment.

The housing 112 defining the vaporization chamber 111 has such size as to provide a mass

$$\frac{N^n}{2}u$$

of gas, for example $10u$, where u is the unit mass injected into the cylinder of the engine for each cycle, so that the pressure prevailing inside the housing 112 remains constantly between a maximum value, which cannot be exceeded and is determined by the power of the pump, and a minimum value necessary for introduction of the gas into the cylinders of the engine with a speed sufficient for ensuring satisfactory running of the engine at all speeds. The fuel feed pipe 122 is provided with one or more jets or nozzles 190 which result in a pulverization of the liquid and thus favours its complete vaporization upon contact with the heated surface. The housing 112 may be of sufficient thickness to form a mass having a great thermal inertia so as to remain constantly at sufficient temperature and thus avoid condensations of vaporized fuel. This housing could also be heat insulated.

This device operates in substantially the same manner as the first embodiment described. If N is for example equal to 5, the pump injects fuel into the chamber 111 for every five revolutions of the crankshaft, that is, every ten cycles, in an amount necessary for these ten cycles of the engine and the chamber 111 feeds the cylinders in succession in the course of these ten cycles.

The pump 168 can therefore be very large and can provide for each stroke of its piston a large amount of fuel the metering of which is in consequence relatively easy. Naturally, the fuel feed devices regulated by means of a needle valve and cam of the first embodiment are eliminated, the pump being started up by means of the accelerator pedal 135 as described hereinbefore under the same conditions as those of the main feed device of the first embodiment.

Although specific embodiments of the invention have been described, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Thus, it is within the scope of the invention to utilize several pump units, it being understood that the pumps,

which would be individual pumps in this case, always have such size and are controlled in such manner as to effect only fuel injections corresponding to the total amount of a plurality of unit injections. It should also be understood that the pump may be driven by any known speed-reducing means, and controlled by any conventional regulating system.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device which is used for operating the engine at normal running speeds and comprises a vaporization chamber for a prior vaporization of the fuel by means of the exhaust gases of the engine, means for feeding said chamber with liquid fuel, a second induction tube connected to said induction manifold, and a nozzle putting said second tube in communication with said vaporization chamber, and second control means for controlling said second feed device; said means for feeding said chamber with liquid fuel comprising a well communicating with the float chamber of said carburetor, nozzles communicating with said vaporization chamber, at least one pipe connecting said well to said nozzles, and closing means which is adapted to selectively close and open said pipe and is connected to said second control means.

2. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device which is used for operating the engine at normal running speeds and comprises a device for effecting a prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, a second induction tube connected to said induction manifold, and a nozzle putting said second tube in communication with said vaporization device, and second control means for controlling said second feed device; said second control means comprising a first regulating device for regulating the supply of fuel to said prior vaporization device and a second regulating device for selectively opening and closing the bore of said second tube, a control device, connecting means connecting said control device to said first regulating device, and a lost-motion connecting means connecting said control device to said second regulating device, whereby when said control device is actuated, it causes firstly the fuel to be fed to said vaporization device and a short period of time thereafter the opening of the bore of said second tube by said second regulating device.

3. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operating the engine at normal running speeds, said second feed device comprising a vaporization chamber for a prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, means for feeding said chamber with liquid fuel, a second induction tube connected to said induction manifold, and a nozzle putting said second tube in communication with said vaporization chamber, and second control means for con-

trolling said second feed device; said second control means comprising a first regulating device for regulating the supply of fuel to said vaporization chamber and a second regulating device for selectively opening and closing the bore of said second tube, a control device, connecting means connecting said control device to said first regulating device, and a lost-motion connecting means connecting said control device to said second regulating device, whereby when said control device is actuated, it causes firstly the fuel to be fed to said vaporization chamber and a short period of time thereafter the opening of the bore of said second tube by said second regulating device.

4. In an engine as claimed in claim 2, wherein said control device is a pedal.

5. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device used for operation of the engine at normal running speeds, said second feed device comprising a vaporization chamber for a prior vaporization of the fuel by means of the heat of the exhaust gases of the engine; means for feeding said chamber with liquid fuel, a second induction tube connected to said induction manifold, and a nozzle putting said second tube in communication with said vaporization chamber, and second control means for controlling said second feed device; said second control means comprising a first regulating device for regulating the supply of fuel to said vaporization chamber and a second regulating device for selectively opening and closing the bore of said second tube, a control device, a lever connected to said control device, a member pivoted to said lever, a first rod rigid with said member and connected to said first regulating device, and a second rod connected to said member in such manner as to be capable of a limited sliding motion relative to said member and connected to said second regulating device which latter is a throttle disposed in the bore of said second tube, whereby when said control device is actuated, it causes firstly the fuel to be fed to said vaporization chamber and a short period of time thereafter the opening of the bore of said second tube by said throttle.

6. In an engine as claimed in claim 1, wherein said vaporization chamber is defined by a housing comprising a flat horizontal wall which is the base of said housing and constitutes a portion of the walls of the exhaust manifold.

7. In an engine as claimed in claim 1, wherein said vaporization chamber is defined by a housing and an aperture is formed in said housing to put said vaporization chamber in communication with the atmosphere, a safety valve being adapted to ordinarily close said aperture but to open the latter by moving inwardly of said housing when the pressure in the said vaporization chamber exceeds a predetermined value.

8. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a vaporization chamber for the prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, an injection pump for injecting liquid fuel into said chamber, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said

vaporization chamber, and means for controlling the output of said pump.

9. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a vaporization chamber for the prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, an injection pump for injecting liquid fuel into said chamber, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said vaporization chamber, a regulating device for regulating the output of said pump, and control means connected to said regulating device.

10. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, the first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a vaporization chamber for prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, a metering pump for injecting the liquid fuel into said chamber, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said vaporization chamber, and means for controlling the output of said pump.

11. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a vaporization chamber for prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, a pump of the type comprising a piston and cylinder for injecting the liquid fuel into said chamber, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said vaporization chamber, and means for controlling the output of said pump.

12. In an explosion engine comprising an induction manifold, an exhaust manifold, a first feed device used for starting the engine and running the latter at idling speed, said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a jet in said carburetor, said jet communicating with said first tube, and first control means controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a housing defining a vaporization chamber for prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, at least a portion of the wall of said housing being dis-

posed in such manner as to be heated by the exhaust gases of the engine, at least one second jet disposed inside said vaporization chamber, in the vicinity of said portion of said wall, a pump of the type comprising a cylinder and piston, the output end of said pump communicating with said jet for feeding said second jet with liquid fuel, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said vaporization chamber, and means for controlling the amount of fuel fed by said pump through said second jet into said chamber.

13. In a four-stroke engine having n cylinders comprising a crankshaft, each cylinder consuming, in each cycle at normal running speed of the engine, substantially a mass u of fuel, the engine consuming therefore for each rotation of the crankshaft a mass $nu/2$ of fuel, said explosion engine comprising an induction manifold, an exhaust manifold, and a first feed device for starting the engine and for operation of the latter at idling speed; said first feed device comprising a carburetor and a first air induction tube connected to said induction manifold, a first jet in said carburetor, said jet communicating with said first tube, and first control means for controlling said first feed device; a second feed device for operation of the engine at normal running speeds, said second feed device comprising a housing defining a vaporization chamber for prior vaporization of the fuel by means of the heat of the exhaust gases of the engine, at least a portion of the wall of said housing being disposed in such manner as to be heated by the exhaust gases of the engine, at least one second jet disposed inside said vaporization chamber in the vicinity of said portion of said wall, a pump of the type comprising a cylinder and piston, the output end of said pump communicating with said jet for feeding said second jet with liquid fuel, a second induction tube connected to said induction manifold, a nozzle putting said second tube in communication with said vaporization chamber; said pump having a single cylinder and having such capacity as to be capable of injecting into said vaporization chamber a mass

$$\frac{nu}{2} \times N$$

of fuel, where N is a number greater than 1, and speed-reducing transmission means operatively connecting the crankshaft of the engine to said pump for driving the latter at reduced speed; the speed reduction ratio being equal to N .

14. In an engine as claimed in claim 13, wherein N is between 2 and 5.

15. In an engine as claimed in claim 6, wherein the wall of said housing is heat insulated.

16. In an engine as claimed in claim 2, wherein said second regulating device comprises two throttles interconnected to be operated simultaneously by said control device and said nozzle communicates with said second tube between said two throttles.

References Cited in the file of this patent

UNITED STATES PATENTS

2,205,750	Ross	June 25, 1940
2,333,167	Garretson	Nov. 2, 1943
2,339,988	Gerson et al.	Jan. 25, 1944
2,658,732	Holl	Nov. 10, 1953