Nov. 3, 1936. N. G. A. GUSTAFSSON 2,059,334

METHOD AND MEANS TO RUN CARBURETOR INTERNAL COMBUSTION ENGINES

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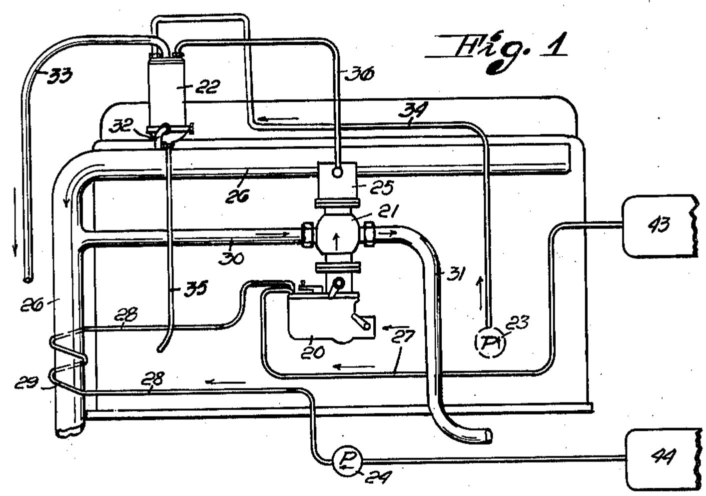

Fig. 1

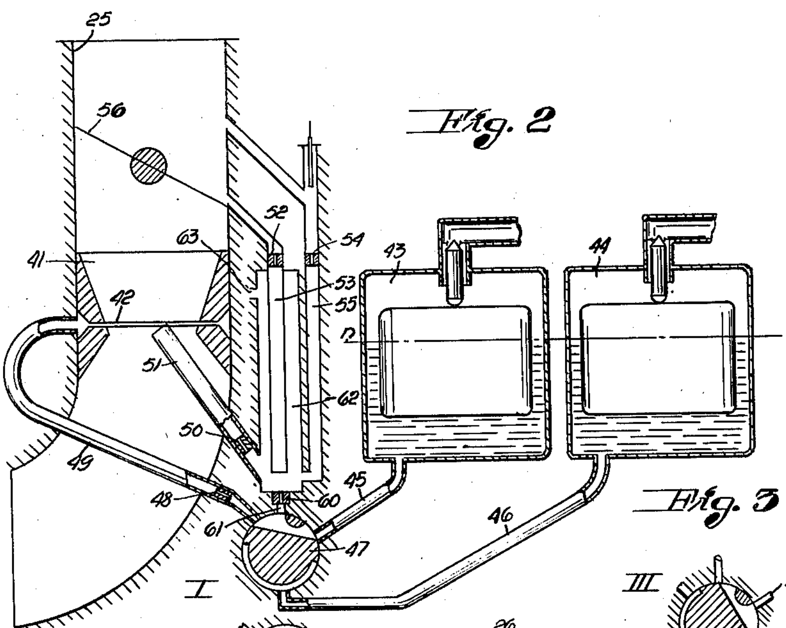

Fig. 2

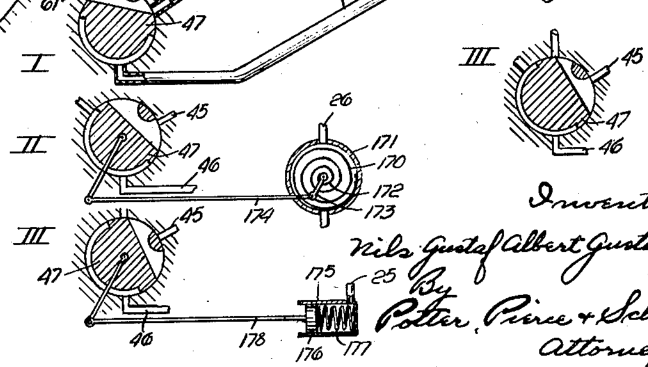

Fig. 3

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Fig. 9

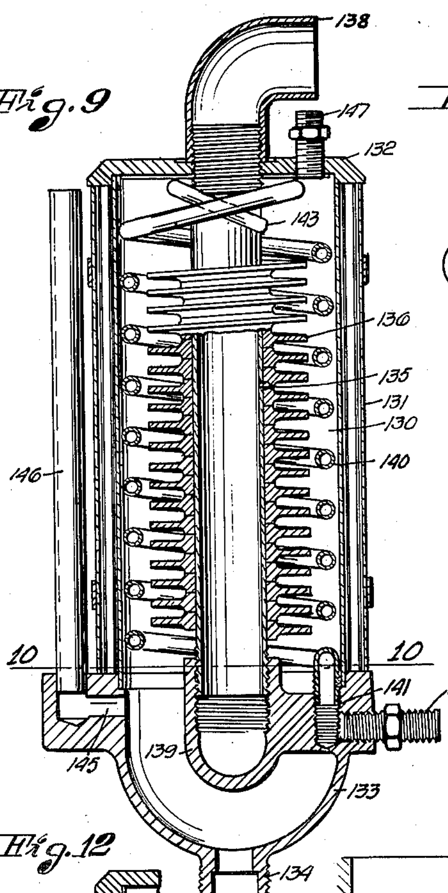

Fig. 10

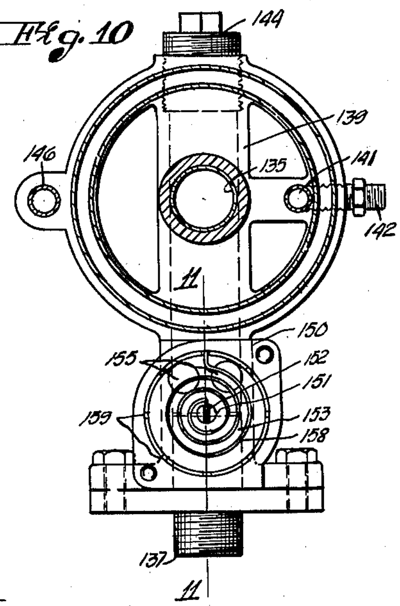

Fig. 12

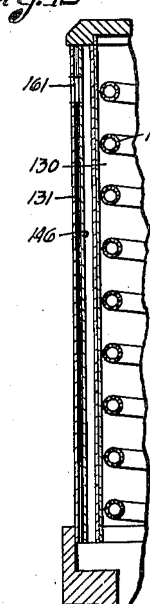

Fig. 11

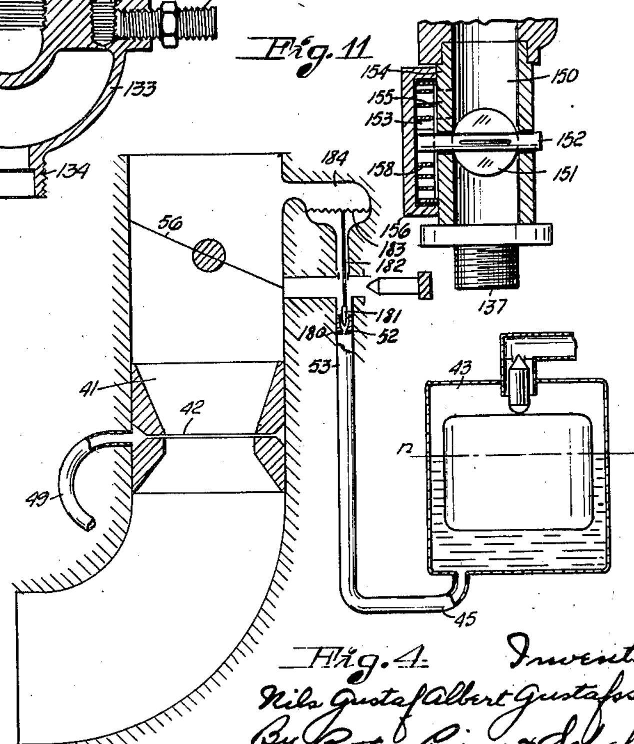

Fig. 4

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METHOD AND MEANS TO RUN CARBURETOR INTERNAL COMBUSTION ENGINES

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Fig. 5

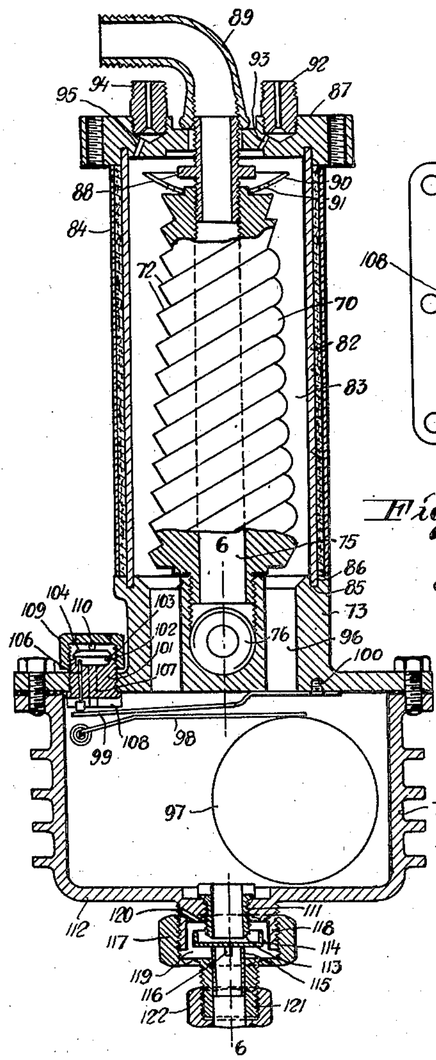


Fig. 8

Fig. 7

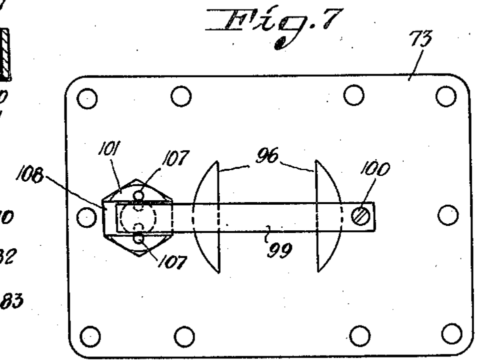
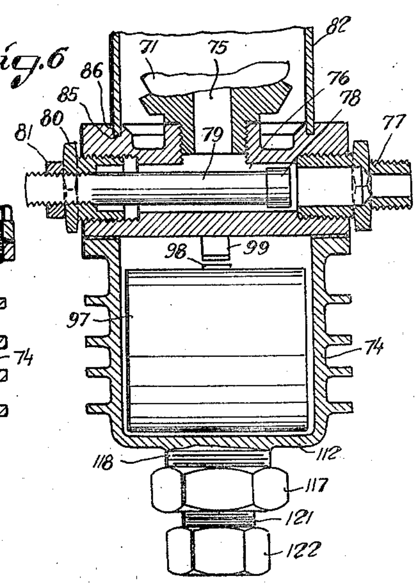


Fig. 6



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UNITED STATES PATENT OFFICE

2,059,334

METHOD AND MEANS TO RUN CARBURETOR INTERNAL COMBUSTION ENGINES

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Application August 3, 1934, Serial No. 738,358
In Germany August 8, 1933

4 Claims. (Cl. 123—127)

Since several years attempts have been made to run carburetor internal combustion engines on heavy fuels. By very strong preheating of the fuel or the air-fuel mixture, e. g. by means of the heat of the exhaust gases of the engine, attempts have been made to transfer the heavy fuel from liquid state into vapor in order to introduce same in the vapor state into the cylinders of the engine. When the engine is running at full or approximately full load the temperature of the exhaust gases may be sufficiently high to cause complete vaporization of the heavy fuel, but already at half load the heat of said gases is insufficient for effecting such vaporization and at still lower load and especially on idle running the vaporization becomes very incomplete.

Another drawback in running common carburetor internal combustion engines on heavy fuels resides in the fact that a contamination of the lubricating oil by fuel condensed therein and entering the crank case of the engine cannot be avoided. Such a dilution or contamination of the lubricating oil occurs also when the engine is run on gasoline, but in such cases, as a rule, a certain purification of the oil takes place automatically on account of the working temperature of the oil being relatively high, about 50 to 100° C., whereas the temperature of vaporization of gasoline is low. When running the engine on gasoline the dilution of the lubricating oil only rises to a given maximal value and remains then constant. On the contrary, when using heavy fuels having, consequently, a higher temperature of vaporization, the dilution of the lubricating oil by fuel condensed therein increases to such an extent that the oil can no longer fulfill its lubricating function.

In order to eliminate these drawbacks it has already been proposed to insert in the circulation system of the lubricating oil a means for expelling from said oil the fuel or other contaminating foreign matters contained therein, e. g. by means of the heat of the exhaust gases. At low load and especially on idle running the temperature of the exhaust gases is, however, insufficiently high to effect a sufficient expulsion of heavy fuel from the oil. In certain cases, e. g. in boat engines, which, as known, are normally running at full load and on manœuvring must be adjusted into idle running position attempts to eliminate this drawback have been made by running the engine on gasoline on idle running but on heavy fuel at conditions of load.

When running the engine on heavy fuel still another drawback arises which consists in the fact that the fuel-air mixture introduced into the cylinders must have a very high temperature the dew-point of such a mixture containing heavy fuel being very high. So for instance, a mixture of kerosene and air has a dew-point of about 120° C. On account of this high temperature on the one hand the volumetric efficiency of the engine will be very low resulting in low power and high fuel consumption and on the other hand the compression ratio to be used must be very low as the temperature at the end of the compression stroke depends on that at the beginning of said stroke and, consequently, the temperature at which the fuel-air mixture is introduced into the cylinders determines the useful compression ratio.

On account of these circumstances the attempts to use cheap and less inflammable heavy fuels, as for instance kerosene, solar-oil etc., for running carburetor internal combustion engines have heretofore failed.

The principal object of my invention is to provide a method and means whereby it will be possible to run on heavy fuels such carburetor internal combustion engines which are constructed to be run on a light fuel.

To this end I control the supply to the engine of a light fuel and a heavy fuel in such a manner that during such periods of time when the temperature of the exhaust gases is insufficiently high to permit expulsion to a sufficient degree from the lubricating oil of heavy fuel having entered said oil as impurity, exclusively or essentially light fuel is supplied to the engine, whereas during such periods of time when said temperature is sufficiently high for effecting expulsion from the oil of heavy fuel, fuel is expelled from the lubricating oil and exclusively or essentially heavy fuel is supplied to the engine, the heavy fuel expelled from the oil being, preferably, supplied to the intake of the engine.

Preferably, the above method is carried out in such a manner that, when the engine is warm, the same is at no load supplied exclusively with light fuel, at partial loads with fuel having, according as the load increases, a decreasing content of light fuel and an increasing content of heavy fuel, and at full load or approximately full load exclusively or essentially with heavy fuel. When the engine is cold, exclusively light fuel is supplied to the engine at no load as well as under load conditions.

Consequently, by supplying exclusively light fuel, e. g., gasoline, on idle running and by successively decreasing the quantity of gasoline and substituting therefor heavy fuel, e. g., kerosene, according as the load increases and the temperature of the exhaust gases rises, the disadvantages above referred to are eliminated. Further it is not necessary to force the preheating of the fuel-air mixture to the high degree which has heretofore been required, but the temperature in the intake of the engine may be kept at about 60° C., thus at the same value as in ordinary gasoline engines. Thereby the advantages are attained on the one hand that it is not necessary to reduce the compression ratio of the engine, when changing from gasoline to kerosene, and on the other hand that in kerosene drive the power of the engine and the fuel consumption are kept at about the same values as when running the engine on gasoline, depending on said low compression ratio and on the low temperature of the fuel-air mixture introduced. These advantages have hitherto not been obtainable.

The quantity of heat to be supplied to the intake of the engine is preferably supplied from a hot surface or heated portion of the wall of the intake (so called hot spot arrangement).

Another object of my invention is to provide a fuel system for carburetor internal combustion engines for carrying out the above-said method, said system comprising a carburetor arrangement for light fuel as well as heavy fuel, in combination with a vaporizer or rectifier to be connected to or inserted into the lubricating oil system of the engine for the expulsion of fuel contained in said oil.

The carburetor arrangement may consist of a single carburetor to which the two fuels are supplied in the above-said manner, or of two carburetors, one for light fuel and one for heavy fuel. Preferably, I use a so-called bi-fuel carburetor for both kinds of fuel.

The carburetor arrangement or bi-fuel carburetor may be constructed to supply in all positions of the throttle valve of the engine a constant or decreasing quantity of light fuel so that this supply becomes independent of the vacuum in the intake of the engine.

In case of a bi-fuel carburetor this may be constructed according to the principles set forth in my co-pending patent application Serial No. 690,727, filed September 23, 1933. In this application a bi-fuel carburetor is shown having an adjustable change over device adapted to control the supply of the two fuels to a main nozzle and auxiliary nozzles of the carburetor, said change over device being so constructed as to allow supply either of light fuel alone or of both fuels simultaneously or of heavy fuel alone.

According to my present invention I may modify the bi-fuel carburetor disclosed in said prior application so as to allow supply of the light fuel to a nozzle of the carburetor in all positions of adjustment of the change over device. By this means the advantage is gained that the fuel-air mixture supplied to the cylinders of the engine will always contain a given quantity of the light fuel which is distributed in said mixture in the form of greater or smaller particles and serves to facilitate the ignition of the heavy fuel. Hereby the combustion of this latter fuel becomes more complete than when using heavy fuel alone, and further the exhaust gases become practically free from smoke, the acceleration of the engine is increased and the dilution of the lubricating oil by heavy fuel is considerably reduced.

In the modification of a bi-fuel carburetor above described in which, consequently, an auxiliary nozzle, e. g., the no load nozzle, is permanently connected with the supply for light fuel, whereas the main nozzle may by means of the change over device be connected either to said supply of light fuel or to that of heavy fuel or be entirely cut off, the supply of the more expensive light fuel has a tendency to increase according as the suction in the intake of the engine increases resulting in the fuel-air mixture introduced into the cylinders of the engine becoming unnecessarily rich in light fuel causing sinking of the fuel economy.

In order to avoid this drawback I provide means in the connection between the adjustable change over device and an auxiliary nozzle, or within said nozzle, said means being adapted automatically to limit the supply of the light fuel to said nozzle which in all positions of the change over device communicates with the supply of light fuel. Preferably, said means consists of a throttling means of any kind.

The vaporizer or rectifier which according to my invention is to be inserted into or connected with the lubricating oil system of the engine may be of any suitable type.

In order to effect rapid and sufficient expulsion of the fuel from the lubricating oil I may use a rectifier having one or more surfaces heated directly, e. g., by means of the exhaust gases, and so arranged as to cause the contaminated oil to flow downwardly on said surface or surfaces, e. g., by its own weight, in the form of a relatively thin layer or film having a free surface of expulsion.

To facilitate the expulsion of the fuel I may dispose the heating body on which said expulsion surface or surfaces are provided in a chamber and provide means to effect the formation of a more or less high vacuum in said chamber so as to cause the expulsion to take place at a relatively low temperature, said vacuum being, for instance, effected by connecting the expulsion chamber to the intake of the engine. To render possible to transfer the purified oil from the expulsion chamber to the crank case of the engine I may, in this case, combine said chamber with a receptacle for the purified oil adapted periodically to be brought into communication with the atmosphere.

In certain cases and especially when a rather non-volatile fuel is used, I may, instead of providing for the formation of a vacuum in the expulsion chamber of the rectifier, combine the latter with means to bring a gaseous medium from a source connected to the rectifier to pass through the chamber serving for the expulsion of the fuel vapors, in such a quantity that medium admixed with fuel vapors is removed, when the vapors have reached their saturation pressure or before.

This supply of a gaseous medium to facilitate the expulsion of the fuel vapors preferably takes place continuously, in which case the expulsion chamber is in constant communication with the source of said medium, but the supply may also take place intermittently, for instance by means of a valve adapted periodically to open said communication, the intervals between the consecutive periods of keeping said communication open having then to be of shorter duration, however, than in rectifiers of the type operating by vacuum.

The said gaseous medium may be of any suitable kind, consisting, for instance, of exhaust gases from the engine. Preferably, however, air is used which together with the expelled fuel vapors forms a fuel-air mixture which may be advantageously introduced into the intake of the engine.

The gaseous medium or air may be preheated before it enters the rectifier, and said preheating may be effected in any suitable manner, for instance by utilizing the heat of the exhaust gases of the engine or the heat in the rectifier proper when air is being used as gaseous medium.

The means to bring the medium to pass through the expulsion chamber may be of any suitable kind, depending on the prevailing working conditions. The medium may be pressed into the expulsion chamber at a suitable pressure, e. g. by a pump, or said chamber may be connected to a suitable source for producing suction, for instance to the intake of the engine, or it may be possible to employ a combination of both.

The heating of the oil-fuel mixture in the expulsion chamber and the preheating of the gaseous medium and/or the entering lubricating oil may be effected in any suitable manner. Generally, however, I utilize the heat in the exhaust gases of the engine for this purpose.

My invention will be best understood by reference to the following description, when taken in connection with the accompanying drawings of specific embodiments thereof while its scope will be more particularly pointed out in the appended claims.

In the drawings:—

Fig. 1 is a diagrammatic view of a fuel supplying device according to my invention which without any difficulty may be connected or combined with a gasoline engine of common types, e. g. an automobile motor, in substitution for the normal gasoline carburetor.

Fig. 2 is a diagrammatic view of an embodiment according to my invention of a carburetor to be used in the fuel system according to Fig. 1 and having a change over device to control the fuel supply conduits.

Fig. 3 is a view of a modification of said change over device in a given position.

Fig. 4 is a diagrammatic partial view of a modification of the carburetor arrangement according to Fig. 2.

Fig. 5 is a longitudinal sectional view of an embodiment according to my invention of a vaporizer or rectifier to be used in the fuel system according to Fig. 1.

Fig. 6 is a sectional view along the line 6—6 in Fig. 5 through a lubricating oil receptacle appurtenant to said rectifier.

Fig. 7 is a view of a cover of said receptacle, seen from below.

Fig. 8 is a detail view of a part of a valve of the rectifier.

Fig. 9 is a longitudinal sectional view of another embodiment of a vaporizer or rectifier according to my invention.

Fig. 10 is a cross-sectional view along the line 10—10 in Fig. 9, a cover for a thermostat chamber inserted into the exhaust gas inlet being removed.

Fig. 11 is a sectional view along the line 11—11 of Fig. 10, illustrating also the thermostat chamber.

Fig. 12 is a partial view of a modification of Fig. 9.

According to Fig. 1 reference numeral 20 designates a carburetor device, 21 a preheater connected with said carburetor device, 22 a vaporizer or rectifier, 23 an oil pump of the engine, 24 a fuel pump of the engine for heavy fuel, e. g. kerosene, 25 the intake of the engine, 26 the exhaust thereof, 27 a conduit connected with a supply for light fuel, e. g. gasoline, and adapted to be connected with the carburetor 20, and 28 a conduit connecting said carburetor device 20 with the fuel pump 14, said conduit 28 being wound spirally around the exhaust 26 as shown at 29.

The preheater 21 of the fuel system is heated by means of the exhaust gases of the engine which are supplied to same through a pipe 30 branched off from the exhaust 26, the gases leaving the preheater through an outlet pipe 31. Also the rectifier 22 is heated by means of the exhaust gases which are supplied to same through a pipe 32 branched off from the exhaust 26, the gases leaving the rectifier through a pipe 33. By a pipe 34 the rectifier is connected with the oil pump 23, by a pipe 35 with the crank case of the engine and by a pipe 36 with the intake 25 thereof.

The combined carburetor and rectifier operates as follows:

The engine is started on gasoline. As long as the engine is cold, gasoline is exclusively supplied to same from the carburetor at no load as well as at all conditions of load. When the engine has become warm and the temperature of the exhaust gases is sufficiently high to render possible by means of the rectifier 22 to expel from the lubricating oil heavy fuel absorbed therein, a change over device appurtenant to the carburetor is adjusted in such a manner that either both gasoline and kerosene or kerosene alone can be supplied to the engine, said change over device being more fully described later on with reference to Figs. 2 and 3. When running the engine wholly or in part on heavy fuel, a contamination of the lubricating oil by fuel, especially heavy fuel, occurs. By the pump 23 the contaminated oil is pumped through the pipe 34 into the rectifier 22 in which the fuel is expelled from the mixture of fuel and oil by means of heat delivered by the exhaust gases, said fuel being supplied to the intake 25 of the engine through the pipe 36. As will be more fully described later on the arrangement is, preferably, such that, when the temperature of the exhaust gases increases, the quantity of gasoline supplied to the engine is successively decreased, whereas the quantity of kerosene is increased to the corresponding degree.

By the addition of gasoline at partial loads the combustion in the cylinders of the engine of heavy fuel will be so complete as to cause the engine to run free from smoke and without smell and formation of soot, the heavy fuel being in such cases introduced into the cylinders in the form of drops. On the other hand, at high loads the quantity of heat at disposal during the compression stroke is sufficient for the vaporization of the heavy fuel, and consequently, the addition of light fuel may during such periods be small or wholly dispensed with.

The embodiment of the carburetor designated by 20 in Fig. 1 and shown in Fig. 2 is of the so-called bi-fuel carburetor type. In this figure, 41 designates the mixing chamber of the carburetor to be connected to the intake 25 (compare Fig. 1) and provided with spraying means for the main fuel in the form of a narrow annular slot 42. The float chambers of the carburetor are designated by 43 and 44, chamber 43 containing light fuel, e. g. gasoline, and chamber 44 heavy fuel, e. g. kerosene. The chambers 43 and 44 are each by a conduit 45 and 46, respectively, connected with a common change over device 47, said device controlling the supply of fuel on the one hand to a main nozzle 48 arranged in the conduit 49 leading to the spraying slot 42, on the other hand to a plurality of auxiliary nozzles, viz. a transition nozzle **50** arranged in a conduit **51**, a no load nozzle **52** arranged in a conduit **53** and a starting nozzle **54** arranged in a conduit **55**. The throttle valve of the engine is designated by **56**.

Arranged in the connection of the gasoline float chamber **43** with the no load nozzle **52** is a throttling means serving to limit the supply of gasoline to said nozzle. In the embodiment shown this means consists of a throttling member **60** arranged in a supply conduit **61** leading from the change over device to all auxiliary nozzles **50**, **52** and **54** in common, the throttling member being, consequently, common to all said nozzles. Arranged in the connection of the gasoline float chamber **43** with the auxiliary nozzle or nozzles before the no load nozzle **52** and, in the embodiment shown, also before the other auxiliary nozzles **50** and **54**, reckoned in the direction of flow of the fuel is a space or chamber **62** communicating with the atmosphere by means of an opening **63**. This opening **63** forms a common air inlet for all auxiliary nozzles and is arranged between said nozzles and the throttling member **60**, reckoned in the direction of flow. The conduits **51**, **53** and **55** in which the auxiliary nozzles are arranged open into the chamber **62** and form liquid seals together with said chamber and the liquid contained therein. Evidently, the air inlet **63** should be arranged before said liquid seals.

As seen from the figure the change over device **47** is common to both fuel float chambers **43**, **44** and also to all nozzles. The device may be adjusted into three different positions.

In the position I of the change over device **47** gasoline is supplied to all nozzles, the main nozzle **48** as well as the auxiliary nozzles **50**, **52** and **54**, whereas the supply of kerosene is entirely cut off. In this position the carburetor operates as a common gasoline carburetor. As stated above the change over device occupies this position on idle running and at all load conditions, when the engine is cold, and at no load, when the engine is warm.

In the position II of the change over device **47** gasoline is supplied to all auxiliary nozzles **50**, **52** and **54** and kerosene to the main nozzle **48**. At no load, that is when the throttle valve **56** is closed, the engine runs on gasoline alone in this position of the change over device **47**, on account of the vacuum in the mixing chamber **41** being insufficiently high to cause any heavy fuel to be sucked in through the spraying means **42**. The change over device **47** should be adjusted into this position II, when the temperature of the exhaust gases is so high that the rectifier **22** (Fig. 1) is capable of expelling from the lubricating oil heavy fuel contained therein. When the throttle valve **56** is opened, the engine changes to run mainly on kerosene, the supply of gasoline being successively reduced according as the load increases and, consequently, the temperature of the exhaust gases rises, this depending, in part upon the fact that the main nozzle **48** opens into the mixing chamber **41** before the throttle valve **56** and the auxiliary nozzles **52** and **54** in or after this valve.

In the position III of the change over device **47** the supply of light fuel or gasoline is according to Fig. 2 entirely cut off and, consequently, heavy fuel alone is supplied to the mixing chamber **41** through the main nozzle **48** and spraying means **42**. If in this position of the change over device **47** the throttle valve **56** is closed, the engine will stop on account of lack of fuel. This position of the change over device is utilized especially in stationary engines and boat engines which operate at continuous or full load.

The carburetor operates as follows:

Before the engine is started, the chamber **62** and the conduits **51**, **53** and **55** stand filled with gasoline to the same level n as in the gasoline float chamber **43**. When the engine is started, the quantity of gasoline contained in the chamber **62** is sucked into the mixing chamber **41** through the starting nozzle **54** and the no load nozzle **52** and from said chamber **41** into the engine cylinders. When the level of the gasoline in the chamber **62** reaches the lower orifices of the conduits **53**, **55** and, consequently, the liquid seals of said conduits are broken, a mixture of gasoline and air from the air inlet **63** is sucked into the mixing chamber more or less intermittently. When then the throttle valve **56** is opened, the main portion of fuel (gasoline or kerosene according to the position of the change over device **47**) is sucked into the mixing chamber **41** through the main nozzle **48** and the spraying means **42** on account of the vacuum in said chamber. However, gasoline continues to flow into the chamber **62**. By means of the throttling means **60** this quantity of gasoline is, however, limited to an amount mainly corresponding to the relatively small head between the level n in the gasoline float chamber **43** and the lower orifices of the pipes **53**, **55**. With other words, this quantity of gasoline will be constant or nearly constant per unit of time and, consequently, independent of the vacuum in the mixing chamber.

In Fig. 3 a modification of the change over device is shown according to which said device permits light fuel or gasoline being supplied also in its third position, although this supply is somewhat choked. According to this modification gasoline is, consequently, supplied to the engine in all positions of the change over device which is, per se, advantageous with respect to the combustion of the heavy fuel, the accelerating property of the engine etc. Because, however, as stated above, this quantity of gasoline does not increase according as the vacuum increases in the intake of the engine but is constant or even sinking per unit of time at all conditions of load, the improved economy of service aimed at is still attained.

As shown in the drawings the change over device is so formed as to prevent in all its positions the supply of a mixture of the two kinds of fuel, said fuels being in the position II in Fig. 2 and III in Fig. 3 supplied to the mixing chamber through separate nozzles. As the vapor pressure of gasoline is considerably higher than that of kerosene, the gasoline will be completely vaporized, whereas the kerosene will only be atomized facilitating to a high degree the vaporization of the latter fuel.

The adjustment of the change over device into different positions may be effected manually. In certain cases it may be preferred, however, to effect this adjustment more or less automatically. So for instance the change-over device may be controlled by a thermostat actuated by the temperature of the exhaust gases (or by that of the cooling medium) in such a manner that when the temperature surpasses a predetermined value the change-over device is adjusted from position I to position II. The adjustment of the device from position II into position III may be controlled by a vacuum cylinder, membrane or the like communicating with the intake and effecting adjustment of the change-over device on lower vacuum into position III and on higher vacuum into position II. Such a device may be used at advantage for instance in automobile motors.

Although automatic adjusting devices of the type above described are self-explaining for a person skilled in the art, I have in Fig. 2 diagrammatically illustrated embodiments of same.

In connection with the position II of the change-over device 47 I have shown a thermostat consisting of a bi-metallic spiral spring 170 housed in a casing 171 connected to the exhaust of the engine, e. g. pipe 26 of Fig. 1. The spring is connected at its one end with the casing and at its other end with a shaft 172, and secured to said shaft 172 is an arm 173 connected to the valve member of the change-over device 47 by a suitable linkage 174. By suitably selecting the heat expansion coefficient of the two layers of the spring 170, it is evident that a decrease in temperature of the exhaust gases will result in an adjustment of the change-over device from position II to position I.

In connection with position III of Fig. 2 I have shown a cylinder 175 having a piston 176 actuated by a spring 177, the space below the piston communicating with the intake of the engine, e. g. pipe 25 in Fig. 1. By means of a suitable linkage 178 the piston is connected to the valve member of the change-over device. The operation is self-explaining. In most cases, the control devices shown in connection with positions II and III are used separately, but it is also possible to use these devices in combination, in which case the position of the change-over device 47 will be determined by the sum of the effects of the thermostat and the pressure device.

In Fig. 4 a modification of the carburetor according to Fig. 2 is shown in which the means to limit the supply of the light fuel, e. g. gasoline to the no load nozzle 52 is provided within said nozzle, the nozzle being adjustable in accordance with the suction in the intake of the engine. By means of conduits 53 and 45, the no load nozzle is directly connected with the light fuel chamber 43 and is formed with a conical valve seat 180 co-operating with a corresponding conical valve body 181. The valve body 181 is secured at the lower end of a spindle 182 which at its upper end is secured to a membrane 183, bellows or the like, arranged in a chamber 184 which is connected with the intake of the engine in such a manner that the membrane 183 is actuated on its one side by the pressure in said intake and on its other side by the atmospheric pressure.

Evidently, at no load, that is when the throttle 56 is closed, the no load nozzle 52 will be entirely open on account of the suction in the intake, whereas, when the throttle is opened, the nozzle will be successively closed according as the suction in the chamber 184 decreases resulting in a corresponding decrease of the supply of light fuel to the no load nozzle.

In Figs. 5 to 8 a specific embodiment of a vaporizer or rectifier is shown to be combined with a carburetor according to my invention. With reference to these figures reference number 70 designates a heating body which has the form of a conical screw having a plurality of threads. The lubricating oil contaminated and diluted by fuel, especially heavy fuel or kerosene flows downwards on the thread surfaces 72 for the purpose of rectification, said surfaces increasing in size from the top and downwardly on account of the conical shape of the screw. The heating body 70 is screwed onto a cover 73 of a lower receptacle 74 for purified lubricating oil and is provided with a central channel 75 communicating with a channel 76 in the cover 73, said last-mentioned channel being adapted to be connected with the exhaust of the engine, (e. g. 26, Fig. 1) by means of a nipple 77 (see Fig. 6) screwed into the cover 73 so as to cause the exhaust gases to pass through pipe 32, Fig. 1, and the channel 75 of the heating body thereby heating same. In order to control the supply of exhaust gases a valve member 78 is provided in the channel 76 in the cover 73, said member 78 being adjustable to and from the inner end of the nipple 77 and having a spindle 79 screwed into a sleeve nut 80 connected with the cover, a locking nut 81 serving to secure the spindle 79 in adjusted position.

The heating body 70 is surrounded by a cylindrical casing 82 having a greater inner diameter than the outer diameter of the heating body so as to provide a space 83 between the casing 82 and the heating body 70. The casing 82 may be heat insulated as shown at 84 and engages by means of a suitable packing 85 a corresponding recess 86 in the cover 73 of the receptacle 74. At its upper end the casing 82 is covered by a lid 87 fitting tightly thereon. In order to lock the lid 87 to the casing 82 and, simultaneously to the heating body 70 a nipple 88 is screwed into the upper end of the heating body and into the lid 87, the upper threaded end of said nipple extending beyond the lid. Engaging said upper end is a pipe bend 89 forming outlet for the heating gases having passed through the control channel 75 of the heating body and through the nipple 88, said pipe bend 89 being adapted to be connected to an exhaust for said gases, e. g. pipe 33 in Fig. 1.

Provided at the upper end of the heating body 70 is a dished plate 90 having apertures 91 and adapted to collect lubricating oil entering the rectifier through a nipple 92 and a channel 93 in the lid 87 and to guide this oil to the thread surfaces 72 of the heating body. The nipple 92 is adapted to be connected with the crank case of the engine, e. g. through pipe 34 in Fig. 1, from which the oil is supplied in known manner by means of a pump, e. g. 23 in Fig. 1. Further, the lid 87 carries another nipple 94 communicating by a channel 95 in the lid with the space 83 between the casing 82 and the heating body 70 and adapted to be connected (e. g. through pipe 36 in Fig. 1) with the intake of the engine, e. g. pipe 25 in Fig. 1.

Channels 96 in the cover 73 connect the space 83 with the interior of the receptacle 74. Provided in this receptacle is a float 97 movably carried by an arm 98 adapted to engage a blade spring 99 secured at its one end as at 100 to the inside of the cover 73 and adapted to actuate a valve device for admitting air into the receptacle 74 in the manner to be described.

This valve device comprises a valve seat 101 having the form of a screw plug threaded into the cover 73 from the inner side thereof, the upper end of said plug being conically chamfered and provided with a central recess 102 so as to form an upper relatively sharp edge 103 at the top of the plug. Loosely resting on this edge 103 is a plane valve plate 104 provided on its underside with a shallow groove 105 (see Fig. 8) and adapted to be actuated by a pin 106 extending through the plug 101 and bearing on the free end of the blade spring 99. Channels 107 in the plug 101 connect the recess or valve chamber 102 with the interior of the receptacle 74. On its underside the plug 101 is provided with a recess 108 (see Fig. 7) to permit upward movement of the blade spring 99. Threaded onto the upper end of the plug 101 is a sleeve nut 109 having lateral apertures 110 and forming a casing for the valve.

Provided at the bottom of the receptacle 74 is a drain valve comprising a sleeve 111 threaded into the bottom 112 from the inside thereof and conically chamfered at its outer end so as to form a relatively sharp edge 113 of the same shape as that on the valve plug 101, said edge 113 serving as valve seat for a valve body 114 having the form of a dished plate with a plane bottom. In its open position this plate 114 bears on the upper edge of a sleeve 115 provided with lateral apertures 116 and secured to a sleeve nut 117 screwed onto a threaded sleeve-shaped member 118 extending from the bottom 112 and forming together with the nut 117 a valve chamber 119 communicating with the surrounding atmosphere by an opening 120. The nut 117 is provided with a downwardly projecting hollow pin 121 having external threads and carrying a sleeve nut 122 adapted to be connected with an outlet conduit for the purified lubricating oil, e. g. pipe 35 in Fig. 1.

The vaporizer or rectifier above described operates in the following manner.

The lubricating oil collected in the crank case of the engine and contaminated or diluted by fuel, especially heavy fuel, as for instance kerosene, is pumped to the rectifier e. g. by pump 23, Fig. 1, through pipe 34, Fig. 1, and nipple 92 and flows through the channel 93 into the dished plate 90 whence the oil is distributed through the holes 91 onto the spirally wound surfaces 72 of the heating body 70. This body 70 is heated to suitable temperature by means of exhaust gases entering the rectifier through pipe 32, Fig. 1, and nipple 77 and passing upwards through the central channel 75. The oil mixture flows downwards on the surfaces 72 in relatively thin films, and on account of the heating the fuel constituents of the mixture are vaporized and returned to the intake of the engine through channel 95, nipple 94 and pipe 36, Fig. 1. On account of the connection of the expulsion chamber 83 with the intake of the engine a partial vacuum is produced in said chamber causing an effective vaporization of the fuel. By the connection of the chamber 83 with the receptacle 74 a partial vacuum will be produced also in this receptacle causing the valves 104 and 114 to be kept closed. The lubricating oil flowing downwardly on the expulsion surfaces 72 and being freed from at least the greatest part of the fuel flows down through the channels 96 of the cover 73 into the receptacle 74. When in said receptacle the oil has risen to a given level the float 97 is lifted causing the float arm 98 to engage the valve spring 99 which is initially stretched on account of the valve plate 104 being kept pressed against its seat with a certain power by the outer pressure. At a given stretching the spring 99 is capable of tilting the valve plate 104 upwardly by means of the eccentrically disposed pin 106 resulting in air flowing into the receptacle 74 through the holes 110 in the nut 109 and the channels 107 of the plug 101 causing a pressure equalization to take place between the interior of the receptacle 74 and the outer air. On account thereof the bottom valve 114 is opened and the purified lubricating oil is returned to the circulation system, e. g. to the crank case through pipe 35 in Fig. 1. The float 97 sinks and the air valve 104 is closed causing a partial vacuum to be produced in the space 83 and the receptacle 74 resulting in the bottom valve 114 being closed. The operation described is then repeated.

On account of the bottom valve 114 being shaped as a cup a liquid seal will be produced around its seat at the lower edge of the sleeve 113. On account of the air valve 104 being provided with a groove 105 (see Fig. 7) through which always a given quantity of air enters the receptacle 74 the vacuum in the latter can be kept at such a value that the air valve 104 can be opened without too great a power being required for this purpose.

In Figs. 9 to 12 another embodiment of a rectifier is shown adapted to be used according to my invention in combination with a carburetor arrangement for carrying out my improved method.

Referring to this embodiment the rectifier comprises an expulsion chamber 130 which is limited by a double-walled jacket 131, an upper cover 132 and a lower dished receptacle 133 serving to collect the purified oil and provided with an outlet 134 for the return of said oil to the crank case of the engine, e. g. through pipe 35 in Fig. 1. Arranged centrally within the chamber 130 is a tube 135 having flanges or other surface-enlarging means provided on the outside thereof, preferably in the form of a helically extending band 136 welded or secured in some other manner to the tube 135, said band 136 forming an extended path of flow for the oil-fuel mixture. At its lower end the tube is screwed into an opening in a pipe 139 extending through the dished receptacle 133, said pipe being closed at its one end as shown at 144 in Fig. 10 and at its other end provided with a nipple 137 (see also Fig. 10) adapted to be connected to the exhaust of the engine or to some other conduit branched off therefrom, e. g. pipe 32 in Fig. 1 so that the exhaust gases are caused to flow upwardly through the central tube 135 whence they escape through an upper pipe bend 138, e. g. through pipe 33 in Fig. 1.

The rectifier is provided with means for heating the entering oil-fuel mixture, before this mixture is brought into contact with the flange 136 serving as an expulsion surface. In the embodiment shown this preheating means consists of a helically shaped pipe 140 arranged around the heating body formed by the flanged tube 135, 136 and outside the flange 136, said pipe being adapted to be connected to the crank case of the engine by means of a passage 141 and a nipple 142, the mixture of fuel and oil being conveyed to the preheater from the crank case in known manner by means of a pump, e. g. pump 23 and pipe 34 in Fig. 1. The upper part of the helix opens at 143 more or less adjacent to the central tube 135, immediately above the uppermost turn of the band 136, so that the oil-fuel mixture from the tube may flow down upon the helix.

In the embodiment referred to the expulsion chamber 130 communicates at its lower end through a passage 145 with a pipe 146 which extends upwardly along the casing 131 and opens freely into the atmosphere at its upper end. At its upper end the expulsion chamber 130 is provided with a nipple 147 or the like, by means of which said chamber may be connected with the intake of the engine, e. g. through pipe 36 with pipe 25 in Fig. 1 so as to cause air from the pipe 146 to pass through the expulsion chamber 130.

Arranged in the circular passage 150 of the pipe 139 connecting the tube 135 with the nipple 137 (see Figs. 10 and 11) is a damper 151 secured on a shaft 152 projecting with its upper end into a chamber 153 which is separated from the passage 150 by a partition 154 provided with openings 155, the chamber 153 being covered at the top by means of a cover 156 removably secured by screws or the like (see Fig. 11). The openings 155 in the partition 154 are so arranged that the chamber 153 communicates with the passage 150 between the damper 151 and the intake to the rectifier, that is to say behind the damper, counted in the direction of flow of the exhaust gases.

The chamber 153 serves as a housing for a thermostat, which according to the invention is of the bi-metal type and consists of a bi-metallic spring 158 attached with its one end to the shaft 152 and adapted to be secured with its other end in one of a number of slots 159 provided in the wall of the chamber. By inserting the bi-metallic spiral 158 controlling the position of the damper 151 in known manner, into varying slots 159, the tension of the spiral and thus also the temperature interval for which the thermostat is to function may obviously be varied. On account of the position of the openings 155 the thermostat 158 will adjust the damper 151 in accordance with the temperature of the exhaust gases behind the damper.

The apparatus operates in the following manner:

The oil contaminated with gasoline, water and/or kerosene or other fuels and collecting in the crank case of the engine, enters through pipe 34, Fig. 1, nipple 142 and passage 141 into the preheating helix 140 whence it flows down upon the uppermost turn of the helically shaped flange 136 of the heating body. By the hot exhaust gases passing through the central tube 135 the heating body 135, 136 and thus the expulsion chamber 130 are kept at a suitable increased temperature, so that the oil mixture will be preheated during its passage through the pipe 140. From the latter the oil mixture flows in the form of a comparatively thin film or layer with a free expulsion surface down the helically shaped band 136. By the direct supply of heat to the heating body 135, 136 from the exhaust gases passing through the tube, constituents of the oil mixture that are volatile relatively to the lubricating oil, that is to say fuel diluting the oil mixture, are vaporized. By the connection of the expulsion chamber 130 to the intake of the engine through the nipple 147 air will be continually sucked in through the pipe 146 and will pass through the expulsion chamber. On account of this continuous passage of gaseous medium, viz. air, through the rectifier, said medium is capable of absorbing a great quantity of fuel vapors, as medium loaded by such vapors is continuously removed when the vapors have reached their saturation pressure, or even before. The expulsion of the fuel vapors will thereby be greatly facilitated. Expelled fuel together with air escape through the nipple 147 to the intake of the motor and thence to the cylinders, where this fuel-air mixture is utilized to perform useful work. The purified oil flows from the lower end of the expulsion surface 136 down into the collecting receptacle 133 and from the latter through the outlet pipe 134 back to the crank case or some other suitable place.

Fig. 12 shows a modification of the rectifier according to Figs. 9 to 11, in which the entering air is preheated before it is brought into contact with the expulsion surface or with the oil-fuel mixture flowing down the same. Here, the pipe 146 is disposed in the space of the double-walled jacket 131 and connected with the atmosphere by means of an opening 161 provided in the outer wall of the jacket. The pipe 146 may obviously also be arranged within the expulsion chamber or at any other suitable place permitting preheating of the air.

Probably my present invention has its most important application to engines adapted to run on gasoline and mainly operating at partial loads, for instance automobile engines, which according to my improved method and means can be run on heavy fuel without any inconvenience.

When in the foregoing description gasoline and kerosene are especially mentioned as examples of light and heavy fuel, respectively, it is to be observed that any other kinds of fuel of the light and heavy type may be used instead thereof.

As many changes can be made in the construction of the carburetor and that of the rectifier above described and many apparently widely different embodiments of the invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not at all limitative of the scope of my invention.

It is also to be understood that the language employed in the appended claims is intended to cover all the generic as well as the specific features of the invention herein described.

What I claim is:—

1. A method of running carburetor internal combustion engines on heavy fuel, which engines are constructed normally to run on light fuel, comprising controlling the supply of the two fuels in such a manner that during such periods of time when the temperature of the exhaust gases is insufficiently high to allow expulsion from the lubricating oil of fuel which entered said oil as impurity, essentially light fuel is supplied to the engine, whereas during such periods of time, when the temperature of the exhaust gases is sufficiently high to effect expulsion from the lubricating oil of heavy fuel, fuel is expelled from said oil and essentially heavy fuel is supplied to the engine.

2. In an internal combustion engine having a system for the circulation of the lubricating oil, the combination of a carburetor arrangement for light fuel as well as for heavy fuel, with a rectifier inserted into said circulation system for the expulsion of fuel from the lubricating oil, means to heat said rectifier by the exhaust gases of the engine, and means to supply light and heavy fuel to said carburetor arrangement, said supplying means being such that at high temperatures of the exhaust gases allowing expulsion of fuel from the lubricating oil by means of the rectifier, essentially heavy fuel is supplied to the engine, whereas at lower temperatures essentially light fuel is supplied to the engine.

3. In an internal combustion engine having a system for the circulation of the lubricating oil, the combination with a carburetor arrangement for light fuel as well as for heavy fuel, of a rectifier inserted into said circulation system for the expulsion of fuel from the lubricating oil, means to heat said rectifier by the exhaust gases of the engine, and means to supply light and heavy fuel to said carburetor arrangement, said

supplying means being such that at high temperature of the exhaust gases allowing expulsion of fuel from the lubricating oil essentially heavy fuel is supplied to the engine, whereas at lower temperatures essentially light fuel is supplied to the engine and the quantity of light fuel supplied decreases according as the temperature of the exhaust gases increases.

4. A method of running carburetor internal combustion engines on heavy fuel, which engines are constructed to run on light fuel, comprising supplying essentially light fuel to the engine during periods when the temperature of the exhaust gases is below the point required for expulsion from the lubricating oil of fuel which entered said oil as impurity, and supplying the engine when the temperature of the exhaust gases is above the said point with fuel expelled from the lubricating oil and with essentially heavy fuel having substantially the temperature at which light fuel is supplied to the engine.

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