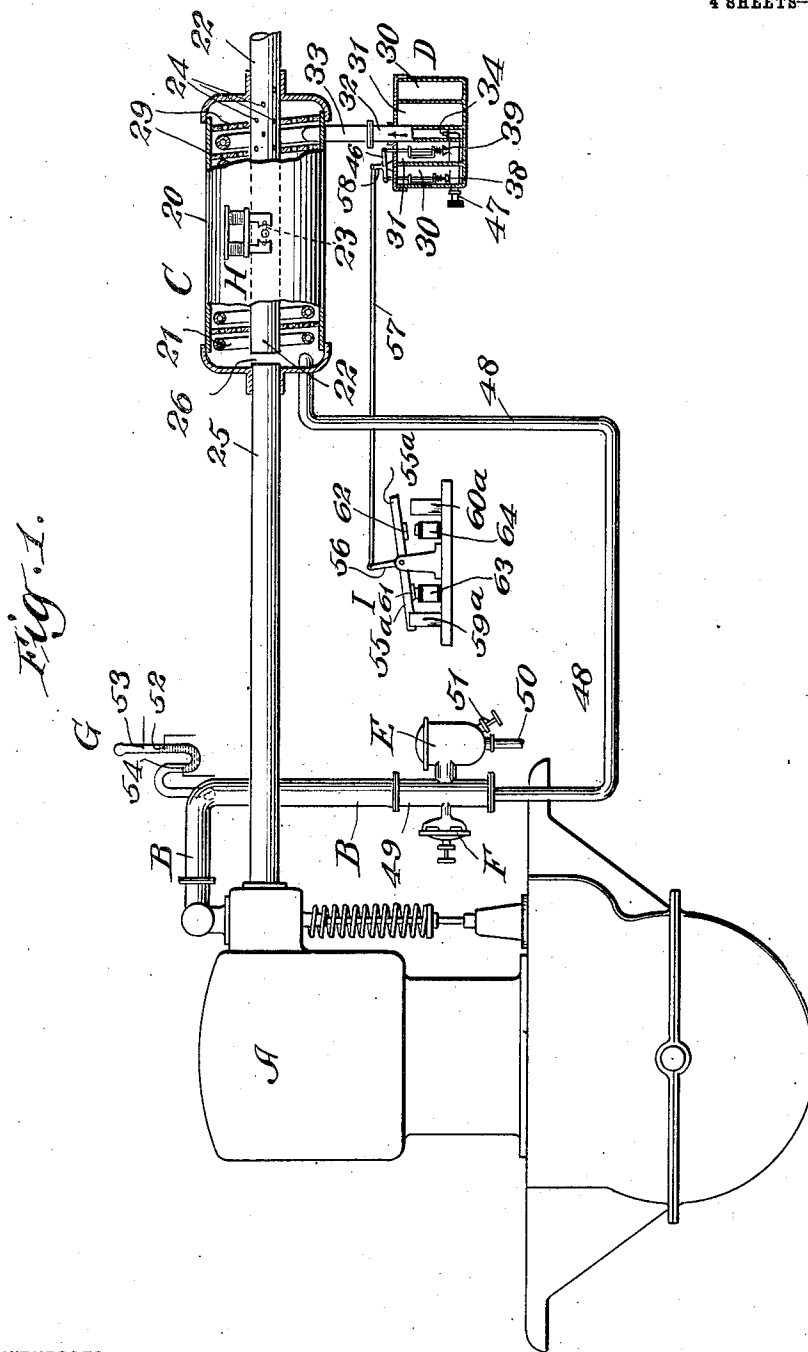


W. K. BASSFORD.
EXPLOSIVE ENGINE.
APPLICATION FILED JULY 29, 1911.

1,105,016.

Patented July 28, 1914.

4 SHEETS-SHEET 1.



WITNESSES
John H. Hanagan
J. Richards

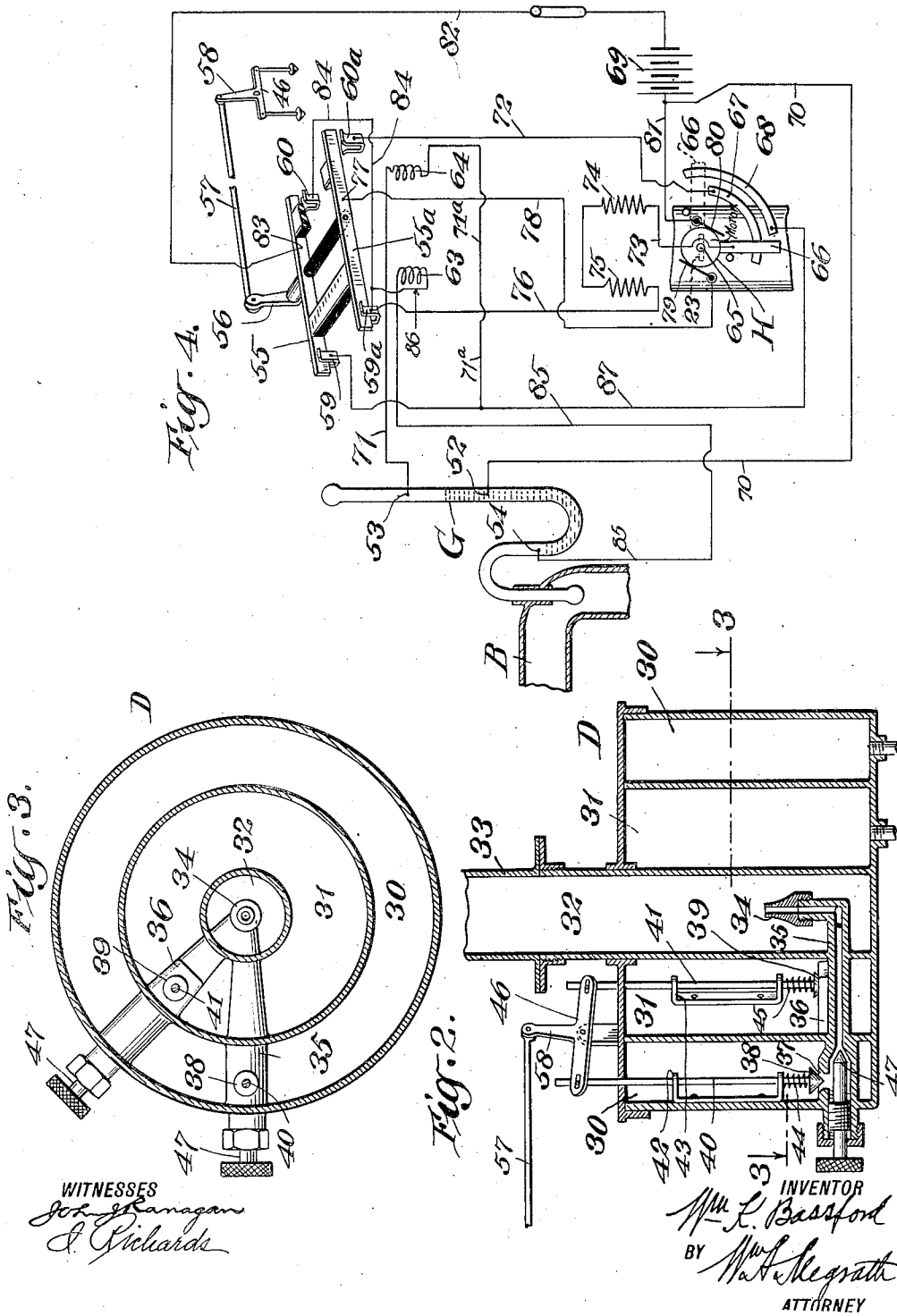
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4 SHEETS—SHEET 2.



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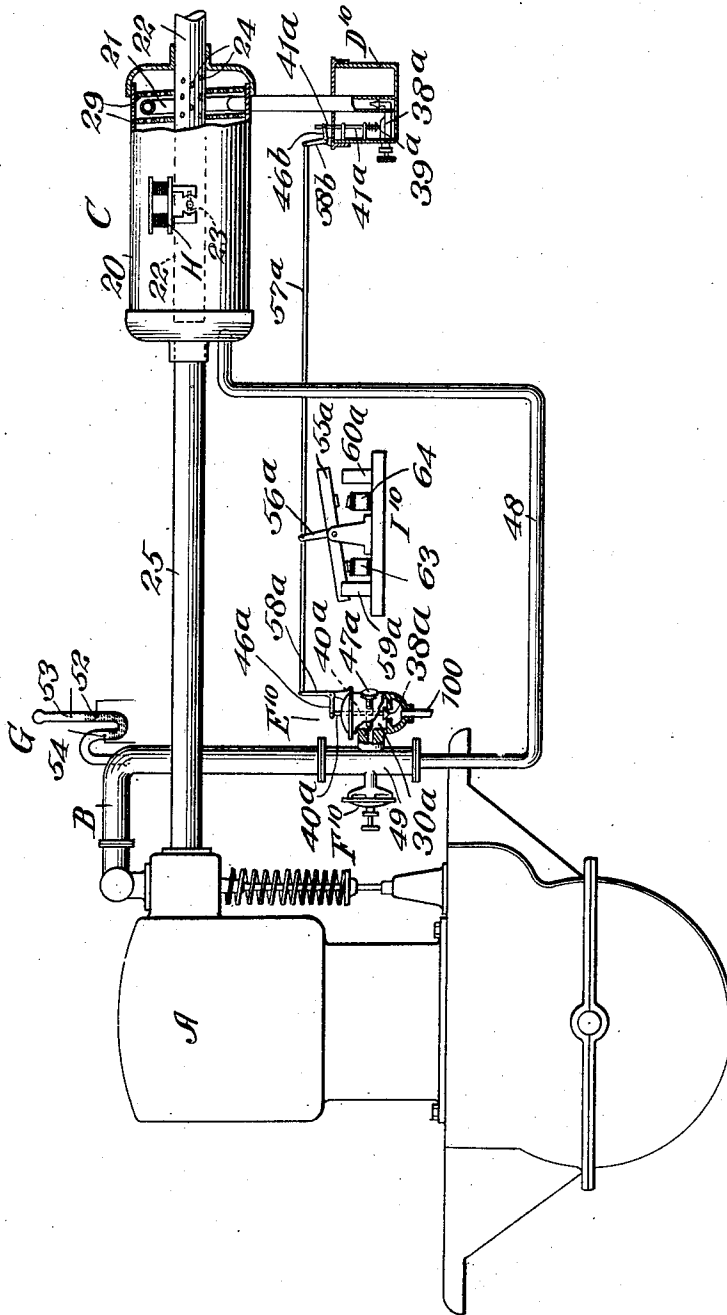
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4 SHEETS—SHEET 3.

Fig. 5.



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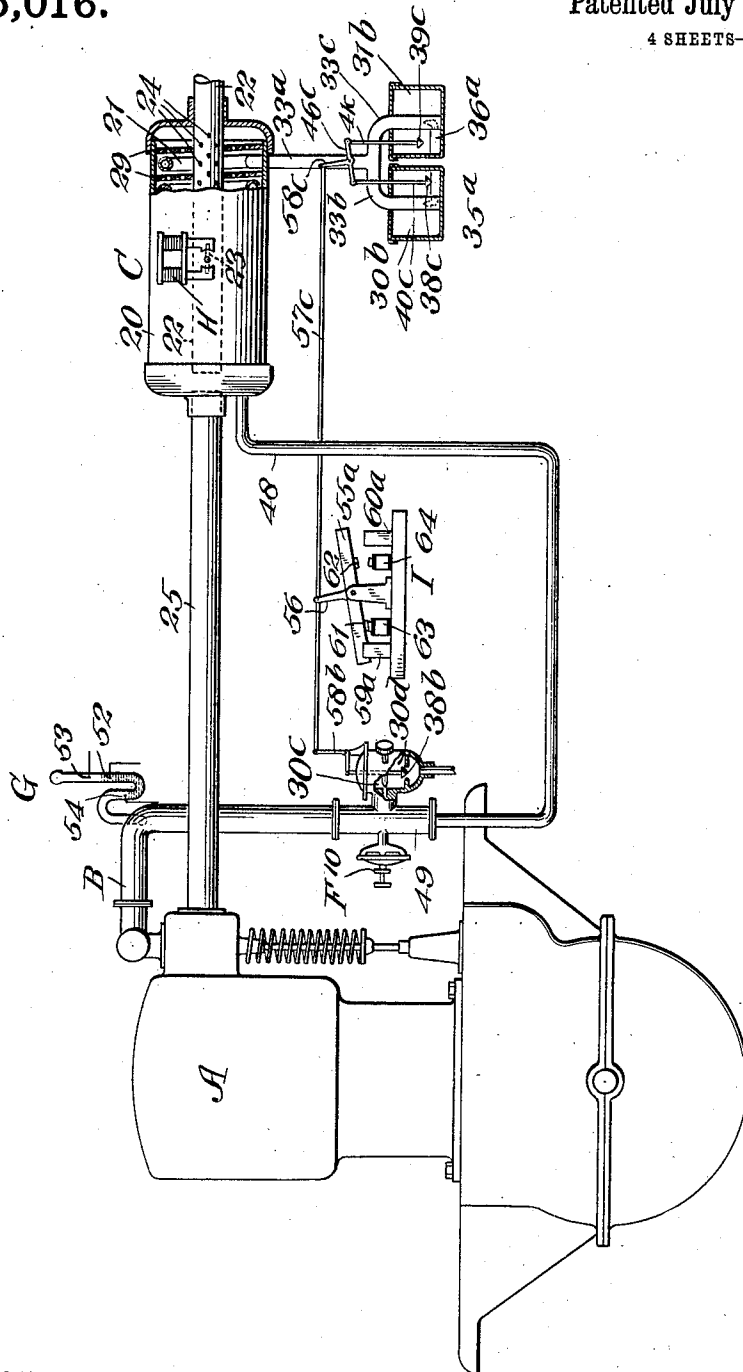
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Patented July 28, 1914.

4 SHEETS—SHEET 4.

Fig. 6.



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UNITED STATES PATENT OFFICE.

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EXPLOSIVE-ENGINE.

1,105,016.

Specification of Letters Patent.

Patented July 28, 1914.

Application filed July 29, 1911. Serial No. 641,187.

To all whom it may concern:

Be it known that I, WILLIAM K. BASSFORD, a citizen of the United States, and a resident of Perth Amboy, county of Middlesex, State of New Jersey, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

This invention relates to improvements in explosive engines of that class wherein hydrocarbon fuel, such as gasoline, kerosene, crude oil, alcohol or other volatile explosive fluids may be used.

In a more specific way, it may be said that the present invention relates to, and aims to provide, a practicable organization of an explosive engine and fuel supply system wherein liquid fuel of different specific qualities, as gasoline and kerosene, for example, are employed.

It is apparent that a system which permits the use of a heavier fuel than is now commonly employed in motor vehicles will reduce the cost of operating these vehicles, the heavier fuel being less expensive than the lighter fuel. In order that such heavier fuel may be practically and economically employed, it should be heated and provision should be made for the use of the lighter fuel when the engine is cold or is not as hot as it should be in order to secure satisfactory results from the particular heavier fuel employed. The system therefore contemplates an organization of parts whereby the engine may be started on the lighter of these fuels and then when working properly on this fuel, automatically shifting certain elements to change to the other fuel. The system includes a means by which the fuel is heated in the passage of the fuel from the fuel container to the engine, and also, includes means for carbureting the fuel prior to its admission to the engine. The heating means is connected with an appropriate part of the engine, preferably the exhaust pipe of the latter, and the means through which the heating medium flows is controllable so as to vary the heating effect received by the fuel in its passage through the heater. Thus, it is apparent that starting with a light fluid, such as cold gasoline, or gasoline in a heated condition, the last named being preferred, the advantage of a light fuel for starting purposes is obtained. When the engine is started and working well the supply

of the lighter fuel is cut off and the supply of the heavier fuel is opened and at the same time a means is operated which causes the flow of the heating medium through the heater to be retarded, so that the heavier fuel is under the effect of said heating medium for a greater length of time and hence receives a greater heating effect therefrom, it being apparent that the heavier fuel now being supplied to run the engine, requires for its best results more heat than did the lighter fuel. Should the temperature of the fuel become too high, means are provided whereby the course of the heating medium is changed, said medium being caused to flow directly through the heater instead of through the circuitous course just referred to. Again, if a condition arises wherein the temperature of this fuel becomes too low, prior to its admission to the engine, means are again operated to cause the heating medium to flow directly through the heater and at the same time to change from the heavier fuel to the lighter fuel until a temperature has been reached which makes it again advisable to use the heavier fuel, when the change to the latter and the retarding of the heating fluid is again effected. By this means it becomes practicable to run the engine with the heavier fuel, thereby reducing operating expenses.

While reference has been made to the use of gasoline and kerosene as the liquid fuels employed, it is apparent that other fuels may be used, and in fact gasoline of relatively high and poor grades may be employed, and it is not the intention herein to restrict the invention to any particular fuels, further than that they be of different specific gravities.

The means by which the courses of the heating fluid within the heater are controlled, and the means by which the flow of the lighter and heavier liquid fuels are controlled, comprise valves which are preferably automatically operated by variations in temperature of a heater fluid. In all of the present exemplifications, this fluid derives its heat primarily from the engine. Preferably, the heat of the fuel mixture is utilized to control the operation of the valves and the means by which these valves are thus operated by variations in temperature are preferably of an electrical nature, said means being most desirably composed

of a temperature actuated switch suitably connected with a motor for actuating the valve which controls the course of the heating fluid in the heater and with a magnet having connection with the valves of the fuel-supply means so as simultaneously to open one and close the other.

In the accompanying drawings, I have shown several specifically different embodiments of the present invention, but it is to be understood that while these different embodiments are very satisfactory and are considered to be the best embodiments of the invention, yet the invention is not restricted thereto and its details may be variously changed without departing from the spirit of the invention or the scope of the subjoined claims.

In the drawings, wherein like characters of reference denote corresponding parts in the several views:—Figure 1 is a view, somewhat diagrammatic of one desirable embodiment of the present invention, showing certain of the parts in section and others in elevation. Fig. 2 is a detail sectional view, on a larger scale than Fig. 1, showing the fuel container and its valves. Fig. 3 is a horizontal section on the line 3—3 of Fig. 2. Fig. 4 is a diagrammatic view of the preferred means for operating the valves which control the flow of the heating medium and of the fluids used as fuel. Fig. 5 is a view, partly in elevation and partly in section of a specifically different embodiment of the invention. Fig. 6 is a like view of another slightly changed embodiment of the invention.

In all the figures of the drawings, the part marked A represents an internal combustion engine of any suitable kind: B the fuel supply pipe thereof: and C a means by which the fuel is heated prior to its admission to the engine. The heating means is of the construction shown in my co-pending application, Serial No. 623,898, filed April 28, 1911, comprising a closed vessel 20 containing a coil 21 and an exhaust pipe 22. Said exhaust pipe preferably discharges into the atmosphere and is provided within the heater with a valve 23 and perforations 24. It extends through one end of the heater and through the coils 21 nearly to the other end of the heater and its latter end is arranged in juxtaposition to and in line with the outlet end of a pipe 25, which pipe extends from the exhaust of the engine A. It will be noted that the outlet end of the pipe 25 and the inlet end of the pipe 22 are separated from each other by an open space, marked 26 and that the valve 23 is arranged at a distance from the inlet end of the pipe 22 while the perforations 24 are between the valve and the outlet end of said pipe. It will therefore be apparent that when the valve 23 is turned to close the

pipe 22 the exhaust products entering the heater by way of the pipe 25 will be caused to flow around the coil 21 and will enter the pipe 22 by way of the perforations 24, whereas when the valve 23 is open the exhaust products, or a considerable part thereof will enter the inlet end of the pipe and will flow directly through the same from the pipe 25. The first-described course of travel of the exhaust products obviously causes it to deliver a greater heat to the fuel which is traveling through the coil 21 than does the second described course of travel of the exhaust products, and in order to further increase the heating effect received by said fuel, a baffling means is interposed in the path of travel of the exhaust products around the pipe 22. This baffling means is preferably formed of a series of spirally arranged perforated diaphragms 29 arranged so that their convolutions alternate with the convolutions of the coil 21. Said baffling means may be continuous or made in sections, as preferred.

Referring now to the particular embodiment of the invention illustrated by Figs. 1, 2, 3 and 4, D designates a suitable container having compartments 30 and 31 for fuel of different specific gravities, as gasoline, and kerosene, for example. These compartments provide separate sources of supply for said fuels and in this particular form are shown as being concentrically arranged. The container also has a pipe or tube 32 which is connected by a pipe 33 with the inlet end of the coil 21. Within the pipe 32 there is a nozzle 34 which is common to two branches 35 and 36, each having an inlet 37, the inlet to the branch 35 being in compartment 30, while the inlet to the branch 36 is in the compartment 31. These inlets 37 are controlled by valves 38 and 39, having stems 40 and 41 respectively slidably mounted in guides 42 and 43, and also having springs 44 and 45 for moving them in one direction. They are moved alternately, in opposition to their respective springs, by a rocker arm 46 which is automatically operated as will be hereinafter more particularly set forth. The branches 35 and 36 are provided with adjustably mounted needle valves 47 by which the quantity of liquid flowing therethrough is regulated.

The discharge end of the coil 21 is connected by a pipe 48 with one end of the fuel-inlet pipe B and between the pipes 48 and B there is a connecting section 49 which is provided with a carbureter or vaporizer E and with a valve F for admitting an auxiliary supply of air to this section 49. The carbureter F is connected by a pipe 50 with a source of supply of light fuel, as gasoline, and has, as usual, a valve, indicated at 51 for controlling the inlet of air thereto.

G designates a thermostatic switch of the mercury type: H designates a suitable motor which is controlled thereby and automatically operates the valve 23 which controls the course of the fuel-heating medium in the heater C and I designates a suitable electro-magnet which is also controlled by said switch and serves to operate the valves 38 and 39 of the fuel-supply means. The thermostatic switch G in practice is located in any appropriate part of the system, being herein shown as having one of its legs extending into the supply pipe B so as to be exposed to the temperature of the medium passing therethrough and in such relation to the engine that it will be exposed to the temperature of the latter, but any other suitable arrangement thereof, may be employed in lieu of the one herein particularly illustrated. The switch has three terminals, marked 52, 53 and 54 respectively arranged for contact with the mercury.

The switch I has rocking blades 55 and 55^a provided with an arm 56 which is connected by a link 57 with an arm 58 projecting from the rocker 46. The ends of the blade 55 respectively make contact with suitable terminals 59 and 60 and the ends of the blade 55^a respectively make contact with terminals 59^a and 60^a. These blades carry armatures 61 and 62 (see Fig. 1) for the electro-magnets 63 and 64 respectively, which control the rocking movement of the switch blades and their contact with the respective terminals. These electro-magnets are preferably of very high resistance.

Suitably mounted on the heater C is the motor H, the shaft 65 of which is attached to valve 23 so as properly to rotate the valve when contact is made by the switch blades 55 and 55^a with the proper terminals, the latter operation being in turn controlled by the closing of circuits through the magnets 63 and 64 by contacts made in the thermostat G. These several circuits will now be traced, reference being had to Fig. 4.

The valve 23 has an arm 66 movable over segments 67 and 68 which are arranged in such relation to each other that one end of each projects beyond the corresponding end of the other, so that when the arm is at the extreme position in either direction it will be in contact with only one of these segments. With the arm 66 in contact with the segment 67 only, in which position it is shown in full lines in Fig. 4, the valve 23 is closed, in the herein exemplified arrangement, and the switch blades 55 and 55^a are engaged with terminals 59 and 59^a. When the temperature of the fuel has attained a predetermined degree, the mercury in the thermostat rises to contact 53 and connects the same with contact 52, whereupon the current from battery 69 flows through wire 70 to contact 52, through the mercury to

contact 53, through wire 71 to the electro-magnet 64, through wire 71^a to terminals 59 through blade 55 to terminal 83 through wire 82 back to battery. This closes a circuit through magnet 64 which operates to rock the switch blades out of contact with terminals 59 and 59^a and into contact with terminals 60 and 60^a, and although a circuit is at the same time completed through the motor it is immediately broken and another circuit is formed as soon as the switch blades contact with terminals 60 and 60^a current flowing from battery through wire 82 to switch terminal 83, through switch blade 55 to terminal 60, through wire 84 to terminal 59^a, through wire 76 and through the fields 75 and 74, through wire 73 and arm 66 to segment 67, through 72 to terminal 60^a, through switch blade 55^a to terminal 77, through wire 78 and through brushes 79 and 80 and wire 81 back to the battery. This latter circuit causes rotation of the motor until the arm 66 moves beyond the end of segment 67 and is on to segment 68 only, thus opening the valve 23 so that the temperature of the fluid flowing through the heater coil will be reduced and afterward breaking the circuit. At the same time, and through the connections previously described, the rocker 46 will be moved to the position shown in Fig. 2.

When the temperature has fallen sufficiently, the mercury in the thermostat will move out of contact with terminal 53 and into contact with terminal 54, so as to bridge contacts 52 and 54, and when this occurs the motor H will be reversed to close the valve 23, this being accomplished as follows. The current from battery 69 will flow through wire 70 to contact 52, through the mercury to contact 54, through wire 85 to electro-magnet 63, through wires 86 through wire 84 to terminal 60, through blade 55 to terminal 83, through wire 82 back to the battery 69, thus closing the circuit through electro-magnet 63 which pulls down the switch blades to the position shown in Fig. 4 wherein they engage the terminals 59 and 59^a, and closing the motor circuit, reversing the field and causing the motor to revolve back to its original position also shown in Fig. 4. The current in this motor-actuating circuit, flows from the battery 69 by wire 82 to the switch terminal 83, through blade 55 to terminal 59, through wire 87 to segment 68, through arm 66 and wire 73, fields 74 and 75 and wire 76 to terminal 59^a, through switch blade 55^a to terminal 77, through wire 78 and brushes 79 and 80 and wire 81 back to battery, causing the motor to revolve in the proper direction until arm 66 passes the end of segment 68 and rests wholly on segment 67. This movement also causes rocker 46, through the described connections to close the gasoline valve 38 and open the

kerosene valve 39 at the same time the valve 23 is closed to cause the exhaust gases to pass around the pipe 22 in the heater. It will thus be seen that, in this exemplification of my invention, each movement of the motor must be in a relatively opposite direction to that of the preceding movement, due to which each motor-actuating circuit is preceded by a circuit changing the position of the switch blades so that the current will thereafter flow through the motor fields in a proper direction. In other words, each circuit completed through the motor is preceded by a circuit which energizes one of the two electro-magnets and arranges the elements of the motor circuit so that current flows therethrough to rotate the motor in a proper direction. Further, the connections between the magnet controlled switch and the valves controlling the supply are such that upon each rocking movement of the switch, one of the fuel valves is cut off and the other turned on. The operations of the fuel valves are in such relation to the movements of the motor, that when the heater valve is open to permit free passage of the exhaust gases, the gasolene valve is open and the kerosene valve is closed, while when the heater valve is closed to retard the exhaust gases and raise the heat therein, the gasolene valve is closed.

It will be apparent that, if it is considered desirable to do so, the two fuel valves may be operated by suitable connections with the motor which operates the valve of the heater; and it will also be apparent that instead of using separate valves for controlling the supply of the hydrocarbon fuels, a single valve of suitable construction may be employed, as a three-way valve for example, and these changes and others not necessary herein to set forth, are contemplated to be within the spirit of the invention considered in its broadest aspect.

In the form of the invention shown in Fig. 5, the separate sources of supply of the lighter and heavier fuels are embodied in separate tanks or containers, one of which is connected by a pipe 100 with a carbureter or vaporizer. In other words, instead of employing a container having two compartments, one for each fuel fluid, a container with one compartment only may be employed with a separately supplied carbureter for the other fluid. The container of this form of the invention is marked D¹⁰ and the carbureter is marked E¹⁰. The former has only one valved pipe (marked 38^a) and is used for the heavier fuel, as kerosene for example. The valve of this pipe is marked 39^a and its stem is marked 41^a. The vaporizer or carbureter E¹⁰ has a valve 38^a whose stem is marked 40^a. The switch I¹⁰ which may be identical with that employed in the other form has its arm 56^a connected

by a link 57^a with the arms 58^a and 58^b of rocking levers whose other arms 46^a and 46^b are connected to the stems 41^a and 40^a respectively. A valve, marked 47^a controls the quantity of the lighter fuel supplied, the latter flowing from the chamber 30^a of the carbureter into the mixing chamber 49, which has the air inlet valve F¹⁰. It will be apparent that this system will operate precisely as does the other, except that the carbureter E and the valved gasolene tank of the latter are dispensed with and their place taken by a vaporizer having a gasolene chamber whose inlet is controlled by a valve in the same manner as is the valve of the gasolene compartment of the first construction.

In Fig. 6 a further modification is shown. In this there are three separate chambers marked 30^b 31^b and 30^c respectively. The chambers 30^b and 30^c are for the lighter fuel, as gasolene, and the chamber 31^b is for the heavier fuel, as kerosene. The chamber 30^c is in a part of the carbureter, the latter being like that shown in Fig. 5. The chambers 30^b and 31^b are shown as separate tanks connected with the coil of the heater by a pipe 33^a having branches 33^b and 33^c leading to the tanks respectively. Each tank has a pipe said pipes being marked 35^a and 36^a. They are provided with inlet valves 38^c and 39^c having stems 40^c and 41^c connected by a rocker 46^c whose arm 58^c is connected by a link 57^c with the switch precisely as in the first construction. This link however, in Fig. 6, also extends to the rocking lever, marked 58^b of the valve 38^b controlling the inlet to the chamber 30^d of the carbureter. The valves 38^c and 38^b are so set that there is one-half a supply of the lighter fluid from the chamber 30^c and the other half from the chamber 30^b, the latter being preheated and mixed with the vapor from chamber 30^c and with air, in the chamber 49, said chamber 49 having the air inlet valve F¹⁰. It will be noted that the two valves 38^c and 38^b operate to open and close together and alternately with respect to the valve 39^c. The operation otherwise will be understood.

Having now described the invention what I believe to be new and desire to secure by Letters Patent, is:

1. In combination with a gas engine, means for supplying the same with explosive gaseous materials respectively derived from liquid fuels of different qualities, comprising separate sources of supply of said fuels, valvular means for controlling said sources of supply, means for conducting a fluid heating medium from the engine and the fluid fuel from one of said sources of supply in such relation to each other that the fuel will be heated by said medium in its passage to the engine, said means providing different courses of travel for one of said

fluids, whereby the heat imparted to the fuel is variable by changing the relative courses of travel of the fuel and heating medium, a valve for controlling said relative courses of travel, and an operative connection between said valve and the valvular means of the fuels-supply.

2. In combination with a gas engine, a heater communicating with the exhaust thereof, means for supplying the engine with fuels derived from liquids of different qualities, said means including a conduit communicating with the engine, said conduit being of such relation to the heater that the fuel will be heated in its passage to the engine, a container for the respective fuels connected to the conduit in advance of the heater, another means for supplying the engine with fuel derived from a liquid and communicating with the conduit between the heater and the engine and a valve-controlled air inlet communicating with the fuel conduit between the heater and the engine.

3. In combination with a gas engine, means whereby the same is supplied with explosive gaseous materials respectively derived from liquids of different specific qualities, comprising a heater having valve-controlled means forming courses of travel for a heating medium therethrough and also having means whereby a hydrocarbon fuel may flow through the heater, valved sources of supply of fluids of different specific qualities and means controlled by heat derived from the engine for automatically controlling the valves of the heater and fuel supplies.

4. In combination with a gas engine, valved means through which the same is supplied with explosive gaseous materials respectively derived from liquids of different specific gravities, a heater in the path of travel of one of the gaseous materials, said heater having valve-controlled passages for a heating medium, a thermostat and means controlled by the latter and having connection with the valves of the heater and hydrocarbon-supply means for operating said valves automatically.

5. In combination with a gas engine, separate chambers for fuels of different specific gravities, a heater having means through which said fuels pass, means for vaporizing the fuels, separate valves for controlling the flow of the fuels, the heater also having means forming a plurality of courses of travel therein for a heating medium, a valve for controlling the courses of travel of the heating medium, and a means controlled by heat derived from the engine for automatically operating the valves of the fluid supply and the valve of the heater.

6. In combination with a gas engine, separate chambers for fuel of different specific qualities, valves for controlling the supply of said fuels, a heater having valve-con-

trolled passages for a heating medium and also having means forming a passage for one of the fuels, a thermostatic element arranged to be operated by heat derived from the engine and means between the thermostatic element and the valves of the fuels supply and heater for operating the same under control of the former.

7. In combination with a gas engine, separate chambers for fuels of different specific qualities, valves for controlling the supply of said fuels, respectively, said valves being connected with each other to move simultaneously in opposite directions so as to close one port while opening the other, a heater having valve-controlled passages for a heating medium and also having means through which said hydrocarbon fuels pass, a thermostatic element arranged to be operated by heat derived from the engine and means connecting the thermostatic element with the valves of the fuel supply and heater for operating said valves under control of the thermostatic element.

8. In combination with a gas engine, separate chambers for fuels of different specific qualities, valves for controlling the supply of said fuels, rocking arms respectively connected to said valves, said arms having connection with each other and being adapted to open and close the valves alternately, a thermostatic element arranged to be operated by heat derived from the engine and means between the thermostatic element and said arms for operating the latter.

9. In combination with a gas engine, separate chambers for fuels of different specific qualities, valves for controlling the supply of said fuels, rocking arms respectively connected to said valves, said arms having connection with each other and being adapted to open and close the valves alternately, a heater having valve-controlled passages for a heating medium and also having means forming a passage for one of the fuels, a thermostatic element arranged to be operated by heat derived from the engine and means arranged to be operated by the thermostatic element to operate the valve of the heater and said arms.

10. In combination with a gas engine, separate chambers for fuels of different specific qualities, valves for controlling the supply of said fuels, rocking arms connecting with each other and being adapted to open and close the valves alternately, a heater having valve-controlled passages for a heating medium and also having means forming a passage for both of the fluids, a thermostatic element arranged to be operated by heat derived from the engine and means connecting the thermostatic element with the valve of the heater and with said arms.

11. In combination with a gas engine, separate chambers for fuels of different

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specific qualities, valves for controlling the supply of said fuels, an exhaust pipe leading from the engine, a heating chamber connected to the exhaust pipe, an exhaust
 5 outlet pipe from said chamber, extending into the latter, a valve in said pipe, the latter pipe having inlets at opposite sides of the valve, means forming an indirect passage for exhaust gases around the exhaust
 10 pipe, means through which one of the fuels pass through said heater, a thermostatic element arranged to be operated by heat derived from the engine, and means whereby the valves of the fuel supply means and the
 15 heater are operated under control of the thermostatic element.

12. In combination with a gas engine, separate chambers for fuels of different specific qualities, valves for controlling the
 20 supply of said fuels, an exhaust pipe leading from the engine, a heating chamber connected to the exhaust pipe, an exhaust outlet pipe from said chamber, extending into the latter, a valve in said pipe, the latter
 25 pipe having inlets at opposite sides of the valve, means forming an indirect passage for exhaust gases around the exhaust pipe, means through which both of the fuels pass through said heater, a thermostatic element
 30 arranged to be operated by heat derived from the engine, and means whereby the valves of the fuel supply means and the heater are operated under control of the thermostatic element.

35 13. In combination with a gas engine, means for the supply of fuels of different specific qualities thereto adapted to shift from one fuel to the other, said means having a controlling element which is operated
 40 by variations in the temperature of the fuel being supplied for causing the shifting from one fuel to the other to be automatically accomplished.

45 14. In combination with a gas engine, valved means for the supply of fuels of different specific qualities, thereto, a heater through which one of the fuels flows in its passage to the engine, said heater having means forming direct and indirect passages
 50 for the flow of the heating fluid thereto with a valve for controlling such flow, an actuating element operated by heat derived from the engine and means whereby the latter automatically operates the valves of
 55 the heater and supply means, to change the course of travel of the heating medium and to change the supply of fuel from the lighter to the heavier or from the heavier to the lighter.

60 15. In combination with a gas engine, valved means for the supply of fuels of different specific qualities thereto, a heater through which both of the fuels flow in their passage to the engine, said heater having
 65 ing means forming direct and indirect pas-

sages for the flow of the heating medium thereto with a valve for controlling such flow, an actuating element operated by heat derived from the engine and means whereby the actuating element automatically operates the valves of the heater and supply
 70 means, to change the course of travel of the heating medium in the heater and to change the supply of fuel from the lighter to the heavier or from the latter to the lighter.

75 16. In combination with a gas engine, valved means for the supply of fuels of different qualities to the engine, and electrically operated means for shifting the valves of the fuel supply means to change from
 80 one fuel to the other, comprising a movable element having connection with said valves and means forming separate circuits for operating said element, the circuit forming means having an element whereby one of
 85 said circuits may be completed and the other broken under control of heat derived from the engine.

90 17. In combination with a gas engine, valved means for supplying explosive fuels of different specific qualities, a heater, connections between said fuel supplying means and the engine, certain of which connections extend through said heater, an exhaust pipe
 95 leading from the engine to the heater, a valve in the heater, electrical connections for alternately opening and closing said heater valve and alternately establishing communication between said supply means and the engine in fixed relation to the move-
 100 ments of the heater valve and means controlled by heat derived from the engine for completing said connections.

105 18. In combination with a gas engine, valved means for supplying fuels of different specific qualities, a heater, an exhaust pipe leading from the engine to the heater, valve controlled means to regulate the temperature within said heater, an electrical element for opening and closing the heater
 110 valve, means forming circuits through said element, a member movable to complete said circuits and cause alternately opposite movement of said element, said member having connection with the fuel supply means
 115 whereby to alternately establish communication between the same and the engine, and means to automatically actuate said movable member including electrical circuits and a switch controlled by heat derived from the
 120 engine for closing the same.

125 19. The combination of a gas engine, a valved heater, valved means for supplying explosive fuels of different specific qualities, having connection with the engine through said heater, a motor having connection with the heater valve to open and close the same, a rocking, double-throw switch in circuit
 130 with said motor and movable to close the motor circuit and cause rotation of the mo-

tor in alternately opposite directions, said switch having armatures upon opposite sides of its pivot and having connections with the supply means to alternately establish communication between the same and the engine, electro-magnets adjacent the said armatures, and a thermostatic switch in circuit with said electro-magnets.

20. In combination with a gas engine, means for supplying the same with explosive gaseous materials respectively derived from liquid fuels of different qualities, comprising separate sources of supply of said fuels, valvular means for controlling said sources of supply, a conduit connected to the inlet port of the engine and common to said fuels, means for conducting a fluid heating medium from the engine and the fluid fuel from one of said sources of supply in such relation to each other that the fuel will be heated by said medium in its passage to the conduit, said means providing different courses of travel for one of said fluids, whereby the heat imparted to the fuel is variable by changing the relative courses of travel of the fuel and heating medium, a valve for controlling said relative courses of travel, an operative connection between said valve and the valvular means of the fuels-supply, and means operatively related to said conduit and adapted to be operated under control of the temperature of the fuel-mixture flowing through the latter, for operating said valves, said means having connection with one of the valves.

21. In combination with a gas engine, valved means for supplying fuels of different specific qualities, a heater, an exhaust pipe leading from the engine to the heater, connections between said fuel supplying means and the engine, certain of which connections extend through said heater, and means to control the temperature of said heater and the communication between said fuel supplying means and the engine, by the temperature of the supply fuel.

22. In combination with a gas engine, valved means for supplying fuels of different specific qualities, a heater, an exhaust pipe leading from the engine to the heater, connections between said fuel supplying means and the engine, certain of which connections extend through said heater, electrical connections to control the temperature of said heater and the communication between said fuel supplying means and the engine, and thermostat means in the fuel supply, to complete said connections.

23. In combination with a gas engine, a heater, an exhaust pipe leading from the engine to the heater, means to regulate the temperature within said heater, said means having a valve, an electrical element having connection with the valve of said means to open and close the same, means forming

separate circuits through said element whereby to move the same in reverse directions, a second electrical element movable to make contact between terminals of said circuits and to alternately open and close the same, and means to automatically actuate said second element including electrical circuits and a switch controlled by heat derived from the engine for closing the circuits.

24. In a fuel supply system for internal combustion engines, valve-controlled chambers for fuels of different specific qualities, a heater through which the fuels flow in their passage from said chambers, said heater having means providing a plurality of courses of travel for a heating fluid there-through, means through which it has communication with the exhaust of the engine for the supply of said heating fluid and a valve for controlling the course of travel of the heating fluid, means connecting the valves of the heater and fuel chambers with each other, and means for automatically operating said valves under control of the heated fuel, comprising an electric motor, contacts, a pivoted arm adapted to engage said contacts, means for operating said arm under control of variations in temperature of the fuel, electrical connections between the contacts and motor, and means whereby the motor is connected to one of the valves.

25. In a fuel supply system for internal combustion engines, valve-controlled chambers for fuels of different specific qualities, a heater through which the fuels flow in their passage from said chambers, said heater having means providing a plurality of courses of travel for a heating fluid there-through, means through which it has communication with the exhaust of the engine for the supply of said heating fluid, and a valve for controlling the course of travel of the heating fluid, and means for automatically operating the valves of the fuel chambers and heater under control of the heated fuel.

26. In combination with a gas engine, a heater, an exhaust pipe leading from the engine to said heater, a valved source of fuel supply for light fuel, a second valved source of fuel supply for heavy fuel, connections between said sources of fuel supply extending through the heater, means for alternately opening and closing the valves of said fuel supplies, and means controlled by heat derived from the fuel being supplied to the engine for actuating said valve operating means.

27. In combination with a gas engine, a heater, an exhaust pipe leading from the engine to the heater, valved means for supplying fuels of different specific qualities, having connection with the engine through the heater, a third valved means for supplying

fuel located in said supply connection between the heater and engine, means for controlling communication between said fuel supply means and the engine, and means controlled by heat derived from the fuel being supplied to the engine for actuating said fuel controlling means.

28. In combination with an engine, a heater, a fuel supply comprising two chambers having connection with the engine through said heater, and adapted to contain fluids of different specific qualities, a spray nozzle extending into the said connection, each of said fluid chambers having a connection with said nozzle, independent adjusting valves in said last named connection, cut-off valves also in said connections, means to alternately open and close the said cut-off valves and means controlled by heat derived from the fuel being supplied to the engine to actuate said valve operating means.

29. In combination with an engine, a

heater, a fuel supply comprising two chambers having connection with the engine through said heater, and adapted to contain fluids of different specific qualities, a spray nozzle extending into the said connection, each of said fluid chambers having a connection with said nozzle, an adjusting valve in each of said last named connections, a cut-off valve also in each of said connections, a rocking switch having connections with said cut off valves to alternately open and close the same, electrical elements for controlling movement of said switch, and a thermostatic switch in the fuel supply and in circuit with said electrical elements to actuate the same.

In witness whereof I have hereunto set my hand at the city, county and State of New York, this 21st day of July, 1911.

WILLIAM K. BASSFORD.

In presence of—

ISABEL R. RICHARDS,

JOHN J. RANAGAN.