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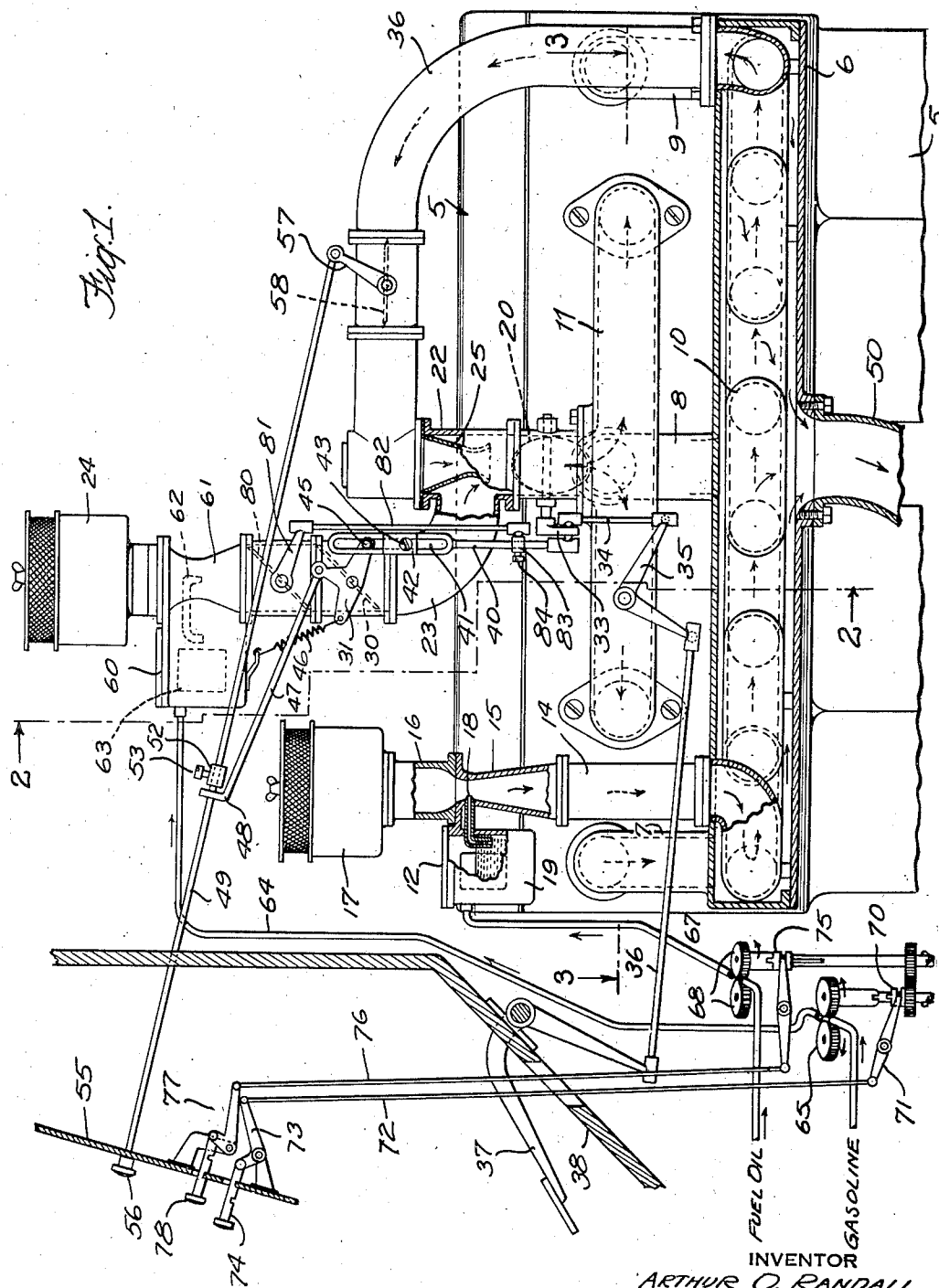
A. O. RANDALL

2,402,080

FUEL SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Filed July 31, 1943

2 Sheets-Sheet 1



INVENTOR

ARTHUR O. RANDALL

BY

Moses & Nott
ATTORNEYS

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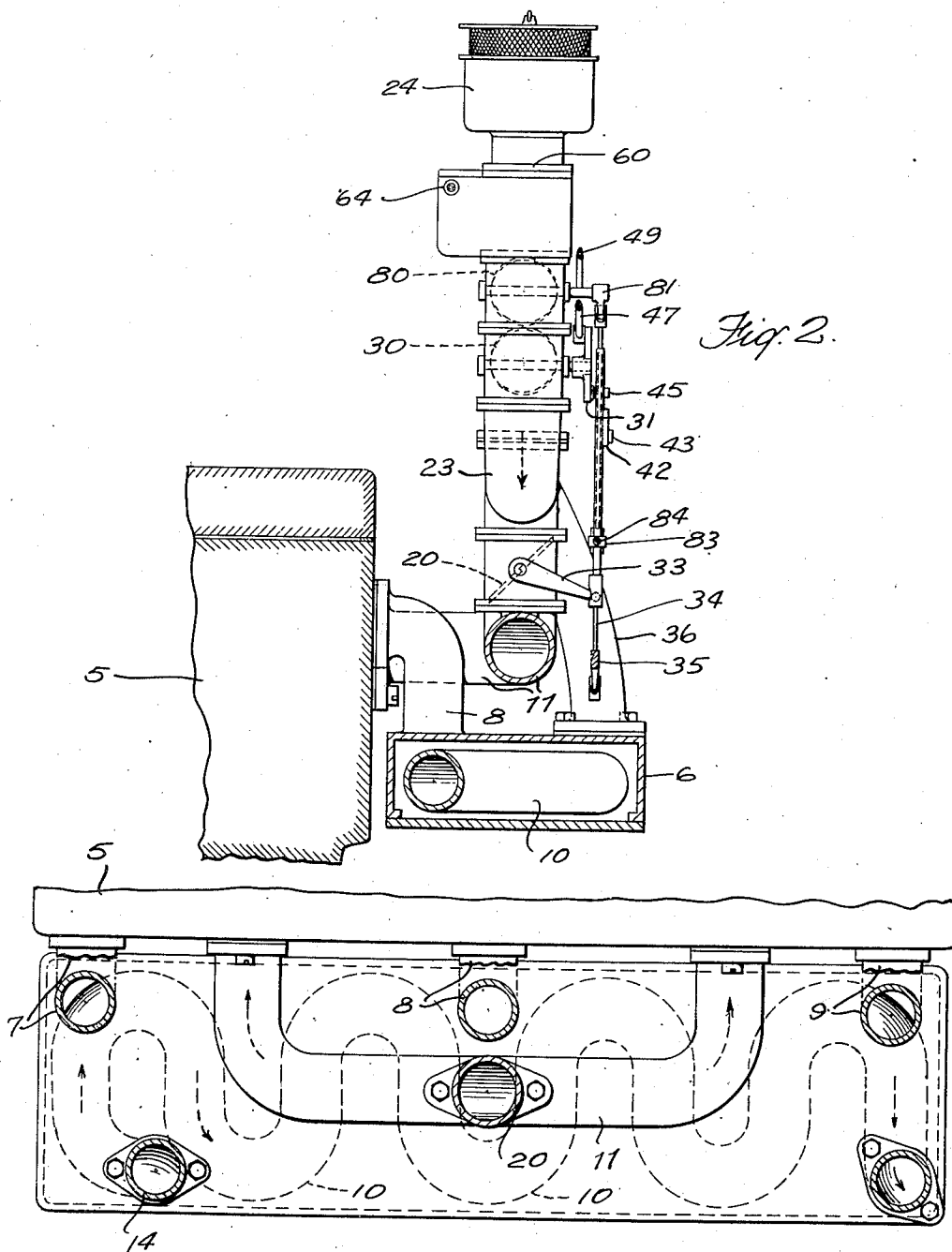


Fig. 3.

INVENTOR
ARTHUR O. RANDALL
BY
Moses & Nott
ATTORNEYS

UNITED STATES PATENT OFFICE

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FUEL SYSTEM FOR INTERNAL-COMBUSTION
ENGINESArthur O. Randall, Sea Girt, N. J., assignor to
Vee-Van Inc., a corporation of New Jersey

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This invention relates to fuel systems for internal combustion engines and its principal object is to provide a system using liquid fuel which is completely vaporized before being introduced into the engine, so that it is used in the form of a gas rather than as an atomized mixture containing liquid particles. The provision of means for completely vaporizing the fuel makes it possible to use fuel of less volatile character than gasoline, but it is also valuable to convert the fuel into gaseous form even in the case of fuels of low boiling point.

A further object of my invention is to provide a fuel system of such nature that when applied to the common low compression or moderate compression engine which is used to power the ordinary automobile it will enable such an engine to operate with economy approaching that of engines of the high compression fuel injection type.

Another object of my invention is to provide a fuel system which by completely vaporizing the fuel prevents liquid fuel from entering the cylinders where it tends to pass the pistons and enter the crankcase thereby diluting the lubricating oil and injuring the lubrication of the engine.

It has heretofore been proposed to utilize means for vaporizing the fuel by preheating the charge before taking it into the engine cylinders, but many difficulties have been encountered in the satisfactory application of such practices. One objection has been that the system would not function properly until heated up, and therefore difficulty was encountered in starting the engine. Another difficulty was that if it were attempted to heat the entire charge a loss in volumetric efficiency of the engine was encountered because of the large volume of the air and gaseous fuel after heating. Another difficulty was due to the lack of flexibility of the system. That is to say, the engine would not instantly respond to changes in the opening of the throttle, such as are constantly taking place in the operation of an automobile. Either the fuel mixture would not be supplied fast enough to take care of maximum power requirements, or the engine would become loaded up with fuel when operating at low power or idling. It is an object of the present invention to overcome all of these difficulties.

In general the above desirable objects are attained by providing a retort or gas generator which may be heated by the exhaust from the engine. Into this heated retort is taken fuel and some air, the volume of air being restricted to an amount sufficient for complete combustion only when the engine is idling or operating at

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minimum power. As greater volume of explosive mixture is required, by increase of speed and power of the engine, the amount of fuel taken into the retort increases, but the amount of air drawn into the retort is not increased in proportion so that a very rich gaseous mixture is furnished by the retort. My system therefore includes means for introducing an increased supply of air into the rich mixture after it leaves the retort, thereby providing the necessary oxygen for complete combustion of the fuel. This air is taken in at normal atmospheric temperature and therefore it is not expanded so as to decrease the volumetric efficiency of the engine, this result being further enhanced by the cooling of the heated rich mixture by contact with this air.

My system also provides controlling means whereby great flexibility in the engine is secured. The engine can be throttled down so as to idle or operate at minimum power without becoming choked or overloaded with fuel. My system also provides means for starting the engine instantly when cold. It is also possible to use one type of fuel for starting and another type for normal operation if that is desired.

In the accompanying drawings, which illustrate one preferred embodiment of my invention,

Figure 1 is a side elevation of a typical automobile engine in outline, showing the invention applied to it, some parts being shown in section;

Figure 2 is a vertical transverse section of the fuel supply system shown in Figure 1 taken on the line 2—2 of Figure 1; and

Figure 3 is a horizontal section taken on the line 3—3 of Figure 2.

Referring to the drawings in detail, the engine cylinder block is designated by the numeral 5. The fuel heating retort or generator is shown at 6. This may comprise any suitable form of heat exchanging means, through which the fuel for the engine may be passed and adequately heated, preferably from the exhaust gases of the engine. In the particular construction illustrated, the generator is in the form of a box-like retort which is connected to the exhaust passages of the cylinder block by the elbow pipes 7, 8 and 9. The exhaust gases from the engine cylinders pass through these pipes into the retort and leave the latter by the usual exhaust pipe 10. Located within the box-like casing of the generator is the retort pipe 11 which is preferably in sinuous form so as to give the maximum surface in contact with the hot gases in the generator chamber. The fuel to be gasified, with sufficient air to convey it and to provide enough explosive mixture

for the engine when idling, enters the retort pipe 10 through pipe 14 and carburetor 12. The latter comprises a venturi 15, air intake pipe 16, which may be provided with an air filter 17, fuel jet 18 and float chamber 19. The size of the air intake and the venturi 15 is such that only enough air is admitted to permit the engine to idle or to operate at lowest power. The fuel and air mixture after it has been heated by passing through the retort pipe 10 so as to completely vaporize the fuel, is conveyed by the pipe 36 to the usual inlet manifold 11 attached to the engine block. Located at the entrance to the intake manifold is the usual throttle valve 20.

In order to supply additional air needed for operation at speeds and powers greater than the minimum, means are provided for introducing air into the stream of gas coming from the retort or generator. In the construction shown this is accomplished by providing between the throttle valve 20 and the pipe 36 from the generator a fitting 22 which is provided with a branch 23 leading to the intake opening, which may be provided with an air filter 24. Suitable provision is made for mixing the air taken in through the branch 23 with the gaseous mixture coming from the pipe 36. In the construction shown this is done by providing a venturi 25 in the fitting 22 through which the gas from the pipe 36 is drawn while air entering through the branch 23 surrounds the incoming gas mixture and becomes thoroughly mixed therewith as it passes through the throttle to the intake manifold.

For controlling the air intake during the operation of the engine at normal power, an air control valve 30 is provided which is connected to function in timed relation with the throttle valve through a lost motion connection. The connections for operating the throttle and the air control valve 30 in the illustrated example are as follows:

The throttle valve 20 is provided with an arm 33 which is connected by a link 34 to the bell crank 35, which in turn is connected through a link 36 with the usual throttle control such as a foot lever 37 mounted on the footboard 38 of the vehicle. The throttle lever 33 is also connected to a link 40 which has an elongated slot 41 in its upper end. An adjustable rider 42 is mounted in the slot and may be clamped in desired position therein by the screw 43. A three branched air control valve lever 31 mounted on the stem of the air control valve 30 has a pin 45 on one of its branches which slides in the slot 41 in the link 40 and is adapted to be engaged by the rider 42 after the throttle 20 has been opened to the desired extent. The point at which the valve 30 will be opened can be regulated by adjusting the position of the rider 42 in the slot 41. A second branch of the air valve lever 31 is connected to a spring 46 which normally holds the valve closed. The third branch of the lever 31 is connected to a link 47 which has an eye 48 at its free end which rides on a rod 49. Mounted on the rod 49 is an adjustable stop 52 which may be held in place by a screw 53. The rod 49 extends to the instrument board 55 of the vehicle where it is provided with an operating knob 56. At its opposite end the rod 49 is connected with a lever 57 arranged to operate a valve 58 in the pipe 36 which conducts the fuel and gas mixture from the retort to the engine.

When the engine is in regular operation, utilizing the heated fuel and gas mixture from the retort or generator, knob 59 on the rod 49 is

pushed out to the right, which is the position shown in Figure 1. This sets the valve 58 in open position, as indicated in Figure 1, and permits the air supply valve 30 to be closed by the spring 46 unless it is opened by engagement of the rider 42 with the pin 45. The speed of the engine may be controlled in the usual manner by the foot lever 37 which opens and closes the throttle 20. When the throttle 20 is opened sufficiently so that more air is required for the proper operation of the engine than can be taken in through the venturi 15, then the rider engages the pin 45 and opens the valve 30 so as to permit sufficient additional air to enter and be mixed with the rich gaseous charge to produce a proper and economical operating mixture. This is secured by so setting the rider 42 that a low vacuum is maintained in the generator but not so low as to prevent drawing air and fuel into the generator. A proper balance between air and gaseous mixture is thus secured at all times and the engine operates with great flexibility.

For starting the engine, means are provided for supplying a highly volatile fuel which will function without preheating. For this purpose a starting carburetor 60 is provided, this being shown as applied between the air intake branch 23 and the air intake filter 24. The carburetor 60 may be of any usual type and is shown as being provided with a venturi 61, and a jet 62 leading from a float chamber 63. The float chamber 63 is furnished with gasoline or the like through a fuel pipe 64 which may be supplied in any suitable manner as by a fuel pump indicated diagrammatically at 65. The fuel for the main carburetor 12 is supplied through a fuel pipe 67 from a fuel pump 68. Means are provided for operating either one or the other of the fuel pumps, the means for accomplishing this being indicated conventionally. As shown the pump 65 is provided with a clutch 70 by which it may be thrown into or out of operation, the clutch being controlled by a lever 71, link 72, bell crank lever 73, and push button 74 on the instrument board. The pump 68 is operated by clutch 75, link 76, bell crank 77 and push button 78. Figure 1 shows the parts in position for regular operation, the knob 56 being pushed in to open the valve 58 in the intake pipe 36, and to allow the control valve 30 to close except when opened in connection with the opening of the throttle 20. The clutch 75 is engaged so that fuel is supplied by the pump 68 to the carburetor 12. The clutch 70 is disengaged so that the fuel pump 65 is supplying no fuel to the starting carburetor 60.

When the engine is to be started cold, the knob 56 is pulled to the left, which causes the rod 49 to close the valve 58 so that no air and fuel is drawn through the retort or generator. The moving of the rod 49 to the left also causes the stop 52 to engage the eye 48 on the link 47 so as to fully open the valve 30. The push button 78 is pulled out so as to throw out of operation the fuel pump 68 supplying the carburetor 12 and the push button 74 is pushed in so as to cause the pump 65 to operate and supply fuel to the carburetor 60.

I have found it desirable in some instances to provide a stabilizing valve 80 mounted in the air intake pipe preferably above the valve 30. This valve is provided with an arm 81 which is connected by a link 82 with a block 83 clamped to the link 40 by means of a screw 84 or in any suitable manner. The valve 80 is thus connected

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to operate with the throttle valve 20 so that whenever the throttle valve 20 is opened the valve 80 is opened. The use of the valve 80 stabilizes or controls the mixture during operation so that more satisfactory action occurs. The valve 80 being directly connected with the throttle 20 opens whenever the throttle opens, so that in the normal operation of the engine the valve 80 opens slightly before the air intake 30 opens. The valve 80 may in some installations be omitted.

After the engine has been operating long enough for the generator to be heated by the exhaust gases, the operating knob 56 is pushed to the right, thus opening the valve 58 and permitting the valve 30 to be closed by the spring except as it may be controlled through its lost motion connection with the throttle. The knob 74 is pulled out to stop the flow of fuel to carburetor 68 and the knob 78 is pushed in to start the pump 68 and supply fuel to the carburetor 12. In fact usually the pump 68 can be left in operation as fuel will not be drawn through the jet 18 when the valve 58 is closed. Of course each fuel pump system includes the usual overflow from the float chamber, such overflow however not being illustrated.

It will be seen that the engine operates normally on the fuel supplied by the carburetor 12 which together with the air taken in through this carburetor is heated in passing through the retort. The engine thus operates on a heated gaseous mixture from the retort or generator with which is mixed sufficient air through the branch 23 to provide a proper explosive mixture for the engine. This final mixture, however, is at relatively low temperature due to the cold air coming in through the branch 23, but not cold enough to condense the gasified fuel. Thus the engine retains its full volumetric efficiency. At the same time the fuel used is all in gaseous form and there is no waste of fuel and no dilution of the crankcase oil to interfere with the proper lubrication. The control of the air and gas by means of the throttle and the air intake valve 30 operated through the regulated lost motion connection with the throttle, results in a highly satisfactory control of the air and gas mixture so that great flexibility of operation is secured together with the highest economy in fuel consumption. As the fuel is heated in the retort or generator it is possible to use any kind of fuel from gasoline to quite heavy oil. By having a separate starting carburetor with its controls this may be supplied with a high volatile fuel which makes starting sure and easy.

What is claimed is:

1. In a fuel system for internal combustion engines, a retort heated from the exhaust from the engine, an intake pipe for said retort having a fuel inlet therein and a restricted air inlet, a duct for conveying the heated fuel-air mixture from the retort to the intake of the engine, means for introducing unheated air into said duct between the retort and the engine intake, two valves arranged in sequence for controlling introduction of such air, and means under the control of the operator for differentially opening and closing said valves during the operation of the engine.

2. In a fuel system for internal combustion engines, a retort heated from the exhaust from the engine, an intake pipe for said retort having a fuel inlet therein and a restricted air inlet, a duct for conveying the heated fuel-air mixture from the retort to the intake of the engine, means

for introducing unheated air into said duct between the retort and the engine intake, a starting carburetor connected to said air intake, and means for closing the duct between the said retort and the engine when said starting carburetor is in use.

3. In a fuel system for internal combustion engines, a retort heated from the exhaust from the engine, an intake pipe for said retort having a fuel inlet therein and a restricted air inlet, a duct for conveying the heated fuel-air mixture from the retort to the intake of the engine, means for introducing unheated air into said duct between the retort and the engine intake, a starting carburetor connected to said air intake, means for closing the duct between the said retort and the engine when said starting carburetor is in use, an air valve in said air intake between said starting carburetor and the point where the air is introduced into the engine intake, a connection between said valve and the cut off valve in the gas duct for opening said air valve when said cut off valve is closed, and a connection between the engine throttle and said air valve for opening said air valve when the engine throttle is opened.

4. In a fuel system for internal combustion engines, a retort heated from the exhaust from the engine, an intake pipe for said retort having a fuel inlet therein and a restricted air inlet, a duct for conveying the heated fuel-air mixture from the retort to the intake of the engine, means for introducing unheated air into said duct between the retort and the engine intake, a starting carburetor connected to said air intake, means for closing the duct between the said retort and the engine when said starting carburetor is in use, an air valve in said air intake between said starting carburetor and the point where the air is introduced into the engine intake, a connection between said valve and the cut off valve in the gas duct for opening said air valve when said cut off valve is closed, and a connection between the engine throttle and said air valve for opening said air valve when the engine throttle is opened, said connection between said valves including an adjustable lost motion device whereby the opening of said air valve may be caused to occur at any predetermined interval after the commencement of the opening of the engine throttle.

5. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a duct for conveying the heated gas mixture from the retort to the intake of the engine, an air intake passage for introducing additional air into said duct between the retort and the engine intake, a throttle valve in the engine intake, an air valve in the air intake passage, and a connection between said throttle valve and said air valve for opening said air valve when the engine throttle is opened, said connection between said valves including an adjustable lost motion device whereby the opening of the air valve may be caused to occur at any predetermined interval after the commencement of the opening of the engine throttle.

6. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a duct for conveying the heated gas mixture from the retort to the intake of the engine, an air intake passage for introducing additional air into said duct between the retort and the engine intake, a throttle valve in the engine intake, an air valve in the air intake passage, and a connection

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between said throttle valve and said air valve for opening said air valve when the engine throttle is opened, said connection between said valves including an adjustable lost motion device whereby the opening of the air valve may be caused to occur at any predetermined interval after the commencement of the opening of the engine throttle, said lost motion device comprising a link connected to move with the throttle valve, said link having an adjustable rider thereon and said air valve having an operating member adapted to be engaged by said adjustable rider.

7. In a fuel system for internal combustion engines, a heated retort, a connection from the retort to the engine, a carburetor for supplying fuel to said retort, said carburetor including a venturi of limited diameter having a fuel jet opening thereinto, said diameter being small enough so that the air velocity through the same during idling of the engine will be sufficient to draw in adequate fuel for idling, the size of said venturi being sufficient to supply adequate air for idling, but limiting the amount of air which can pass therethrough to substantially less than the air necessary to supply the engine during normal power operation, said jet being capable of supplying fuel sufficient for full power operation of the engine, and means for mixing an additional quantity of air with the air and fuel mixture coming from said retort in order to supply the air necessary to operate said engine at increased speed and power.

8. In a fuel system for internal combustion engines, a heated retort, a connection from the retort to the engine, a carburetor for supplying fuel to said retort, said carburetor including a venturi of limited diameter having a fuel jet opening thereinto, said diameter being small enough so that the air velocity through the same during idling of the engine will be sufficient to draw in adequate fuel for idling, the size of said venturi being sufficient to supply adequate air for idling, but limiting the amount of air which can pass therethrough to substantially less than the air necessary to supply the engine during normal power operation, said jet being capable of supplying fuel sufficient for full power operation of the engine, and means for mixing an additional quantity of air with the air and fuel mixture coming from said retort in order to supply the air necessary to operate said engine at increased speed and power, a throttle valve in the engine intake, an air valve for regulating the additional supply of air, and actuating means under the control of the operator for actuating said throttle valve and air valve in coordinated relation.

9. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a

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duct for conveying the heated gas mixture from the retort to the intake of the engine, a throttle valve in the engine intake, an air intake passage for introducing additional air into said duct between the retort and the throttle valve, two air valves in the air intake passage on the side of the throttle valve away from the engine, and means under the control of the operator for opening and closing said air valves, said means being constructed and arranged to open one of said valves before the other of said valves is opened, and to close the last opened valve before the first opened valve is closed.

10. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a duct for conveying the heated gas mixture from the retort to the intake of the engine, an air intake passage for introducing additional air into said duct between the retort and the engine intake, a throttle valve in the engine intake, an air valve in the air intake passage, and actuating means under the control of the operator for actuating said throttle valve and air valve in coordinated relation, said means including connections for opening the throttle valve before the air valve is opened, and for permitting the air valve to close before the throttle valve closes.

11. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a duct for conveying the heated gas mixture from the retort to the intake of the engine, an air intake passage for introducing additional air into said duct between the retort and the engine intake, a throttle valve in the engine intake, two air valves arranged in sequence in the air intake passage, actuating means under the control of the operator for actuating said throttle valve, and connections from the throttle valve actuating means to said air valves for differentially opening and closing said valves.

12. In a fuel system for internal combustion engines, a heated retort, means for supplying fuel and a limited amount of air to said retort, a duct for conveying the heated gas mixture from the retort to the intake of the engine, an air intake passage for introducing additional air into said duct between the retort and the engine intake, a throttle valve in the engine intake, two air valves arranged in sequence in the air intake passage, actuating means under the control of the operator for actuating said throttle valve, means for directly connecting said throttle valve actuating means to one of said air valves, and means including a lost motion connection for connecting said throttle valve actuating means to the other air valve.

ARTHUR O. RANDALL.