Aug. 10, 1943. J. R. DOWDELL 2,326,205

CHARGE FORMING DEVICE

Filed Aug. 3, 1940 5 Sheets-Sheet 1

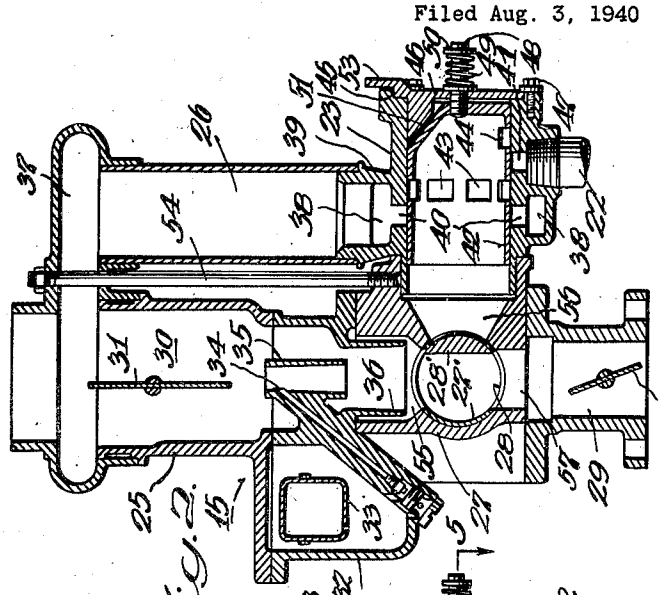

Fig. 2.

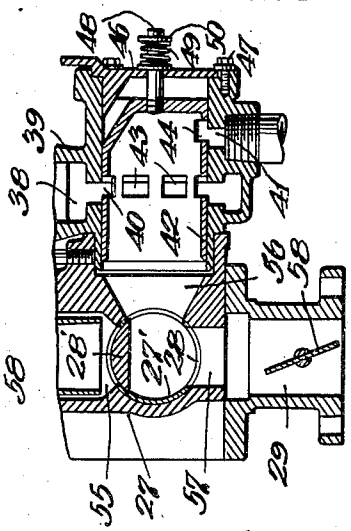

Fig. 3.

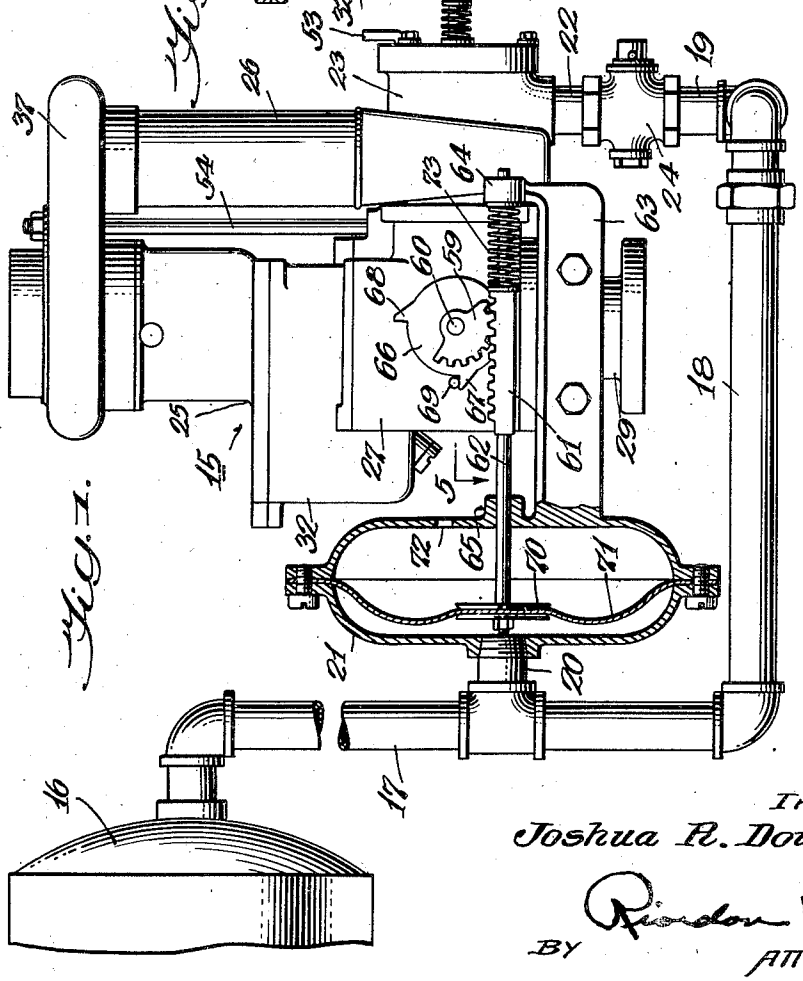

Fig. 1.

Inventor
Joshua R. Dowdell,
By Riordon & Riordon
Attorneys

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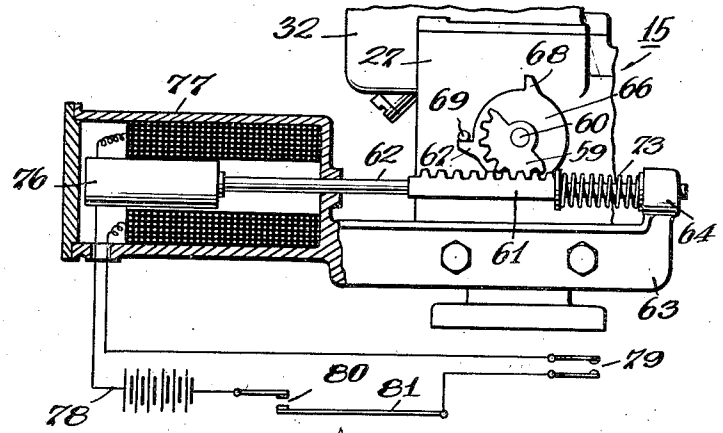


Fig. 4.

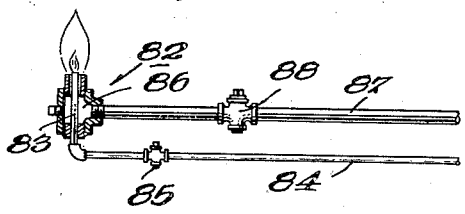
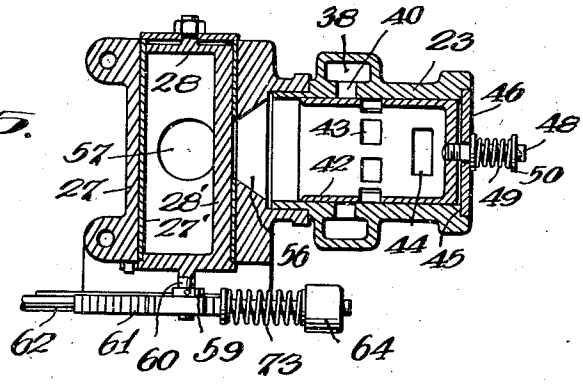


Fig. 5.



Inventor
Joshua R. Dowdell,
By Riordon & Riordon
Attorneys

Aug. 10, 1943. J. R. DOWDELL 2,326,205

CHARGE FORMING DEVICE

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Fig. 7

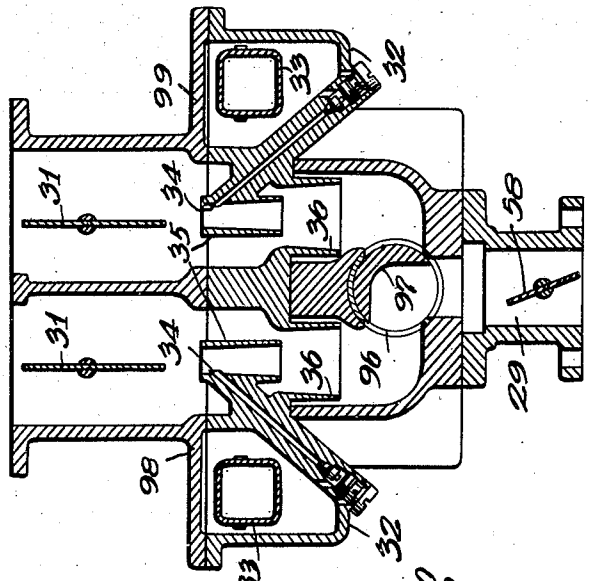
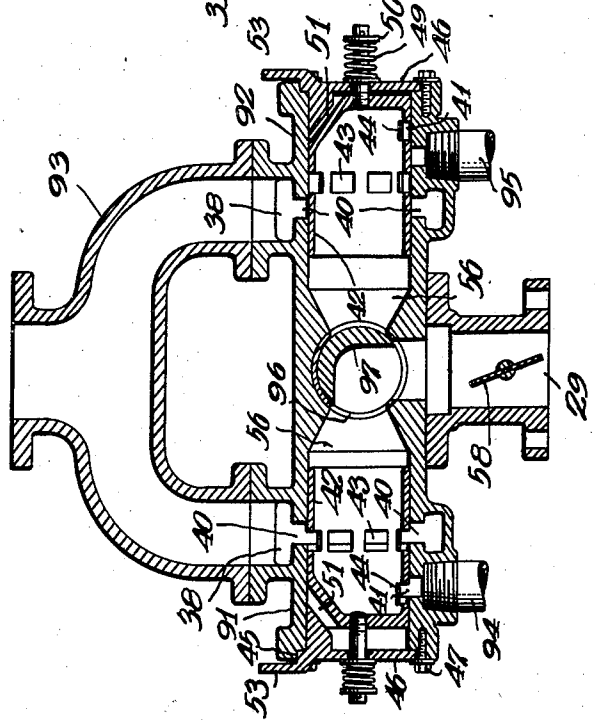


Fig. 6



INVENTOR
Joshua R. Dowdell,

BY Riordon & Riordon
ATTORNEYS

Aug. 10, 1943. J. R. DOWDELL 2,326,205

CHARGE FORMING DEVICE

Filed Aug. 3, 1940 5 Sheets-Sheet 4

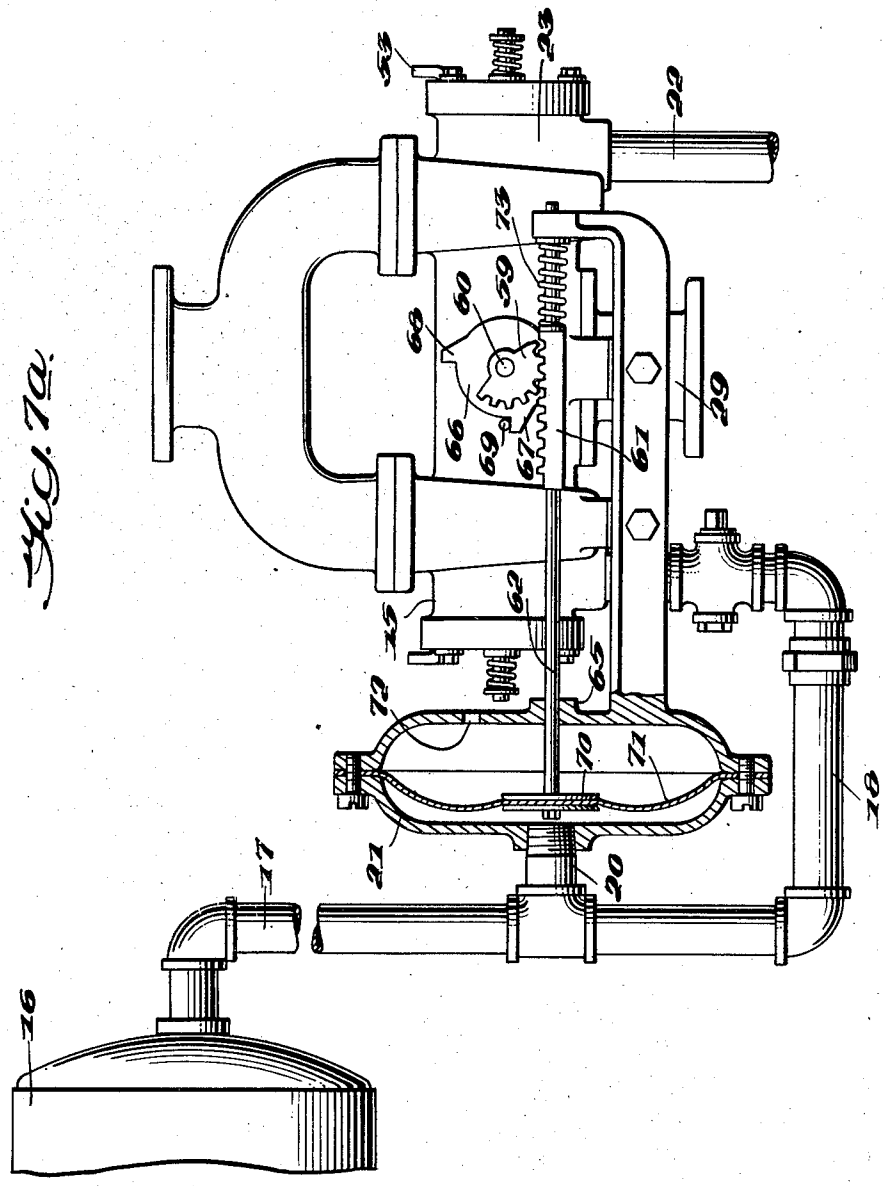


Fig. 7a.

Inventor

Joshua R. Dowdell,

By Rinaldo & Rinaldo

Attorneys

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CHARGE FORMING DEVICE

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Fig. 8

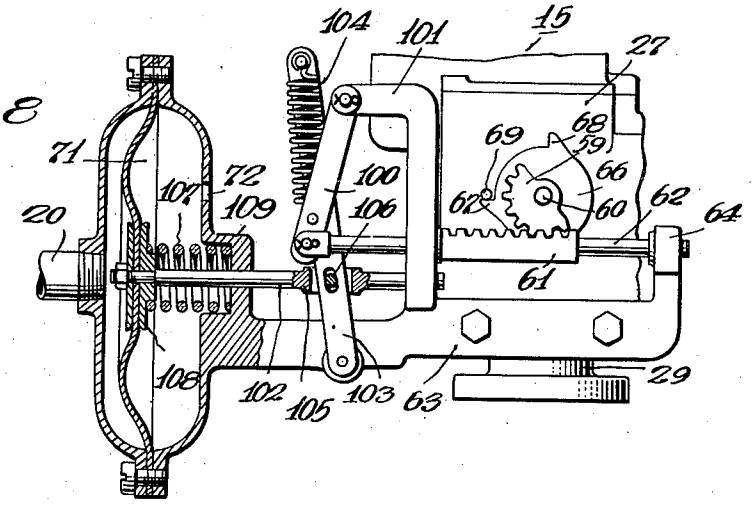
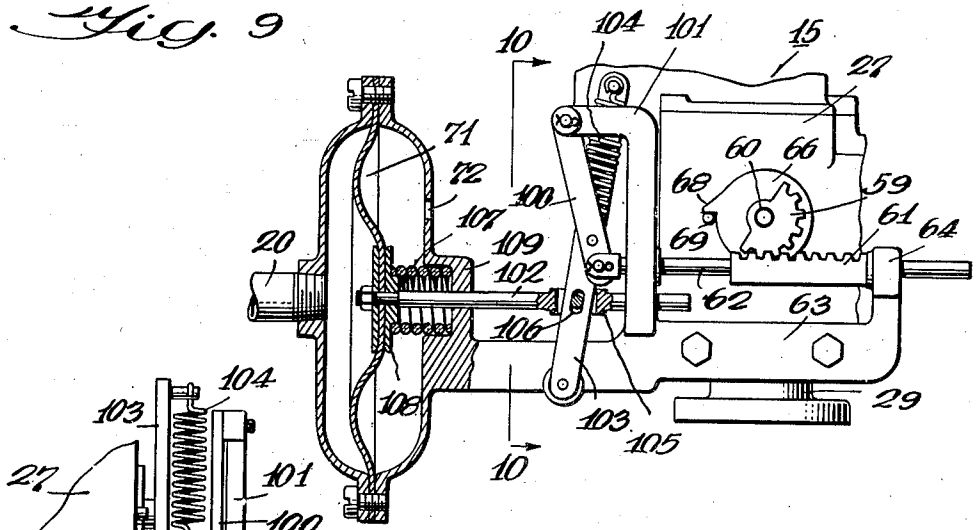


Fig. 9



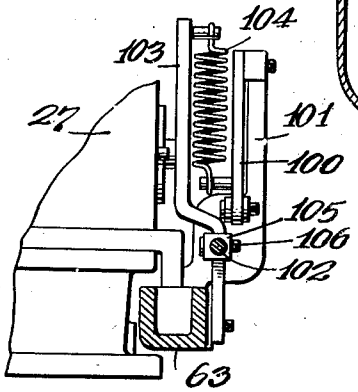


Fig. 10

INVENTOR
Joshua R. Dowdell,

BY Riordon & Riordon
ATTORNEYS

Patented Aug. 10, 1943 2,326,205

UNITED STATES PATENT OFFICE

2,326,205

CHARGE FORMING DEVICE

Joshua R. Dowdell, Dallas, Tex., assignor to Nash Engineering Company, South Norwalk, Conn., a corporation of Connecticut

Application August 3, 1940, Serial No. 350,449

4 Claims. (Cl. 261—16)

This invention relates to charge forming devices of the type designed to accommodate a plurality of fuels, either of the same or of different characteristics, and more particularly to control mechanisms for such devices wherein a change-over from one fuel to another may be quickly effected automatically, or manually if so desired.

Specifically the invention contemplates a dual carburetor, or fuel-air mixer for charge forming systems applicable to internal combustion engines, and other purposes, so constructed that the engine or other means of utilizing fuel mixtures may run either on liquid fuel or gaseous fuel, or upon two liquid fuels, or upon two gaseous fuels.

One object of the invention is to provide an improved organization including a gasolene or other liquid fuel carburetor and an improved gas mixer wherein natural or other gas and air may be mixed, and a change-over mechanism arranged so that the engine or burner utilizing the fuel may run on one or the other of the fuels exclusively, the control mechanism for the charge forming device automatically effecting a change-over from one fuel to the other and vice versa, as conditions warrant.

Another object includes the provision of means for effecting such a change-over in accordance with pressure, B. t. u. content of gas, or other conditions in the fuel supply.

Still a further object contemplates a means for effecting the change-over from one fuel to another in accordance with operating conditions at the point of utilization of the fuel.

Means are provided in accordance with the structural features of this invention whereby the parts are caused to operate under lower suction conditions than conventionally regarded as normal, resulting in a minimum detraction from the horsepower of the engine, where an engine is utilized.

One structural feature of the invention includes the use of an adapter valve mechanism operatively interposed between the portions of the charge forming device which handle the respective fuels.

The invention includes, as an important feature of the change-over from one fuel to another, structure by means of which graduated action all the way from full supply on one side to full supply on the other side of the charge forming device is obtained, or, when desired, a non-graduated, or snap-over action from normal operations on one fuel to normal operations on the other fuel.

To the attainment of the foregoing, and other objects which will appear as the description proceeds, reference may be made to the accompanying sheets of drawings, wherein:

Fig. 1 is a side elevation of the device, partly in section showing a hook-up for operation on liquid fuel, and natural gas;

Fig. 2 is a vertical section through the charge forming device of Fig. 1, per se, with the parts positioned to operate on liquid fuel;

Fig. 3 is a fragmentary, vertical section of the lower part of the device shown in Fig. 2, but with the parts positioned to operate on gaseous fuel;

Fig. 4 is an elevation, partly in section, showing a variation from Fig. 1, in the change-over control mechanism;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 1;

Fig. 6 is a vertical section of a modified form of charge forming device showing an arrangement for handling two gaseous fuels, but utilizing a change-over mechanism such that one fuel only will be available at a time;

Fig. 7 is a vertical section of a still different embodiment of charge forming device wherein the arrangement is such as to handle two liquid fuels;

Fig. 7ª is a side elevation, partly in section, showing the control mechanism for the modification of Fig. 7;

Fig. 8 is an elevation partly in section illustrating a variation from Fig. 1 in the pressure control change-over mechanism;

Fig. 9 is a view similar to Fig. 8 but showing the parts in a different position; and

Fig. 10 is an elevation partly in section taken on the line 10—10 of Fig. 9.

While several variations of charge forming device are disclosed herein for purposes of illustration, and modifications in the change-over device are likewise shown for illustrative purposes, it will be appreciated that the invention herein does not reside primarily in any particular type of charge forming structure nor any particular control therefor, nor in the adaptation of any disclosed structures to any given types of fuel, but is directed to a combination structure with a control therefor, whereby a change-over may be effected from one selected fuel, to another selected fuel. The fuels may even be identical in character, wherein the first fuel is a normal running fuel and the second fuel is a reserve or stand-by fuel.

While reference is made hereinafter to "natural" gas, such reference is not intended as limiting, for it is contemplated that the invention may operate on other gases such as propane, butane, coal gas, or gases stripped from any suitable hydrocarbon fluid, etc.

Referring now to the drawings, wherein like reference numerals indicate like parts, and particularly with reference to Figs. 1, 2 and 3, the unit is illustrated as applied to a system utilizing a liquid fuel such as gasolene, with a change-over to a different type of fuel such as natural gas, and it is contemplated that the change-over will be effected, in this embodiment of the invention by pressure conditions in the gas accumulator.

The charge forming unit, indicated generally at 15, is shown connected to a gas accumulator tank 16 by means of a pipe line which includes sections 17, 18 and 19. The section 17 is tapped to provide a connection 20 establishing communication with a diaphragm or pressure control chamber 21, and the section 19 communicates through a connection 22 with the air and gas mixing housing or portion 23 of the unit 15. Interposed between the sections 19 and 22 of the gas line, is a gas pressure regulator valve 24 which may be either automatically or manually controlled, as desired.

The charge forming device or unit 15 comprises generally a liquid carburetor portion 25, the air and gas mixer portion 23 with its air inlet tube 26, the three-way adapter 27 including the change-over valve 28, and the fuel mixture supply passage 29 which is common to both fuel sides. A removable liner 28' may be provided for the valve 28, if desired, for replacement in case of wear.

The liquid carburetor portion of the unit, in its simplest form is more or less conventional in nature, and includes the air inlet passage 30, in which is pivoted the usual butterfly or choke valve 31. The usual gasolene or float chamber 32 contains a float 33, this chamber being supplied with gasolene or like liquid fuel from a source not shown, and being provided with vaporizing jets 34 which communicate with a Venturi tube 35. The main venturi 36 projects toward the control or change-over valve 28, and hence to the mixture supply conduit 29.

The air and gas mixing portion of the unit comprises the main housing 23, and the air inlet tube 26, it being noted that there is a common chamber 37 for supplying air to the air inlet passage 30 as well as the air inlet tube 26. The housing 23 is formed with a circumferential air inlet chamber 38 to which the air inlet tube 26 is connected by a boss 39, and a cylindrical port 40 serves to establish communication with the interior of the main housing 23. A gas inlet port 41 is provided adjacent the inlet connection 22.

Mounted for sliding movement, axially within the housing 23 is a sleeve valve 42 having air inlet ports 43 and a gas inlet port 44. The housing 23, which is formed wth an opening at each end, is machined to form an annular recess 45 in which is mounted a cap or cover plate 46. This plate is somewhat less in diameter than the recess, and is loosely and rotatably confined in the recess by a pair of screws 47—47.

The sleeve valve 42 has a stem 48 which extends through the cover plate 46, and is encircled by a coil spring 49, confined on the stem by the plate 46 and a washer 50. The spring, bearing against the plate 46 tends to hold the sleeve valve 42 in its outer, or port closing position. This spring resists the inward movement of the valve, acting in opposition to the suction of the engine, and closing the valve when the engine is stopped, it being noted that the valve is of the hollow piston type, and will be pulled inwardly, upon the application thereto of suction from the engine.

The gas ports 41 and 44 are preferably of equal height, and the air slot or circumferential port 40 and air inlets 43 are also of equal height. The inlets for air and gas are spaced from each other approximately the same longitudinal distance in both the piston and the housing, consequently both are opened in proportion to each other. That is to say, when the air ports of the valve and housing begin to register, the gas ports of the housing and valve will also begin to register.

When the engine is stopped, the spring 49 being under compression will force the valve outwardly to its closed position, as shown in Fig. 2. In order to effectively close the gas port 41 and prevent leakage, the valve 42 is given a loose sliding fit in the bore of the housing 23, so that it may have a limited lateral movement. A wedge key 51 is formed integral with the plate 46 and engages in a complementary slot 52 in the valve. When the valve moves outwardly under the influence of the spring 49, it is shifted laterally by the key, which is located diametrically opposite to the port 41. This brings the solid wall of the valve into intimate contact with that portion of the wall of the bore surrounding the gas port 41, thereby sealing off said port. It is noted that when the valve is in its outer position it will be assured that the key will positively act to displace the valve laterally, there being a space provided between the head of the valve and the cap plate.

The plate 46 has a hand lever 53 extending radially, whereby the plate may be rotated, and through the engagement of the key 51 with the slot 52, rotate the valve. This shifts the gas ports 41 and 44 circumferentially with each other, and varies the quantity of gas admitted.

The two carburetor portions of the unit are secured together by means of the common air chamber 37, in which the ends of the air passage 25 and air tube 26 are mounted. The three-way adapter 27 is secured to the inner ends of the liquid carburetor and gas mixer, and held in position by the tie-bolt 54, and is provided with three passages, one of which 55, communicates directly with the liquid carburetor, another of which, 56, communicates with the air and gas mixer, and the third of which, 57, establishes communication with the mixture conduit 29. The conduit 29 of course functions to supply a mixture of air and vaporized liquid or air and gas to the engine or other means for utilizing fuel from the charge forming device. A throttle valve 58 will be located in the supply passage 29 for operation in a conventional manner.

The rotary valve 28 in the adapter 27 is arranged to establish communication between one side or the other of the unit, and the supply conduit 29. Actuation of this valve is effected by means of a pinion 59 secured to the valve stem 60 and positioned to mesh with a rackbar 61 formed upon or secured to an actuator lever 62. A bracket 63 serves to provide a bearing 64 for the rod 62 at one end thereof, and a support for the diaphragm housing 21 which in turn provides a bearing 65 near the other end of the rod 62.

Secured to the valve stem 60 is a lug plate 66 provided with lugs 67 and 68, which, through cooperation with a stop pin 69 serves to limit the rotary movement of the valve 28, thus in-

suring that it is properly positioned to control the discharge from the carburetor when at one limit of movement and the discharge from the gas mixer when at its other limit of movement. A head member 70 on the actuator stem 62 is secured to a suitable diaphragm 71 inside of the diaphragm case 21, which case is vented to atmosphere at 72 on one side of the diaphragm and in communication with the natural gas connection 20 on the other side of the diaphragm.

The tank 16, in the illustrated embodiment of Fig. 1 may be a gas accumulator tank for storing natural gas, stripped from crude oil, and the pressure therein will consequently vary in accordance with volume and other conditions prevailing in the field. It is contemplated that the diaphragm 71 and the return spring 73 for the actuator stem 62 will be proportioned to operate the valve 28 when the pressure in the line 17, leading from the accumulator tank, reaches approximately three pounds gage. That is to say, when the pressure reaches three pounds, the diaphragm will be operated to move the stem 62 and rack bar 61 in opposition to the spring 73, rotating the valve to change over from the liquid carburetor operation to the natural gas and air carburetor operation, the spring 73 being thereafter effective to reverse the change-over, should the pressure in the line 17 fall below three pounds gage. As stated above, the pressure in the lines 17, 18, 19 can be regulated either automatically or manually by virtue of the valve 24, and of course regulation by such valve will, likewise control the gas supply pressure at the point of entry to the gas mixer through the port 41.

From the foregoing the operation of this embodiment of the invention will be readily understood. Upon commencement of operation of the engine, burner, or other means of utilizing fuel, and assuming that the pressure of the actuator tank is below three pounds gage, the liquid carburetor portion of the unit 15 will be in operation, and the valve 28 will be in the position shown in Fig. 2, establishing communication with the mixture passage 29. In this position the wall 28' will block off communication between the air-gas carburetor or mixer, the valve 42 will not be subject to suction, and hence will block off the air and gas supply ports, and this portion 23 of the unit will be inoperative. When the pressure in the line 17 reaches the desired point, the diaphragm, through the connections to the valve stem 60 will rotate the change-over valve 28 to the position shown in Fig. 3, establishing communication with the air-gas portion of the device and rendering the liquid-air side of the unit inoperative. When this occurs suction from the engine, through the passage 29 will act to draw the valve 42 inwardly, and air and natural gas from the accumulator tank will enter the assembly 23 in proper proportion, and pass as a mixture through the passage 29.

It is not necessary to rely solely upon pressure as a means for operating the change-over valve and Fig. 4 illustrates an electric solenoid to effect the change-over, the energizing and deenergizing of the solenoid being opened and closed by contacts of a bi-metallic thermostat, which in turn is controlled by the height and intensity of a flame, burning gas from the accumulator tank. The height and intensity of the flame will be controlled as a natural function of the pressure and B t. u. content of the natural gas.

Thus, in Fig. 4, we find that the core 76 of the solenoid 77 is secured to the end of the valve actuator stem 62, the solenoid being inserted in the electrical circuit diagrammatically shown at 78. A main control switch 79, in parallel with the engine ignition switch is included in this circuit to ensure operation or non-operation in accordance with engine requirements.

The thermostatic switch 80 consists of a pair of contacts, one of which is formed as part of a bi-metallic strip 81. The burner 82 which controls the thermostat in accordance with pressure and B. t. u. content of natural gas comprises a pilot 83 operating on an outside supply of fuel through a line 84 controlled by a regulator valve 85. The main burner head 86, illustrated as surrounding the pilot 83, is connected by the pipe line 87, through the regulator valve 88 to the accumulator tank or other supply of natural gas, whereupon when the pressure and B. t. u content of the natural gas reaches a predetermined figure it will be ignited by the pilot light, and the resultant flame will heat the thermostatic element 81, when the flame becomes high enough under the influence of the pressure and B. t. u. content of the gas. This will close the contacts, energizing the solenoid 76—77, resulting in positioning the change-over valve for operation on natural gas from the mixer 23, cutting out the other side of the charge forming unit.

It will be understood that this description is primarily illustrative, as obviously the contacts of the thermostat could be arranged to be closed instead of opened when operating on gasolene, and opened for the more usual condition of operating on natural gas, to requiring energization of the solenoid for a minimum period of time. Again, the regulator valves 85 and 88 may be automatically operated, or manually operated as desired.

Similarly, when considering the diaphragm arrangement of Fig. 1, it is obvious that the invention is not limited to a diaphragm, as a bellows, a piston and cylinder, or any equivalent pressure means might be substituted.

The figure of three pounds gage, given as an arbitrary example of pressure which might be relied upon to operate the diaphragm is not intended as limiting, for obviously any predetermined pressure may be utilized. The diaphragm and the spring 73 will of course be proportioned such that when the pressure reaches the desired value the diaphragm will overcome the resistance of the spring, and obviously the spring must be proportioned to return the diaphragm to its original position when the pressure drops below the predetermined value.

In lieu of the thermostat 81, a pressure switch might be used, in fact there are many obvious variations which will occur to those skilled in the art, another example being the use of updraft carburetion instead of downdraft carburetion as shown herein, and it is not intended that the invention is to be limited by the illustrated embodiments, other than as defined in the claims appended hereto.

As further illustrative of modifications which embody the instant invention, reference may be made to Figures 6 to 10. Instead of being limited to a structure consisting of a liquid fuel carburetor and a gaseous fuel mixing valve, a structure, such as shown in Fig. 6, involving two gas and air carburetors will merit consideration. In this form of the invention the unit is provided with duplicate gaseous mixer assemblies 91 and 92, each of which is identical with the

housing and assembly 23 of Figures 1 to 3. Being identical, the elements are designated by the same reference numerals and need no further detailed description. In lieu of the common head or air supply chamber 37, however, an air manifold 93 is provided, and instead of having but a single gas inlet pipe 22, obviously each of the mixers 91 and 92 will require its own gas line, the gas line to 91 being indicated at 94 and the gas line to 92 being indicated at 95. The change-over valve 96 is in all respects similar, both structurally and functionally to the valve 28, except that the cutoff wall 97, corresponding to the cutoff portion 28' of the valve 28 has been extended to accommodate the somewhat different design of unit, in which the discharges from the respective mixers are diametrically opposed to each other, instead of being at right angles, as in the case of the showing of Figures 1 to 3.

In Fig. 7 another variation appears, this form being directed to duplicate liquid carburetors 98 and 99, each of which in turn duplicates the liquid carburetor portion of Figures 1 to 3. The change-over valve in this form will be the same as that shown in Fig. 6. The pressure control for the modification shown in Fig. 7 is shown in Fig. 7a, and the change-over valve is operated in a manner similar to that shown in Fig. 1. Accordingly, the same reference numerals applied to Fig. 1 are applied to Fig. 7a, and the different parts in Fig. 7a indicated by the same reference numerals as used to indicate corresponding parts in Fig. 1. Advantages of such a structure as that shown in either Fig. 6 or Fig. 7 is that the change-over from the normal supply of fuel which may or may not be the same for each carburetor or mixer, to another source of fuel supply is provided, thus permitting maintenance of a required supply to the engine or other means of utilizing fuel. Thus one portion of the unit may be connected to a normal fuel supply, and the other portion of the unit connected to a reserve or stand-by supply.

Figures 8, 9 and 10 disclose a snap-over action for the control valve, primarily designed for a dual unit which utilizes pressure in the accumulator tank or gas line as a means of operating the valve. The purpose of the snap action is to ensure that the change-over valve will not stay in an intermediate position, should the valve start to move under a pressure insufficient to completely actuate the valve through its limits of movement. Fig. 8 shows the valve in position to open one side of the unit, and Fig. 9 shows the valve after it has been operated to change over to the other side of the unit. In this form of control mechanism, the spring 73 may be omitted. The valve stem 62 is pivotally connected to a link 100 which in turn is pivotally connected to a rigid bracket 101. This bracket 101 forms a bearing for the stem 62, and also forms a bearing for one end of a diaphragm rod 102. Pivoted to the bracket 63 is a lever 103 which is connected to the link 100 by a spring 104, the lever 103 being suitably offset to permit interposition of the spring as shown in Fig. 10. The diaphragm stem 102 is formed with a ported enlargement 105, and the lever 103, extending therethrough is connected to the stem 102 by a lost motion slot and pin connection 106.

Since the spring 73 has been eliminated, because of considerations of size and strength, some means of restoring the diaphragm, and hence returning the change-over valve to its original position must be provided, there being rarely any occasion upon which suction will be applied or available at the normal pressure side of the diaphragm. Hence a spring 107 is placed within the diaphragm case in a location between the diaphragm washer 108 and the wall 109 of the casing.

It will appear then that when pressure is applied to the diaphragm through the connection 20, the diaphragm will push the stem 102 against the action of the spring 107, moving the lever 103 correspondingly. When the spring 104 which is connected to the lever 103 and the link 100 passes dead center in its movement between the lever 103 and the link 100, its tension will produce a snap action, actuating the valve lever 62, and hence operating the change-over valve. Upon a relief in pressure conditions against the diaphragm, the spring 107 will act to reverse the foregoing action.

The operation of the various embodiments of the invention has been given in connection with the description thereof, and the many advantages of the invention are readily apparent. For example, a carbureting or mixing unit applicable to the utilization of a plurality of fuels either of different, or of the same characteristics has been provided, and the structure is by no means limited merely to two fuels since by suitable adaptation of the change-over valve a third or even more mixers might be made available. In fact it is not even essential that the several mixers or carburetors be built into a common structure, as they might be separable or separate from each other.

A control mechanism for a multi-fuel charge forming device operable under the influence of pressure and/or B. t. u. content, and/or other characteristics of fuel or demand requirements is presented, in which the control may be effected by a graduated action or a non-graduated action, i. e., snap-over action, whenever supply of normal fuel is insufficient to meet demand requirements.

Mechanically speaking, the change-over may be effected by pressure, thermostatic means, or other equivalents.

The invention is intended for use with any liquid and/or gaseous fuel, the illustrations of gasolene and natural gas herein being merely exemplary. As examples of other fuels, both liquid and gaseous, which might be used, are a variety of forms of fuel oil of varying volatility, in fact, any liquid fuel which requires carburetion and mixing with air, propane, butane, coal gas or gases stripped from any suitable hydrocarbon fluid, in fact, any gas which when suitably mixed with air satisfies the demand requirements of an internal combustion engine, or other fuel burner such as a boiler, evaporator, heater or the like.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A charge forming device comprising a liquid fuel carburetor, a gaseous fuel mixer, and a three-way discharge adapter operatively interposed between said carburetor and mixer, means to supply liquid fuel to said carburetor, means to supply gaseous fuel to said gaseous fuel mixer, means to supply air to said carburetor and mixer, means including a change-over valve in the adapter effective to connect one of said carburetor and mixer to a common point of mixture distribution to the exclusion of the other, and means to actuate said valve automatically in accordance with the

pressure of the gaseous fuel supply compirsing pressure responsive means in communication with the gas supply, and operating connections including a snap action mechanism between said pressure responsive means and said valve.

2. A charge forming device comprising a liquid fuel carburetor, a gaseous fuel mixer, and a three-way discharge adapter operatively interposed between said carburetor and mixer, means to supply liquid fuel to said carburetor, means to supply gaseous fuel to said gaseous fuel mixer, means to supply air to said carburetor and mixer, means including a change-over valve in the adapter effective to connect one of said carburetor and mixer to a common point of mixture distribution to the exclusion of the other, and means to actuate said valve automatically in accordance with the pressure of the gaseous fuel supply comprising pressure responsive means in communication with the gas supply, an actuator rod extending from said pressure responsive means, a valve rod operatively connected to said valve, and a snap action linkage operatively connecting said rods.

3. A charge forming device comprising a pair of independent fuel and air mixers, respectively constructed and arranged to handle different fuels, said mixers being adapted for connection to a common point of distribution of fuel mixture from said mixers, a discharge adapter operatively interposed between said mixers, means to supply fuel independently to each of said mixers, means, including a rotary valve in the adapter and valve ports in the adapter cooperative with said valve, effective when said valve is in one position to connect one of said mixers exclusively to the common point of distribution of fuel mixture and effective when in another position to connect the other of said mixers exclusively to said common point of distribution, and automatically controlled means to actuate said valve comprising a pressure responsive means tapped into the fuel supply for one of said mixers and thereby effective to actuate said rotary valve in accordance with pressure conditions in said fuel supply.

4. A charge forming device comprising a pair of independent fuel and air mixers, respectively constructed and arranged to handle different fuels, said mixers being adapted for connection to a common point of distribution of fuel mixture from said mixers, a discharge adapter unit operatively interposed between said mixers and forming a mechanical interconnection therebetween, said adapter comprising a valve housing having three conduits for respective co-operation with the individual mixers and the common point of distribution of fuel mixture from one or the other of said mixers, means to supply fuel independently to each of said mixers, means including a rotary valve in the adapter and valve ports communicating with the conduits of the adapter and co-operative with said valve, effective when said valve is in one position to connect one only of said mixers to the common point of distribution of fuel mixture, and to cut off the other of said mixers from said point of distribution, and effective when in another position to connect the other of said mixers exclusively to said common point of distribution, and simultaneously to cut off the first-mentioned mixer from said point of distribution, said valve being ported to always connect the common point of distribution with one or the other of said mixers, and automatically controlled valve actuating means to rotate said valve in the adapter from one control position to another with respect to the mixer conduits, comprising a pressure responsive means tapped into the fuel supply for one of said mixers, and a mechanical valve actuating linkage connecting the valve to the pressure responsive means, whereby to actuate the rotary valve in accordance with pressure conditions in said fuel supply.

JOSHUA R. DOWDELL.