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2 Sheets-Sheet 1

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Fig. 3.

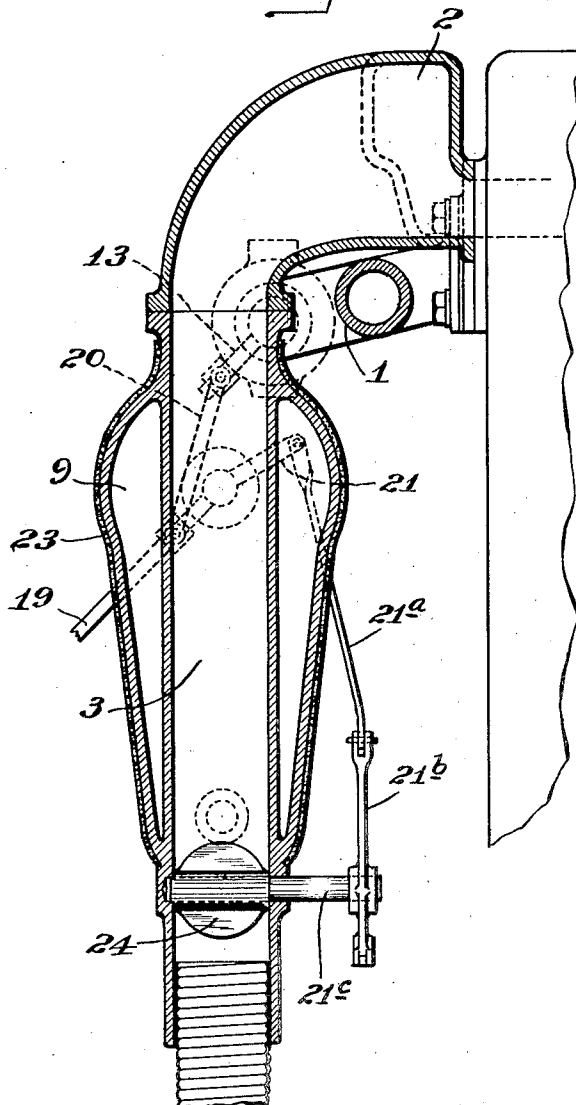


Fig. 4.

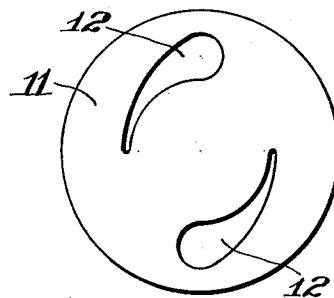
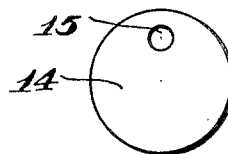


Fig. 5.



Fig. 6.



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FUEL-SUPPLY APPARATUS FOR INTERNAL-COMBUSTION ENGINES

Application filed October 27, 1927. Serial No. 229,064.

The invention relates to fuel supply means for gas engines, and constitutes an improvement on my copending application, Serial No. 571,721. It has for its principal objects, the provision of improved means for controlling the supply of gas and air to the inlet manifold; the provision of improved means for controlling the supply of hydrocarbon fluid to the superheater in a quantity having a definite and proper relation to the outflow therefrom; the provision of improved means for preventing any undue backflow of pressure through the float chamber to the fuel supply line and tank; and the provision of improved means for starting the engine preliminary to the heating of the vapor cracking or superheating means to a temperature suitable for its proper functioning. One embodiment of the invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a vertical section through the apparatus. Fig. 2 is an enlarged section through the float chamber. Fig. 3 is a section on the line III—III of Fig. 1. Fig. 4 is a face view of the air valve plate. And Figs. 5 and 6 are face views of the gas valve plate, and the end of the gas valve body respectively.

Referring to the drawings, 1 is the inlet conduit to an explosion motor, from which the usual passages lead to the engine cylinders, and 2 is the exhaust manifold discharging through the upright exhaust pipe 3. The inlet pipe 1 is flared at its left hand end, forming the chamber 4, and into this chamber extends the nozzle 5, having at its end, the flared caps 6 and 7, for improving the suction effect of the air flowing to the right through the inlet conduit or pipe and produced by the rearward movement of the engine pistons. The nozzle 5 is connected by the pipe 8 with the upper end of the expansion or superheating chamber 9, from which the nozzle receives its supply of gas for mixing with air in the inlet 1.

The end of the pipe 1 is provided with a closure plate 10 having a pair of ports there-through, the amount of whose opening is regulated by the rotating valve plate 11, having a pair of holes 12 therethrough of the shape shown in Fig. 4, which is a face view of the plate 11. This gives a finely graduated cutoff, as the plate is rotated, thus regulating the volume of air admitted for mixing with the gas. The valve plate is provided with a collar having the downwardly extending handle 13.

A fixture 14 is provided at the inlet end of the pipe 8, the cap portion of such fixture having a port 15 therethrough (Figs. 1 and 6), and this opening is governed by a rotatable valve plate 16, having an opening 17 therethrough (Fig. 5), which registers with the port 15. The plate 16 is provided with a stem 18 carrying at its end the handle 19, by which the plate may be turned to give a graduated flow of gas to the nozzle 9. The handles 13 and 19 of the air and gas valve plates are connected by the member 20, which is adjustable longitudinally of the handles, so that the relative degree of opening of the two valves may be adjusted to give the right proportion of gas and air. The collar, which carries the handle 13, also carries another handle 21 (Fig. 3), which is pivoted to the downwardly extending connecting rod 21^a. This rod is connected at its lower end to one arm of the bell crank lever 21^b, keyed to the shaft 21^c, which carries the throttle valve 24 located in the exhaust pipe. The other arm of the bell crank lever is connected to the rod 21^a, which is governed by the operator, of the vehicle, the control preferably corresponding in location and arrangement to the standard foot and hand gas operating means of the ordinary car. A spring (not shown) applies pressure to move the connected lever system, as above described, and including the handles 13 and 19 and the lever 21^b to position closing the valves 11, 16, and 24, so that when the operator releases the pressure on the foot lever or pedal, the valves are all closed, and their opening is regulated by the amount of movement of said foot pedal or lever. It will be understood in this connection, that the showing of the operating connections, including the levers, handles, etc., is, for the sake of clearness and simplicity in showing, some-

what diagrammatic in form, both in arrangement and proportions, the parts being so proportioned that a definite movement of the rod 21^a by the operator will give the proper relative degree of closure to the valves 11, 16 and 24, and so that in one extreme position such valves will all be entirely open and in the other extreme position all entirely closed.

The expansion chamber 9 increases upwardly in cross sectional area, as in my application heretofore referred to, and the walls of this chamber, and of the pipe 8, are preferably covered with non-conducting coatings 22 and 23 of asbestos, or the like, in order to utilize to the fullest extent the heating effect of the exhaust pipe upon the gas. The butterfly valve 24 is also of assistance in this connection, particularly in starting the engine, as with this valve partly closed, the exhaust pipe and the chamber 9 are much more rapidly heated than would be the case with the exhaust pipe completely open.

Hydrocarbon fluid is supplied from the float chamber 25, which is in turn fed from a supply tank, not shown. The connection from the float chamber to the expansion chamber 9 comprises the pipe lines 26, 27 with the valve fixture 28 therein. This fixture carries a needle valve 29, having an operating cam 30, and a handle 31, operated from the end of the handle 19. The end of the handle 31 is provided with a series of holes, any one of which may be engaged by the finger 31^a, mounted for endwise adjustment through a collar on the end of the handle 19, thus permitting of the adjustment of the opening of the valve 29 due to a given movement of the handle 19. By this arrangement, when the valve plates 11 and 16 are moved to open them, the valve 29 is opened, and when the valve plates are moved toward closed position, the valve 29 is similarly moved. This gives a feed of fluid to the expansion chamber, which is proportional to the gas withdrawn therefrom, so that a relatively uniform condition of vapor density in the expansion chamber is maintained, any over supply of fluid to the chamber, as well as any under supply, being guarded against. The requirement here is, that the hydrocarbon fluid shall be vaporized by the heat of the walls of the chamber, or by the walls of the pipe 27, where such pipe enters the chamber, so that the full heating effect of the walls of the chamber shall be applied to superheating the vapor and reducing it to a thin dry gas. This result is best achieved in the absence of any liquid whatever in the chamber, so that the control of the hydrocarbon liquid by the valve 29 to avoid any over supply to the chamber, or flooding thereof is important.

The fixture 28 is also provided with a two-

way valve 32 having a handle 33 operated from the dash of the vehicle by suitable connections, not shown. When this valve is in the position shown, the pipe 26 is placed in communication with the pipe 34 leading to the valve casing 35 located upon the upper side of the chamber 4 and connecting such pipe with the chamber. The casing 35 is provided with a needle valve 36, to regulate the flow of liquid to the chamber 4. This device is used in starting the engine before the chamber 9 is sufficiently heated to properly vaporize the fluid admitted thereto and superheat it. At such time, the valve 32 cuts off communication between the pipes 26 and 27 and opens communication to the casing 35. The operation of the engine by the starter draws in air through the chamber 4, and this flow past the valve opening of the casing 35 causes a flow of hydrocarbon liquid into the chamber 4 in the form of a spray, giving the necessary explosive mixture to operate the engine. This device is in effect a carburetter, which functions with about the same efficiency as an ordinary carburetter until the exhaust pipe 3, and the chamber 9 are sufficiently heated to permit of a switch in operation to the use of gas from such chamber. This switch may ordinarily be made to advantage after about ten minutes of operation, in which the spray from the casing 35 is used. At such time the valve 32 is turned ninety degrees, bringing the pipes 26 and 27 into communication. Vapor now flows through the pipe 27 into the chamber 9 and the dry gas formed in the chamber flows through the pipe 8 to the nozzle 5, the gas being drawn from such nozzle and mixed with the air flowing in through the inlet pipe 1. The tapering form of the inlet pipe, where it merges into the chamber 4, causes an increase in velocity of the air at this point, and this increase in velocity, in connection with the cap 7, causes the incoming air to flow past the end of the cap 6, so as to provide a very effective drag upon the gas flowing through the nozzle 5.

The float chamber, with its float and valve, are preferably constructed as shown in Fig. 2, the liquid hydrocarbon being supplied through the pipe 37, and being controlled by the needle valve 38, having the seats 39 and 40 at its ends. The valve is secured to a sheet metal float 40 having the flaring skirt 41 at its lower end in light yielding contact with the inner walls of the chamber. This skirt arrangement guards effectively against damaging back flow of pressure from the chamber 9, which might otherwise occur and be transmitted through the pipe 37 and the parts connected thereto. Any excess pressure communicated to the chamber below the float, causes the float to move up, pressing the upper end of the valve 38

tightly against its seat, the skirt being pressed outward by the pressure, so that any flow of fluid to the upper side of the float is prevented.

5 In operation, the engine is started, as heretofore explained, by opening the valve 32 to admit hydrocarbon fluid past the valve 36, and cut off the supply of fluid to the pipe 27 and chamber 9, the operator at the same time
10 moving the foot pedal or hand lever to partially open the air valve 12, and also the throttle valve 24 in the exhaust, and the gas valve 11, although the latter is ineffective, since the valve 32 is closed. The air flowing
15 through the pipe 1, draws vaporized fluid past the valve 36 and into the pipe 10, thus providing a combustible mixture. After the exhaust has heated the pipe 3 and chamber 9 to a high temperature, the valve 32 is
20 moved to cut off the flow of fluid past the valve 36 and admit it to the pipe 27. The fluid is vaporized, as it enters the highly heated chamber 9, or just before, and as it rises through the chamber, is heated to a
25 dry or superheated form, and passes through the pipe 8 and nozzle 5. It then mixes with the air in the pipe 1, and is discharged into the engine cylinders at a relatively low temperature, the air inlet pipe being out of contact with the highly heated parts of the engine, such as the exhaust pipe, so that the only additional heat in the mixture, is that incident to the hot gas. As the volume of hot gas to air is small, the mixture is discharged to the engine cylinders at a relatively low temperature, which makes for efficiency in operation, as explained in said co-
35 pending application. The temperature in the chamber 9 varies, depending on operating conditions, but is ordinarily upwards of five hundred degrees F., and at such relatively high temperatures, the vapor achieves the characteristics of a true gas, being apparently cracked or decomposed,
45 with a slight deposit of carbon on the walls of the chamber in the course of time. The vapor or gas as it emerges from the chamber 9 has a bluish tinge like smoke, which gives a further indication of a change in the composition other than that which occurs
50 when gasoline is merely vaporized. The foregoing method of operation results in a high economy in fuel consumption, the combustion being very complete and without any perceptible deposit of carbon in the cylinders of the engine during a long period of use. When the engine is stopped and the foot pedal released, permitting the valve 24 to close, the heat retained in the exhaust pipe and walls of the chamber 9 is such as to permit the starting of the engine for a very considerable period without using the carburetter mixture 35. The system also permits
60 of a powerful breaking effect by the cylinders when the foot of the operator is re-

moved from the operating pedal permitting the valves 11, 16 and 24 to approach a closed position, while the clutch is left in engagement. Under these conditions, with the ignition on, a maximum resistance to the
70 movement of the pistons in the engine cylinders is secured. As the valve 36 is at this time closed against a flow of liquid through the pipe 34, no gasoline is drawn into the engine cylinders. Under these conditions
75 and with this equipment the use of brakes can be dispensed with in descending practically all hills, and without moving the gear shift lever from the high speed position. A considerable degree of the efficiency of the
80 apparatus depends upon the entrance of the combustible fluid to the chamber 9 in the form of vapor, rather than in the form of a liquid, and this vaporizing is due in part to the heating of the end of the pipe adjacent
85 the chamber 9 from the highly heated wall of such chamber, as heretofore pointed out, and in part to the spraying effect of the closely adjusted valve 29 upon the liquid as it passes such valve. The suction effect
90 from the nozzle 5 transmitted through the pipe 8 and chamber 9, is communicated to the pipe 27 producing a drag at the opening controlled by the valve 29, so that the liquid drawn into the pipe 27 is finely divided.
95 The pipe is therefore filled, under operating conditions, with fluid which is in the form of a vapor, thus relieving the chamber 9 of the work of vaporizing the fluid, so that its superheating effect is correspondingly increased. The placing of the expansion or
100 superheating chamber outside of the exhaust pipe, instead of inside such pipe involves substantial advantages, and is preferred, as is also the case in making the chamber of
105 the form shown, but it will be understood that the invention is not limited in these particulars.

What I claim is:

1. The combination with an explosion
110 motor having an upright exhaust pipe and a superheater chamber extending therealong, one inside the other, of an air inlet pipe leading to the cylinders of the engine, a connection from the upper end of said chamber
115 leading into the air inlet pipe, a valve for controlling the flow of air through the air inlet pipe, a connection for supplying hydrocarbon fluid to the lower end of said chamber, a valve in said connection, a throttle
120 valve in the exhaust pipe on the side of said chamber away from the engine, and connecting means whereby said throttle valve and the valve for controlling the flow of fluid to the lower end of said chamber and the air
125 valve are caused to move in unison in opening and closing.

2. The combination with an explosion motor having an exhaust pipe and a heating chamber extending therealong so that such
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chamber is heated from the exhaust pipe, of
an air inlet pipe leading from the atmos-
phere to the cylinders of the engine, a con-
nection from said heating chamber to the
5 air inlet pipe, means for supplying a hydro-
carbon fluid to said heating chamber, a
throttle valve for controlling the flow of air
through the air inlet pipe, a throttle valve
in the exhaust pipe on the side of said cham-
10 ber away from the engine, and a common
means for causing said throttle valves to
move in unison.

In testimony whereof, I have hereunto sub-
scribed my name this 25th day of Oct., 1927.

15 JOHN MILES BARTLEY.

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