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VARIABLE FUEL ORIFICE CARBURETOR

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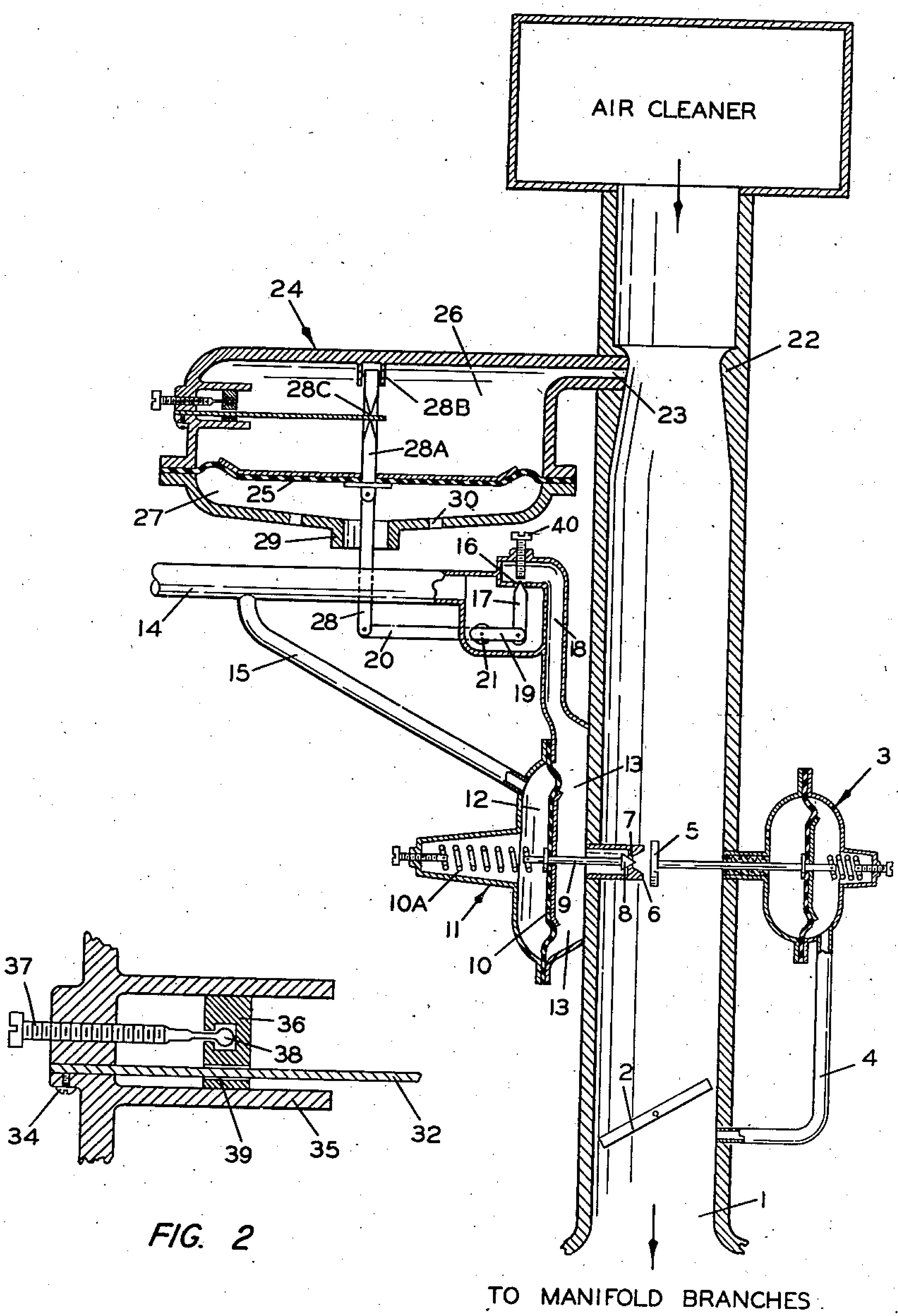


FIG. 2

FIG. 1

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# UNITED STATES PATENT OFFICE

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## VARIABLE FUEL ORIFICE CARBURETOR

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2 Claims. (Cl. 261—69)

My invention relates to improvements in carburetors for internal combustion engines.

More specifically, my invention provides means in communication with but removed from the intake air stream to vary the adjustment of a variable orifice in the fuel line. The rate of fuel injection is controlled by maintaining a constant differential across a variable fuel orifice, independent of the direct manifold suction effect upon the final jet or terminus of the fuel conduit system in the manifold.

In my present disclosure, the variable fuel orifice is controlled by means responsive to the induced static pressure reduction furnished by a fixed venturi. The air flow responsive device is thus rendered sensitive to significant changes in the air intake rate without being subjected to undue response or sensitivity to minor disturbances of insignificant order. A desirable balance between sensitivity and stability is, therefore, obtained.

Bearing in mind that conventional carburetors induce the flow of fuel through utilization of atmospheric pressure on the fuel to flow the same into a region of subatmospheric pressure, the limitations of such an arrangement are obvious. In contrast, my invention takes advantage of the superior injecting action to be had by imposing superatmospheric pressure on the fuel and then subjecting this superior potential of fuel flow to control by throttling the fuel itself in proportion to the requirements as manifested by the rate of air intake at any particular instant.

Since my invention utilizes a source of fuel under superatmospheric pressure, it is well adapted to the carburetion of high vapor pressure fuels such as 26 and 40 pounds per square inch Reid vapor pressure gasolines. Regular gasoline could also be used, however, by employing a fuel pump or the equivalent to impose a superatmospheric pressure on the liquid fuel.

An object of my invention is to provide for introduction of fuel under pressure to a charge forming device for ultimate consumption in a gas engine.

Another object is to provide control of the high pressure fuel flow by means of a variable opening orifice or valve.

It is an object to provide automatic adjustment of the fuel flow in direct response to the rate of air intake.

A further object is to render the fuel flow control sensitive to significant changes of air intake, as when accelerating, but without undue sensitivity to minor fluctuations.

A further object is to provide for accurate proportioning of the air and fuel charge throughout the entire speed range by a single control device.

Other objects will be recognized upon consideration of the drawing and description forming a part of this specification.

Figure 1 is a sectional elevation illustrating the manner in which essential elements cooperate in accordance with my invention.

Figure 2 is an enlarged detail of the spring adjusting means employed in connection with the differential pressure controller 24 of Figure 1.

The drawing is a sectional elevation of a desirable embodiment of my invention, in which the numeral 1 delineates the main branch or riser of a downdraft intake manifold containing a conventional throttle valve 2. A vacuum shutoff device 3 is shown to the right of the manifold riser, and is connected thereto by means of the line 4 below the throttle. Since this device may take many forms and is only incidental to the invention, description of this part will be limited. It is sufficient to say that the valve member 5 should seat on the nozzle 6 at any time when the engine is not running, and at all other times the valve member 5, because of operation of manifold suction on the diaphragm 7, should be withheld at some appreciable distance from the nozzle 6. In other words, the device is purely a shutoff, and no throttling action on the fuel nozzle is to be permitted while the engine is running.

Inside the wall supporting the nozzle 6 is an orifice 7, with a needle 8 in cooperation therewith. These parts form a secondary metering device which has final control over the fuel flow, and at the same time serve as the medium by which the fuel is introduced to the air stream to form a mixture. The needle point 8 is carried by a stem 9, by means of which motion of the diaphragm 10 is transmitted to the valve. The diaphragm 10 is an element of a differential pressure controller, indicated generally by the numeral 11, and separates the interior of the same to form compartments 12 and 13. Compartment 12 is connected to the main fuel line 14 by means of a conduit 15, which latter conduit is for the purpose of pressure communication only, there being no flow of fuel therethrough. A tension spring 10A which may be adjustable is attached to the diaphragm and serves to urge the needle 8 away from the orifice 7.

A primary metering device including a needle valve composed of a seat 16 and needle 17 is located before the inlet line 18 which leads into chamber 13. The actuation of the needle by means outside the valve body, in the embodiment shown, is accomplished by a pair of bell cranks 19 and 20, the former of which is inside the valve body and operatively connected to the needle. The crank 20 is outside the valve body and is mounted on a shaft 21 common to both cranks. The shaft 21 passes through the wall of the valve body and requires a packing gland (not shown) to prevent leakage of fuel to the atmosphere.

In the air intake is a fixed venturi 22 having a pressure take-off 23 communicating with a controller indicated generally by the numeral 24. A diaphragm 25 divides the controller into upper and lower chambers 26 and 27, respectively.

A stem 28A on the top side of the diphragm connects the spring 32 operatively thereto. The spring engages the stem 28A through a rectangular opening 28C, provided with knife edges on the top and bottom edges. A tubular guide 28B is formed in the upper diaphragm case to receive the top end of the stem 28A. A connecting member 28 transmits motion of the diaphragm to the bell crank 20, passing through a boss or bell portion 29 in the bottom of the controller case. I prefer to leave a substantial clearance between the inside of boss 29 and member 28 so that the movement of member 28 will not be restrained, and at the same time the chamber 27 will be vented to the atmosphere through this clearance. However, if the device were to be operated under extremely dusty conditions, it would probably be well to provide a boot of rubber or other flexible material so as to exclude dirt from the chamber 27, in which case a vent port 30 would be required.

In Figure 2 is shown an enlarged detail of the spring adjusting means employed in the controller 24. The spring 32 is a flat leaf-spring of the cantilever type. One end of the spring is fixed to the controller case in a permanent manner, or by means such as the set-screw 34. Formed on one wall of chamber 26 are a pair of parallel guide members 35, whose adjacent inner faces are finished smooth and flat to form bearing and guide surfaces for the crosshead 36, which is moved from right to left or vice versa by the adjusting screw 37. A ball 38 formed on the screw and fitting in a T-slot in the outward face of the crosshead serves to engage the latter operatively with the screw. The spring passes through a slot 39 in the crosshead, the engagement between these elements being such that the spring is supported by the crosshead, but the latter may be freely moved by the screw 37, independent of the spring. By this means, the effective length of the spring, and hence, the deflection rate, can be varied by manipulation of the screw 37.

In the embodiment illustrated herein, idling has been provided for by means of the stop screw 40, which prevents complete closure of the needle 17 against the orifice 16. This is only one of several possible arrangements, however. The needle 17 could be allowed to close entirely and a bypass line for idling fuel could be connected at any of several locations.

The throttle plate 2 is shown below the final fuel orifice, as this is the preferred location in view of the idling fuel arrangement illustrated. However, as pointed out above, other idle arrangements can be used with my device, and in some cases the throttle butterfly could as well be located above the fuel orifice, so long as it is not placed above the idle fuel jet as well.

In operation, fuel is supplied to the inlet conduit 14 under superatmospheric pressure. The pressure at which the fuel is supplied will depend upon the particular fuel used. The important consideration in this respect is to select an operating pressure which will furnish a great enough differential across the orifice 16 to insure adequate control without undue orifice size and/or needle movement, and to provide a great enough static pressure to prevent vapor lock in the liquid fuel lines. In the case of low vapor pressure fuels, as for example, regular grade gasolines, the pressure would be generated by use of a fuel pump. In the case of high vapor pressure fuels, the fuels themselves would provide the pressure.

Upon cranking the engine, vacuum below the substantially closed throttle causes opening of the shutoff valve 3, and fuel admitted from the orifice 7 enters the manifold riser to form a combustible mixture with the incoming air. After starting, the speed of the engine is controlled by the position of the main throttle butterfly, which is manually operated in the conventional manner.

As the throttle is opened, the differential pressure across the increased opening in the manifold riser permits a flow of air past the venturi 22 in proportion to the degree of throttle opening and modified by the engine speed and degree of differential pressure available at the instant across the throttle. As air passes through the venturi a pressure reduction proportional to the rate of air flow will occur in the opening 23 and the chamber 26. Thus, for any given rate of air flow through the venturi, a definite position of the diaphragm 25, and hence the needle 17, will be established. Since the differential across the orifice 16 is maintained at a substantially constant value (due to the differential controller 11, explained later), the rate of fuel flow will be proportional to the needle position established as explained above. Therefore, it follows that the rate of fuel flow is directly controlled by the rate of air flow, and proportioning of the air-fuel mixture becomes a matter of matching the flow characteristics of the fuel valve with the respective operating requirements.

The differential controller 11 operates to maintain a substantially constant differential pressure across the orifice 16, in a manner now to be explained. The diaphragm 10 is subjected to three principal forces, namely: (1) the fuel line pressure imposed through the conduit 15; (2) the reduced fuel pressure on the downstream side of the main fuel orifice 16, and (3) the tension load in the spring 10A. The first-named force is, at all conditions of equilibrium, equal to the other two forces combined. Thus it may be seen that the difference in the two pressure forces will always be equal to the resilient force supplied by the spring. It follows that, if the spring is designed so as to have a very low rate of change in load per unit of deflection increment, the difference between the two pressures on opposite sides of the diaphragm, and therefore, across the orifice 16, will always be a constant amount. Any fluctuation in either of the two pressures will result in a slight displacement of the diaphragm and the resultant adjustment of the needle 8 with respect to the orifice 7 will reestablish the equilibrium condition.

Having a constant differential across the orifice 16, the flow therethrough becomes subject to one variable, namely, the effective free area around the needle 17. Thus, by properly shaping the needle so as to give the desired flow characteristic, accurate metering of the fuel with respect to the rate of air intake may be had. By proper matching of the fuel orifice size, the leverage ratio of the fuel valve linkage and the other factors involved, an air-fuel injection curve of any desired form may be obtained.

My invention is extremely well adapted to provide any variation of mixture ratio characteristics that could be desired. The air-fuel injection curve can be made to assume any desired general shape by shaping the needle 17 appropriately. The degree of curvature of the injection curve can be modified at will by adjusting the rate of deflection of the spring 32, which may be done by means of screw 37. The adjustment of the flow characteristics of the fuel valve is also subjected to many other obvious modifications, such as variations of orifice and diaphragm sizes, bell crank ratios, Venturi shape and size, etc.

The adaptability of my invention to varying conditions of use and to a wide range of fuels will suggest many variations of structure. The scope of the invention, therefore, must be limited only in accordance with the following claims.

I claim:

1. A charge forming device for internal combustion engines having a source of fuel under super atmospheric vapor pressure comprising an air intake conduit having a venturi, a fuel passage connecting the air intake conduit with the source of fuel, a primary variable fuel valve controlling the flow-rate of fuel in said passage, a secondary variable fuel valve in said fuel passage downstream of the primary fuel valve and controlling the pressure of the fuel going into the intake conduit to maintain the same under substantially constant pressure at all times, a housing having a pressure responsive diaphragm dividing the housing into an upper and lower chamber, said diaphragm connected operably with the primary fuel valve, spring means within the upper chamber urging said primary fuel valve closed, the upper chamber communicating with the air intake conduit at the venturi and the lower chamber with the atmosphere, so that air flow through the air intake conduit will open the primary fuel valve against the action of the spring in the upper chamber, a pressure responsive diaphragm operably connected with the secondary fuel valve communicating on one side with the fuel passage upstream of the primary fuel valve, the opposite side of the diaphragm communicating with the fuel passage downstream of said primary fuel valve and spring means opposing the pressure exerted on said last diaphragm by the pressure of the fuel upstream of the primary valve along with the pressure on the opposite side of said last mentioned diaphragm to insure a substantially constant pressure differential across said primary fuel valve.

2. A charge forming device for internal combustion engines having a source of fuel under super atmospheric vapor pressure comprising an air intake conduit having a venturi, a fuel passage connecting the air intake conduit with the source of fuel, a primary variable fuel valve controlling the flow-rate of fuel in said passage, a secondary variable fuel valve in said fuel passage downstream of the primary fuel valve and controlling the pressure of the fuel going into the intake conduit to maintain the same under substantially constant pressure at all times, a housing having a pressure responsive diaphragm dividing the housing into an upper and lower chamber, said diaphragm connected operably with the primary fuel valve, spring means with adjusting means to control the pressure thereon within the upper chamber urging said primary fuel valve closed, the upper chamber communicating with the air intake conduit at the venturi and the lower chamber with the atmosphere, so that air flow through the air intake conduit will open the primary fuel valve against the action of the spring in the upper chamber, a pressure responsive diaphragm operably connected with the secondary fuel valve communicating on one side with the fuel passage upstream of the primary fuel valve, the opposite side of the diaphragm communicating with the fuel passage downstream of said primary fuel valve and spring means opposing the pressure exerted on said last diaphragm by the pressure of the fuel upstream of the primary valve along with the pressure on the opposite side of said last mentioned diaphragm to insure a substantially constant pressure differential across said primary fuel valve.

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