Oct. 7, 1947. T. A. MORRIS 2,428,377

INJECTION TYPE CARBURETOR

Filed March 1, 1943 2 Sheets-Sheet 1

FIG.1.

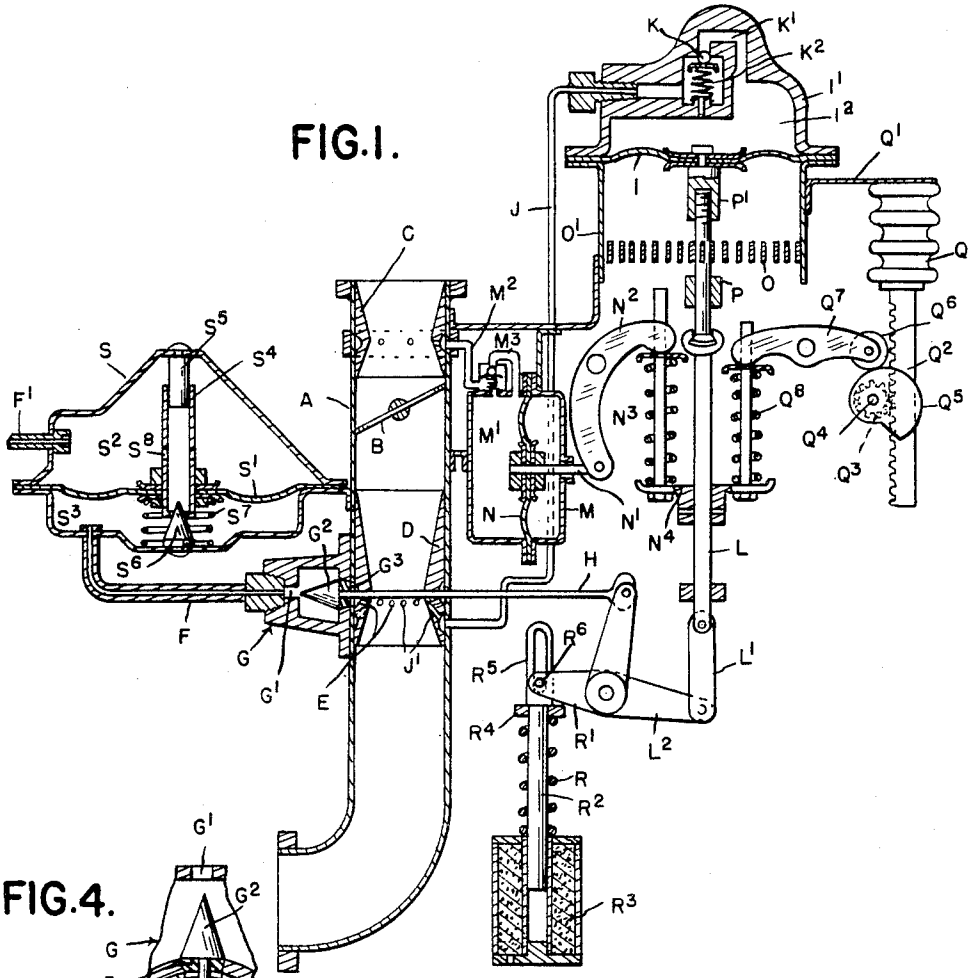


FIG.4.

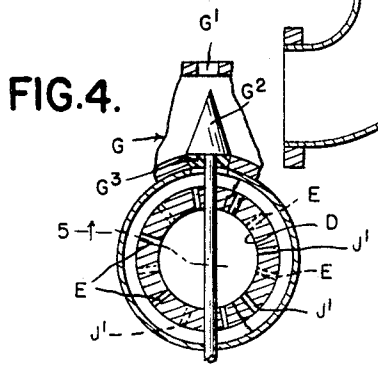
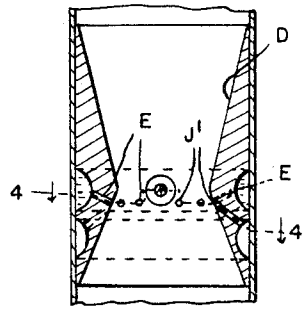


FIG.5.



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FIG.3.

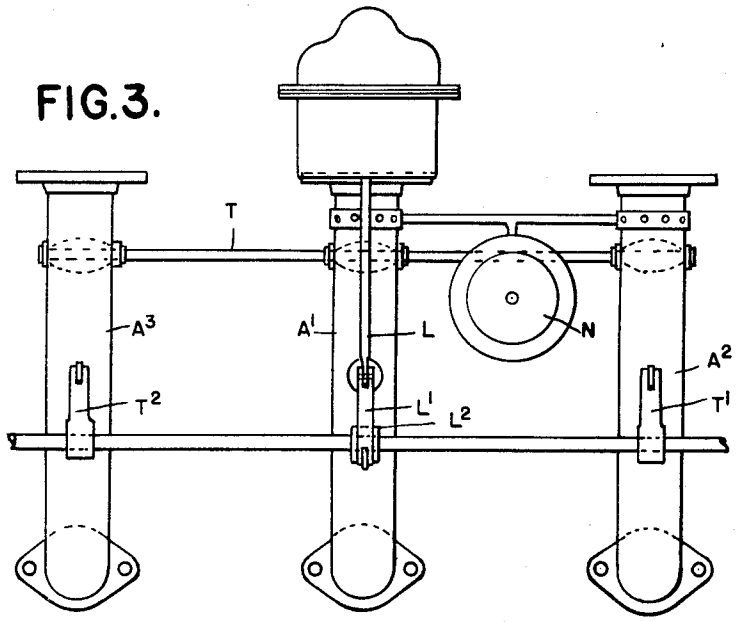
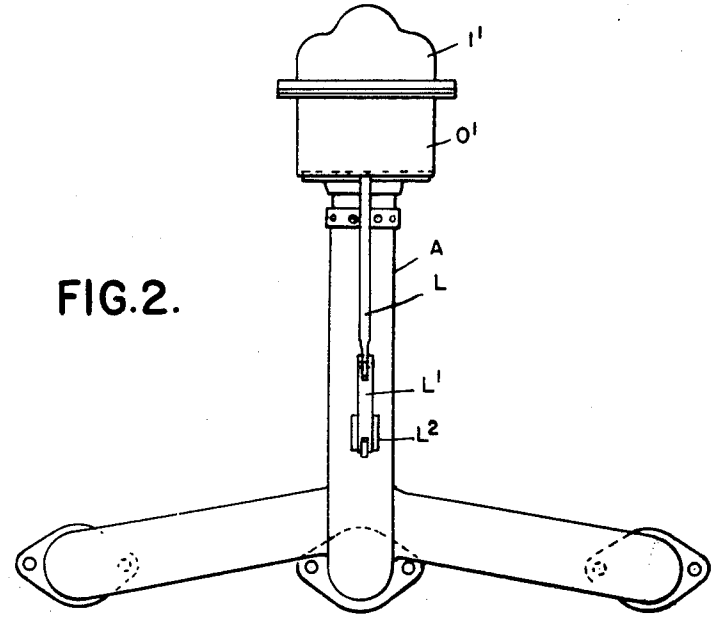


FIG.2.



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INJECTION TYPE CARBURETOR

Thomas A. Morris, Detroit, Mich.

Application March 1, 1943, Serial No. 477,627

6 Claims. (Cl. 123—119)

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The invention relates to carburetors designed for use with either single or multicylinder internal combustion engines and the present application forms a continuation in part of my earlier application, Serial No. 371,420, filed December 23, 1940, now Patent Number 2,318,008. The construction in this earlier case comprises a Venturi conduit having a fuel injection port in the constricted portion thereof and metering means controlling this port. This metering means, specifically shown as a tapered pin, is itself actuated by a flexible diaphragm which is responsive to variations in pressure within the conduit whereby the port is progressively restricted by decrease in pressure in the venturi and is enlarged by increase in pressure. There is, however, a valve portion which completely closes the port when the pressure within the conduit is equal to atmosphere. In addition to this response to depression within the conduit, the metering means is also responsive to means controlled by barometric pressure and further to means responsive to temperature changes.

The present invention includes the features above referred to but has, in addition thereto, controlling means for the fuel injection which is responsive to other conditions. Thus, in the operation of an internal combustion engine, the pressure within the inlet conduit or manifold is determined partly by the position of the throttle but also by the load. For instance, if the load is high and the speed is low, the throttle will be open to such an extent that the depression within the manifold is small. On the other hand, with the same throttle position but a greater speed, the depression within the manifold will be correspondingly greater.

It is one of the objects of the present invention to provide a control which will be conjointly responsive to manifold pressure and to velocity of the gases passing therethrough. It is a further object to obtain a construction in which controls responsive to conditions in the inlet conduits for one or more cylinders of a multicylinder engine will control the fuel injection in all of the cylinders so as to obtain uniformity in the operation thereof.

Still further it is an object to obtain certain other improvements and with these objects in view, the invention consists in the construction as hereinafter set forth.

In the drawings:

Figure 1 is a more or less diagrammatic section through my improved carburetor;

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Figure 2 is a front elevation thereof;

Figure 3 is a view similar to Figure 2 illustrating a modified construction;

Figure 4 is a horizontal section through a portion of the inlet conduit on line 4—4, Figure 5; and

Figure 5 is a section on line 5—5, Figure 4.

As shown in Figure 1, A is an inlet conduit leading to one or more cylinders of an internal combustion engine (not shown). B is a throttle valve in the conduit A. C and D are Venturi members arranged within the conduit A respectively outside and inside the position of the throttle valve. The member D is formed with a fuel injection port preferably a series of small ports E surrounding the venturi at a point adjacent to the plane of greatest restriction in area. These ports are supplied with liquid fuel from a conduit F which has arranged therein a metering device G shown as mounted on the outside of the conduit A. This metering device includes a port G' and a tapered member G^2 movable in relation thereto to vary the amount of open area. The member G^2 also has a valve portion G^3 for engaging a seat within the member G to completely cut off connection between the conduit F and the ports E. An actuating stem H is connected to the member G^2 and after passing through the conduit A is connected to a controlling mechanism of the following construction.

I is a flexible diaphragm within a housing I', said housing having a chamber I^2 on one side of the diaphragm which is connected by a conduit J with suction ports in the venturi D. These ports J' may be arranged intermediate the ports E in substantially the same plane and, therefore, connect with the portion of the conduit which is under highest vacuum. As the vacuum within the conduit A will be pulsating in accordance with movement of the piston in the cylinder connected thereto, I have provided means for minimizing the effect of these pulsations on the pressure within the chamber I^2, this comprising a check valve K restricting but not completely closing a passage K' between the conduit J and chamber I^2. A spring K^2 normally holds this check valve to its seat but will yield under the suction of the venturi.

The diaphragm I is connected by a suitable intermediate mechanism with the stem H so as to actuate the latter. As shown, a rod L is connected to the diaphragm and at its opposite end is connected by a link L' to a bell crank lever L^2, one arm of which is connected with the stem H. Thus, any movement of the diaphragm I

caused by a change in pressure within the chamber I^2 will be communicated through the rod L and other connections to the tapered metering member G^2 moving it in relation to the port G'. As the depression within the chamber I^2 is increased, this will move the member G^2 farther into the port G' to increase the restriction thereof. On the other hand, a rise of pressure within the chamber I^2 will move the member G^2 in the opposite direction enlarging the area of the port G'.

The construction which is described is similar to that in my former application but, as above stated, such control is not fully responsive to variations in velocity of the gases passing through the manifold. Consequently, the quantity of fuel may not be in precise ratio to the quantity of air and greater precision is obtained by the following construction. The venturi C previously described is arranged in the conduit A on the outer side of the throttle valve B where it will be responsive solely to the velocity of air passing therethrough. M is a casing containing a flexible diaphragm N and having a chamber M' on one side of said diaphragm which is connected by a conduit M^2 with ports in the venturi C adjacent to the area of greatest restriction. The diaphragm N is connected by a rod N' with one arm of a bell crank lever N^2, the other arm of which engages one end of a spring N^3 seated upon a collar N^4 on the rod L. This is merely a diagrammatic representation of means for applying variable pressure to the rod L through the spring N^3 responsive to variations in atmospheric depression within the chamber M' due to variations in velocity of the air passing through the venturi C. Thus, an increase in velocity of the air will increase the resilient pressure of the spring N^3 and in cooperation with the force produced by the diaphragm I will move the metering means G^3 to increase the discharge of fuel through the ports E. On the other hand, a decrease in the velocity of air will correspondingly reduce the pressure of the spring N^3 with the effect of decreasing the discharge of fuel through said ports E. However, the effect on the rod L due to change in pressure on the spring N^3 is modified by the length and original stressing of the spring, and this is so adjusted as to produce the proper regulation of the fuel discharge. Means M^3 similar to the check valve K may be used in connection with the chamber M' to minimize pulsations.

In my former application a thermostatic element was used for also controlling the discharge of fuel but this element was located in the conduit directly in the path of air passing through the venturi. In my present construction I have removed this thermostatic means from the inlet conduit but have located it so as to be responsive to the heat of the engine. As shown, a spiral thermostatic member O is arranged within the casing O' connected to the casing I' and surrounding the rod L, said casing being in heat conductive relation to the engine (not shown). P is a rod having at one end a swivel connection with the rod L and threaded at its opposite end to engage a corresponding nut P' connected with the diaphragm I. One end of the spiral thermostatic member O is connected with the rod P and the arrangement is such that any change in temperature affecting said member O will cause a rotation of the rod P to correspondingly increase or decrease the length between the diaphragm I and the rod L.

Another feature present in my former application was a means responsive to changes in barometric pressure for correspondingly changing the amount of fuel introduced into the inlet conduit. Thus, a reduction in atmospheric pressure and consequent decrease in density of the atmosphere would decrease the amount of fuel discharged but there was nothing to insure that the change in ratio of fuel discharge would exactly correspond to the change in density of air. In my present application I have corrected this deficiency by the following construction. Q is a metallic bellows having one end secured to a stationary support such as a bracket Q' and the opposite end connected to a rack bar Q^2 which is in mesh with a pinion Q^3 on a shaft Q^4. On this same shaft Q^4 is a cam Q^5 which engages a roller bearing Q^6 on one end of a lever Q^7, the opposite end of which engages one end of a spring Q^8 seated upon the shelf N^4 on the rod L. This construction also is merely a diagrammatic representation of a connection between the member Q and the rod L to apply a variable force thereto cooperating with the force of the diaphragm I. However, by suitably fashioning the cam Q^5, this force produced by the member Q and applied to the rod L will always be in correct ratio to change in the density of the air.

As previously described, the primary function of the valve member G^3 is to completely close the connection between the fuel supply conduit F and the discharge ports E when the carburetor is not in operation. A further function of this element is to form an additional metering means which is effective under certain conditions in operation. Thus, when the engine is operating under heavy load, the throttle may be fairly wide open but the speed of the engine and consequent velocity of gases through the inlet is relatively low. Under such conditions there is a tendency to discharge more fuel than required for the quantity of air. However, the valve member G^3 which is tapered to engage a tapered seat will operate as a metering device to restrict the fuel discharge and the lower the suction the more restriction until finally the valve closes to cut off all fuel. To insure this complete closure, I have provided additional means for holding the valve G^3 to its seat when the carburetor is not in operation. This means comprises a spring R which bears against an arm R' connected to the bell crank lever L^2 and actuating said lever in a direction to seat the valve G^3. The spring R' is sleeved upon a rod R^2 which forms the core member of a solenoid R^3. One end of the spring is seated on the casing of the solenoid and its opposite end engages a collar R^4 which bears against a shoulder on a slotted head R^5. A pin R^6 on the arm R' engages the slot in said head and the arrangement is such that when the solenoid R^3 is deenergized the spring operating through the collar R^4, head R^5 and pin R^6 actuates the arm R' to hold the valve G^3 to its seat. If, on the other hand, the solenoid R^3 is energized, this will draw downward the rod R^2 relieving pressure against the pin R^6 so as to permit the bell crank lever L^2 to be actuated solely by its other connections. The coil of the solenoid R^3 may be connected into the ignition circuit R^7 of the engine so that it will always be energized when the engine is to be operated. The discharge of fuel into the inlet conduit is not dependent solely upon the suction of the venturi B but is under a positive head. It is, however, very essential that this head should remain constant and I, therefore, provide a pressure regulator of the fol-

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lowing construction. S is a casing containing a flexible diaphragm S' which divides the interior into two chambers S^2 and S^3. S^4 is a tube connecting with and passing through the center of the diaphragm and slidably engaging at its upper end a pin S^5. A port S^8 connects the chamber S^2 with the interior of the tube and the lower end of the tube which is in the chamber S^3 is moved by the flexing of the diaphragm in relation to a metering member S^6 which restricts the open area as the diaphragm moves downward and enlarges said area as it moves upward. A spring S^7 resiliently lifts the diaphragm. The fuel conduit F is connected to the chamber S^3 and a fuel supply conduit F' is connected to the chamber S^2. Thus, the pressure of the liquid fuel in the chamber S^2 is balanced against the spring S^7 which lifts the diaphragm. Should the pressure increase in the chamber S^2 this by depressing the diaphragm and moving the tube S^4 towards the metering device S^6 restricts the opening for the passage of fuel into the chamber S^3. On the other hand, if the pressure in the chamber S^2 becomes less, the diaphragm will be raised and the discharge area around the metering device S^6 enlarged. Therefore when the carburetor is in operation, the pressure within the chamber S^3 is maintained substantially constant regardless of fluctuations in pressure of the liquid in the chamber S^2.

The construction as thus far described is applicable to a single cylinder engine. When, however, it is to be applied to a multicylinder internal combustion engine, either line or radial, it is unnecessary to duplicate all of the parts of the organization. Thus, the diaphragms I and N may be controlled by connections with an inlet conduit of a single cylinder or with a plurality of said conduits but not the whole number for all of the cylinders. The inlet conduit for each of the cylinders is, however, provided with a venturi D, the fuel inlet ports E and the fuel connections thereto. There is also a metering member G^2 and a valve G^3 but these instead of directly responding to variations within the inlet conduit to which they are applied may be mechanically connected to the corresponding metering means for each of the cylinders. The diaphragms I and N are connected to operate this mechanical connection so as to simultaneously and correspondingly control the fuel discharge in each of the conduits leading to an engine cylinder. Such an arrangement has the advantage that the power developed in each of the several cylinders will be uniform resulting in a smoother operation of the engine.

As illustrated in Figure 3, the diaphragm I is operatively connected to the conduit A' for only one of the cylinders of a multicylinder engine. The diaphragm N is operatively connected to the conduits A' and A^2 for two cylinders of the engine while the third conduit A^3 is not directly connected with either of the diaphragms I and N. However, the rod L and bell crank lever L^2 directly connected to the diaphragm I operate all of the metering means through a shaft T and levers T', T^2. Also the diaphragm N through connections not shown in detail but similar to those in Figure 1 modifies the operation of the rod L by the diaphragm I. The throttle valve B in the conduit A' is mechanically connected by a shaft T with corresponding throttle valves B', B^2 in the conduits A^2 and A^3.

What I claim as my invention is:

1. In a carburetor for multicylinder engines, the combination with a plurality of inlet conduits leading to different cylinders of the engine each conduit provided with a fuel injection port and a fuel supply therefor, of metering means for the fuel to each port, and means conjointly responsive to the static depression and the velocity of the gases through one or more of said conduits for simultaneously and correspondingly operating all of said metering means.

2. In a carburetor, the combination with an inlet conduit having a throttle valve therein, of Venturi portions respectively on the inner and outer side of said throttle, a fuel supply having a discharge port into the inner venturi, suction motors respectively responsive to said inner and outer venturis, and metering means for said fuel supply conjointly controlled by said suction motors.

3. In a carburetor for internal combustion engines provided with an electric ignition system, the combination with an inlet conduit, a throttle valve controlling the same and a fuel injection passage entering said conduit on the inner side of said throttle valve, of metering means responsive conjointly to variations in static depression in said conduit and variations in velocity of the gases travelling therethrough to decrease the area of said fuel passage upon increase in static depression and/or velocity, and to increase the area of said fuel passage upon decrease in static depression and/or velocity up to a predetermined point while further decrease in static depression and/or velocity will decrease the area of said fuel passage to finally completely close the same, auxiliary means for holding said metering means in completely closed position, and magnetic means energized when the ignition circuit of the engine is closed for releasing said holding means.

4. In a carburetor, the combination with an inlet conduit having a throttle valve therein, of Venturi portions of said conduit respectively on the inner and outer side of said throttle, a fuel supply having a discharge port into the inner venturi, suction motors respectively responsive to the suction of said inner and outer venturis, means for minimizing the amplitude of pulsations of said suction motors and metering means for said fuel supply conjointly controlled by said suction motors.

5. In a carburetor, the combination of an inlet conduit, a throttle valve therein, a venturi in said inlet conduit on the inner side of said throttle valve, a venturi in said inlet conduit on the outer side of said throttle valve, a fuel supply having a discharge port into said inner venturi, metering means for the fuel passing through said port, motor means responsive to the suction of said inner venturi, motor means responsive to the suction of said outer venturi, and means responsive to variations in barometric pressure, said metering means being conjointly operated by the three aforesaid responsive means.

6. In a carburetor, the combination of an inlet conduit, a throttle valve therein, a venturi in said inlet conduit on the inner side of said throttle valve, a venturi in said inlet conduit on the outer side of said throttle valve, a fuel supply having a discharge port into said inner venturi, metering means for the fuel passing through said port, motor means responsive to the suction of said inner venturi, motor means responsive to the suction of said outer venturi, means responsive to variations in temperature, and means responsive to variations in barometric pressure, said metering

means being conjointly operated by the four aforesaid responsive means.

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