July 15, 1958 G. P. RANSOM ET AL 2,843,099

FUEL METERING MECHANISM

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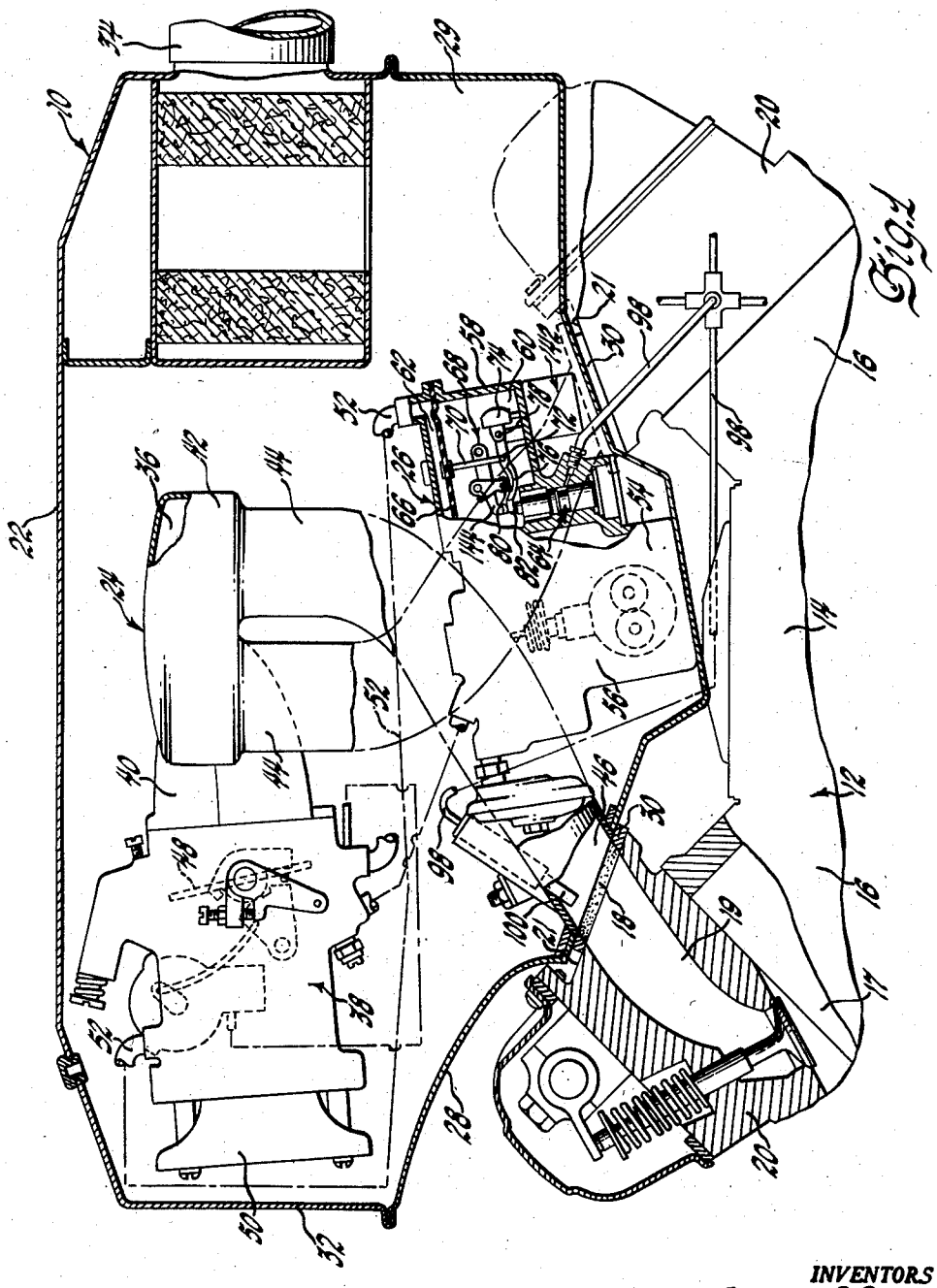


Fig. 1

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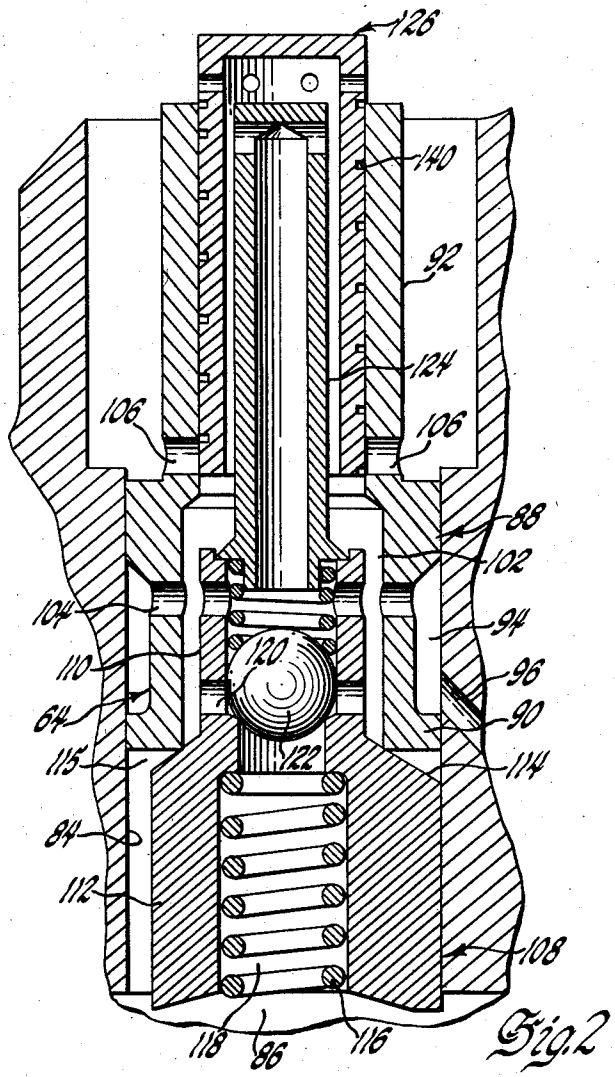


Fig. 2

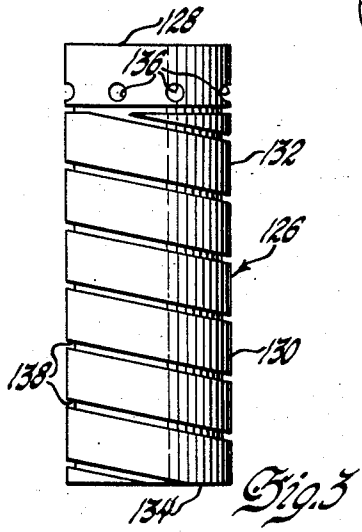


Fig. 3

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FUEL METERING MECHANISM

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13 Claims. (Cl. 123—119)

The present invention relates to internal combustion engines and more particularly to the charge forming means therefor.

In the operation of a so-called spark ignited engine, certain advantages may be derived from employing charge forming means having a fuel injection system for injecting metered quantities of fuel into the charge in the induction passages immediately adjacent the intake valves. Although such systems have been employed heretofore, for numerous reasons they have not been entirely satisfactory for use in mass produced automotive engines. In order to perform satisfactorily, such systems must be capable of accurately metering the fuel flow in precise proportion to the air flow. However, at times the amount of fuel flow in such engines is comparatively small and the forces involved are correspondingly small. Thus the working parts of the system must be very sensitive and free from any frictional effects. This is particularly true of a fuel metering valve.

It is now proposed to provide a fuel injection system having a fuel metering valve which is particularly adapted for use in a fuel injection system and is capable of accurately and precisely metering the fuel with a minimum amount of frictional and inertia effects. This is to be accomplished by providing a valve that includes a hollow, lightweight valve member having a cylindrical barrel portion. The exterior of the barrel includes a helical groove that is arranged to cause the valve member to rotate as a result of the leakage of fuel therepast. The lower end of the valve member registers with a plurality of ports and is thus effective to meter the fuel by opening and closing the ports. In addition, the upper end of the valve member includes a second set of spill ports that will simultaneously open and close with the lower ports to thereby meter the fuel with a minimum amount of travel.

In the drawings:

Figure 1 is an end view with a portion thereof being broken away of a charge forming unit embodying the present invention.

Figure 2 is a cross-sectional view on an enlarged scale of the fuel metering valve assembly.

Figure 3 is a side view of the fuel valve.

Referring to the drawings in more detail the present invention may be incorporated in a charge forming unit 10 that is adapted to be employed on an internal combustion engine 12. Although the engine 12 may be of any suitable design, in the present instance it is of the so-called V-type having a cylinder block 14 with a pair of angularly disposed banks 16 of cylinders 17 with an upwardly opening space therebetween. Each bank 16 includes a row of aligned cylinders with a cylinder head 20 secured along the top thereof to close the ends of the cylinders and thereby form the combustion chambers. Each cylinder head 20 includes separate intake passages 19 for each cylinder 17 that extend transversely therethrough with the outer ends forming rows of intake ports 18 along the inner sides or faces 21 of the heads 20 and

the inner ends forming intake valve seats opening into the combustion chambers.

In order to supply a combustible charge of air and fuel to the cylinders, the charge forming unit is enclosed in a shroud 22 and includes an air induction system 24 and a fuel injection system 26.

The shroud 22, which may be fabricated from any suitable material such as sheet metal, includes a lower member 28 that is supported by thermal insulating means 30 extending along the faces 21 on the sides of the cylinder heads 20. A cover member 32 is secured to the lower member 28 and thus encloses an enlarged plenum chamber 29 which draws all of the air through the inlet 34 in the side of the shroud 22. A filter element is disposed in the inlet 34 so that all of the air in the chamber is filtered.

The induction system 24, in addition to the shroud 22, includes an intake manifold 36 and an air meter 38 mounted on the manifold inlet 40. The intake manifold 36 comprises a main body 42 and a plurality of substantially identical ram pipes 44 that open into a chamber in the body. The lower ends of the pipes 44 register with the intake ports 18 and thus form induction passages 46 preferably shaped to produce a ramming of air into the cylinders.

The air meter 38 which is mounted on the manifold inlet 40 comprises a generally cylindrical housing having a substantially cylindrical passage extending therethrough for drawing the filtered air from inside of the plenum chamber 29 and delivering it to the intake manifold 36 for distribution to the cylinders 17. A manually controlled throttle valve 48 is disposed in one end of the passage to regulate the volume of air flow therethrough and a suitable metering restriction is placed adjacent the opposite end of the passage to create a signal indicative of the amount of said air flow. In the present instance this restriction comprises a tapered member 50 mounted on studs to project into the inlet end of the passage. The exterior of the member 50 is tapered to cooperate with the interior of the passage so that the cross-sectional area of the air flow will vary similar to that in a more conventional venturi. An annular port extends around the inside of the passage to sense the vacuum developed by the air flow and transmit this vacuum signal through the vacuum line 52.

The fuel injection system 26 includes a control unit having a housing 54 with a float bowl portion 56 in one end and a metering portion 58 in the other end. The float bowl 56 includes an inlet connected to any suitable source of fuel and has an injector pump immersed therein. The metering portion 58 in the opposite end of the housing 54 includes a linkage compartment 60 with a diaphragm chamber 62 thereabove and a fuel meter 64 therebelow.

The diaphragm chamber 62 is interconnected with the venturi throat by the vacuum signal line 52 and includes a diaphragm 66 responsive to the vacuum signal from the air meter 38. Thus the diaphragm 66 will have a force thereon indicative of the amount of air flow. The diaphragm 66 is interconnected with the fuel meter 64 by means of a linkage 68 comprising a vertical pin 70 having the upper end connected to the diaphragm 66 and the lower end connected to the joint 72 between a counterweight lever 74 and a control lever 76. The counterweight lever 74 pivots about a fixed point 78 while the control lever 76 pivots about the end of an adjustable ratio arm 80 with the outer end 82 bearing upon the fuel meter 64.

The fuel meter 64 is disposed in a cylindrical passage 84 having the lower end 86 thereof interconnected with the outlet of the injector pump to receive fuel therefrom under pressure. A sleeve 88 is disposed in the passage 84

with an enlarged part or hub **90** on the lower end thereof that tightly fits the passage **84** to form a seal therebetween and a valve guide **92** on the upper end that projects above the upper end of the passage **84**.

The exterior of the hub **90** includes an annular recess that cooperates with the passage **84** to form an annular distributing chamber **94**. Fuel passages **96** intersect the chamber at symmetrical points so as to radiate outwardly therefrom and be attached to injector lines **98** having nozzles **100** on the outer ends thereof for injecting the fuel into the charge. If there are only two fuel passages **96** they will always intersect the chamber **94** symmetrical about some point and the fuel will divide equally therebetween. The axial passage **102** in the center of the sleeve **88** is interconnected with the annular distributor **94** by a plurality of radial apertures **104** and also includes a plurality of spill ports **106** adjacent the lower end of the guide **92**. These ports **106** allow the surplus fuel to drain therethrough for return to the float bowl.

A hollow valve body **108** is disposed in the passage **84** below the sleeve **88** and includes a reduced upper portion **110** and an enlarged lower portion **112** that is slidably disposed in the passage **84**. These two portions are separated from each other by a tapered cone **114** that is adapted to engage the lower end of the sleeve **88** and thereby form a valve **115** therebetween. A spring **116** biases the valve body **108** upwardly against the sleeve **88** to retain the valve **115** normally closed. Thus all of the fuel must flow upwardly through the passage **118** in the center of valve body **108** and outwardly from the apertures **120** into the passage **102** inside of the sleeve **88**. A spring biased check valve **122** may be disposed in the passage **118** to maintain the pressure of the fuel anterior thereto in excess of some predetermined amount. A spindle **124** projects upwardly from the top of the valve body **108** to terminate approximately flush with the upper end of the guide **92**.

A hollow piston valve **126** is reciprocably disposed in the guide portion **92** and includes a closed upper end **128** and a barrel portion **130** with a cylindrical exterior that slides in the guide **92**. The lower end **134** of the barrel **130** registers with the spill ports **106** to partially close them and regulate the amount of fuel passing therethrough. It is, of course, apparent that controlling the amount of fuel by-passed through the spill ports **106** will indirectly control the amount of fuel flow through the lines to nozzles **100**. If desired, the upper end of the barrel may have spill ports **136** therein which will register with the upper end of the guide **92** and supplement the action of the lower ports **106**. As a result of the two sets of spill ports **106** and **136**, a minimum amount of piston travel will be required for a maximum amount of fuel regulation.

The upper end **128** of the piston **126** has the control lever **76** resting thereon and tending to depress the piston **126** with a force proportional to the amount of air flow. The under side of the piston **126** is exposed to the fuel pressure inside of the sleeve **88**. Since the injector lines **98** and nozzles **100** have a predetermined hydraulic resistance, this pressure will be indicative of the fuel flow. Thus there will be a downward force on the piston **126** tending to close the spill ports **106** and **136** proportional to the amount of air flow and an upward force on the piston **126** tending to open the spill ports **106** and **136** proportional to the fuel flow. These forces will adjust the position of the piston **126** relative to the spill ports **106** and **136** and, consequently, meter the fuel flow until the two forces balance and the air and fuel are flowing in some predetermined ratio.

The exterior **132** of the barrel portion **130** includes a helical groove **138** that extends therearound to cooperate with the passage **84** in the guide **92** to form a helical channel **140**. Thus any fuel which leaks between the piston **126** and passage **84** will collect in this channel **140** and will flow upwardly and escape from the top thereof. The

fuel flowing in such a spiral pattern will produce a torque on the piston **126** which will cause it to rotate. As a result of this rotation the piston **126** will "float" in the passage **84** and static friction will be eliminated. Thus the piston **126** will be very sensitive to the slightest change in either of the forces acting thereon. In addition, if a particle of dirt, etc. should appear between the surfaces of the piston **126** and the passage **84**, the relative rotation will cause the particle to work its way along the surfaces until it drops into the channel **140** from whence it will be carried away with the fuel.

Under some circumstances, for example, during a starting operation, it may be desirable to eliminate the pressure drop created by the check valve and to insure all of the fuel delivered from the injector pump being delivered to the charge. Accordingly, an enrichment means **142** is provided that is effective to rotate the arm **144** until it strikes the top of the control lever **76** and depresses the piston **126**. This will cause all of the spill ports **106** and **136** to be closed and the piston **126** to strike the spindle **124** and force it downwardly to thereby open the valve **115**. This will thus permit the fuel to by-pass the check valve **122** and to flow directly into the distributing chamber **94**.

It is to be understood that, although the invention has been described with specific reference to a particular embodiment thereof, it is not to be so limited since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

We claim:

1. A fluid control valve comprising a housing member having a cylindrical passage extending therethrough, a piston member adapted to be reciprocably disposed in said passage, at least one of said members having a set of metering ports therein for the flow of fluid therethrough, said ports being positioned so that reciprocating movement of said piston member will be effective to vary the unobstructed area of said ports to thereby regulate the amount of said fluid flow therethrough, said piston member having a cylindrical exterior with a helical groove therein adapted to cooperate with the surface of said passage and form a passage in which fluid leaking between said piston member and said passage will collect and produce a torque on said piston member.

2. The combination of claim 1 wherein said set of metering ports are formed in said housing member and are positioned to register with one end of said piston member.

3. The combination of claim 1 wherein said set of metering ports are formed in said piston member and are positioned to register with the end of said housing member.

4. The combination of claim 2 wherein said piston member includes a second set of metering ports adjacent the opposite end thereof and positioned to register with the end of said housing member so that said sets of ports are in parallel and movement of said piston will be effective to simultaneously vary the area of the ports in both sets.

5. In a housing member having a cylindrical passage extending therethrough with outlet ports adjacent one end thereof, a cylindrical piston valve reciprocably disposed in said cylindrical passage and effective to have one end thereof register with said outlet ports to regulate the amount of fuel flowing therethrough, the cylindrical exterior of said valve including a helical groove adapted to cooperate with the surface of said passage to form a spiral channel into which fluid leaking between the exterior of said valve and the surface of said passage will collect and produce a torque on said valve.

6. A fluid control valve comprising a housing member having a cylindrical passage extending therethrough, a piston member adapted to be reciprocably disposed in said passage, at least one of said members having a set of

metering ports therein for the flow of fluid therethrough, said ports being positioned so that reciprocating movement of said piston member will be effective to vary the unobstructed area of said ports to thereby regulate the amount of said fluid flow therethrough, said piston member having a cylindrical exterior with a helical groove therein adapted to cooperate with the surface of said passage and form a passage in which fluid leaking between said piston member and said passage will collect and produce a torque on said piston member, means operatively interconnected with said piston member and effective to position said piston member relative to said ports.

7. In a fuel injection system for delivering metered quantities of fuel to the charges for the cylinders of an internal combustion engine, a fuel metering valve comprising a housing member having a cylindrical passage extending therethrough, a piston member reciprocably disposed in said passage, a set of metering ports in one of said members for the flow of fuel therethrough, a second set of metering ports in the other of said members disposed in parallel with said first set, said sets being positioned so that movement of said piston member will be effective to simultaneously vary the unobstructed area of the ports in both sets, one side of said piston being exposed to a fuel pressure indicative of the amount of metered fuel flowing to the engine cylinders, and means for exerting an opposed force on the opposite side of said piston indicative of the amount of air flow.

8. In a fuel injection system for delivering metered quantities of fuel to the charges for the cylinders of an internal combustion engine, a fuel metering valve comprising a housing member having a cylindrical passage extending therethrough, a piston member reciprocably disposed in said passage, a set of metering ports in one of said members for the flow of fuel therethrough, said ports being positioned so the unobstructed area thereof will vary with axial movement of said piston, one side of said piston being exposed to a fuel pressure indicative of the amount of metered fuel flowing to the engine cylinders, and means for exerting an opposed force on the opposite side of said piston indicative of the amount of air flow, a helical groove in the exterior of said piston member forming a channel in which leakage fuel will collect and produce a force tending to rotate said piston member.

9. In a fuel injection system for delivering metered quantities of fuel to the charges for the cylinders of an internal combustion engine, a fuel metering valve comprising a housing member having a cylindrical passage extending therethrough, a piston member reciprocably disposed in said passage, a set of metering ports in one of said members for the flow of fuel therethrough, a second set of metering ports in the other of said members disposed in parallel with said first set, said sets being positioned so that movement of said piston member will be effective to simultaneously vary the unobstructed area of the ports in both sets, one side of said piston being exposed to a fuel pressure indicative of the amount of metered fuel flowing to the engine cylinders, and means for exerting an opposed force on the opposite side of said piston indicative of the amount of air flow, a helical groove in the exterior of said piston member forming a

channel in which leakage fuel will collect and produce a force tending to rotate said piston member.

10. Valve means comprising a member having a passage extending axially therethrough, a piston member reciprocably disposed in said passage, at least one of said members having metering ports therein, said piston member being movable between two extreme positions so as to vary the unobstructed area of said ports, a pressure responsive check valve disposed upstream of said piston member for maintaining the pressure of the fuel anterior thereto in excess of some predetermined amount, and means for simultaneously moving said piston member to one of said extreme positions and also to eliminate the effectiveness of said check valve.

11. Valve means comprising a first member having a passage extending axially therethrough, a piston member reciprocably disposed in said passage, at least one of said members having metering ports therein, said piston member being movable between two extreme positions so as to vary the unobstructed area of said ports, a valve body disposed upstream of said first member and engaging said first member to form a normally closed valve therebetween, said valve body including the pressure sensitive check valve for maintaining the pressure of the fuel anterior thereto in excess of some predetermined amount and means for simultaneously moving said piston member to one of said extreme positions and to separate said valve body from said first member to by-pass said check valve.

12. In a fuel injection system a housing having a passage therein, a guide member mounted in said passage and having an axial passage therethrough, a piston member reciprocably disposed in said axial passage and effective to regulate the amount of fuel flowing therethrough in proportion to the amount of air flowing to an engine, a valve body disposed in said first passage and engaging said guide member to form a normally closed valve, said valve body including a pressure responsive check valve in parallel with said normally closed valve and adapted to maintain the fuel pressure anterior thereto in excess of some predetermined amount, means for simultaneously moving said piston member to the maximum fuel position and opening said normally closed valve.

13. In a fuel injection system a housing having a passage therein, a guide member mounted in said passage and having an axial passage therethrough, a piston member reciprocably disposed in said axial passage, at least one of said members including metering ports, means for distributing metered fuel from said passage to the cylinders of an engine, movement of said piston member being effective to meter said fuel by controlling flow of surplus fuel through said ports, a valve body disposed in said first passage and engaging said guide to form a normally closed valve, said valve body including a pressure responsive check valve in parallel with said normally closed valve and adapted to maintain the fuel pressure anterior thereto in excess of some predetermined amount, means for simultaneously moving said piston to close said ports and open said normally closed valve.

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