

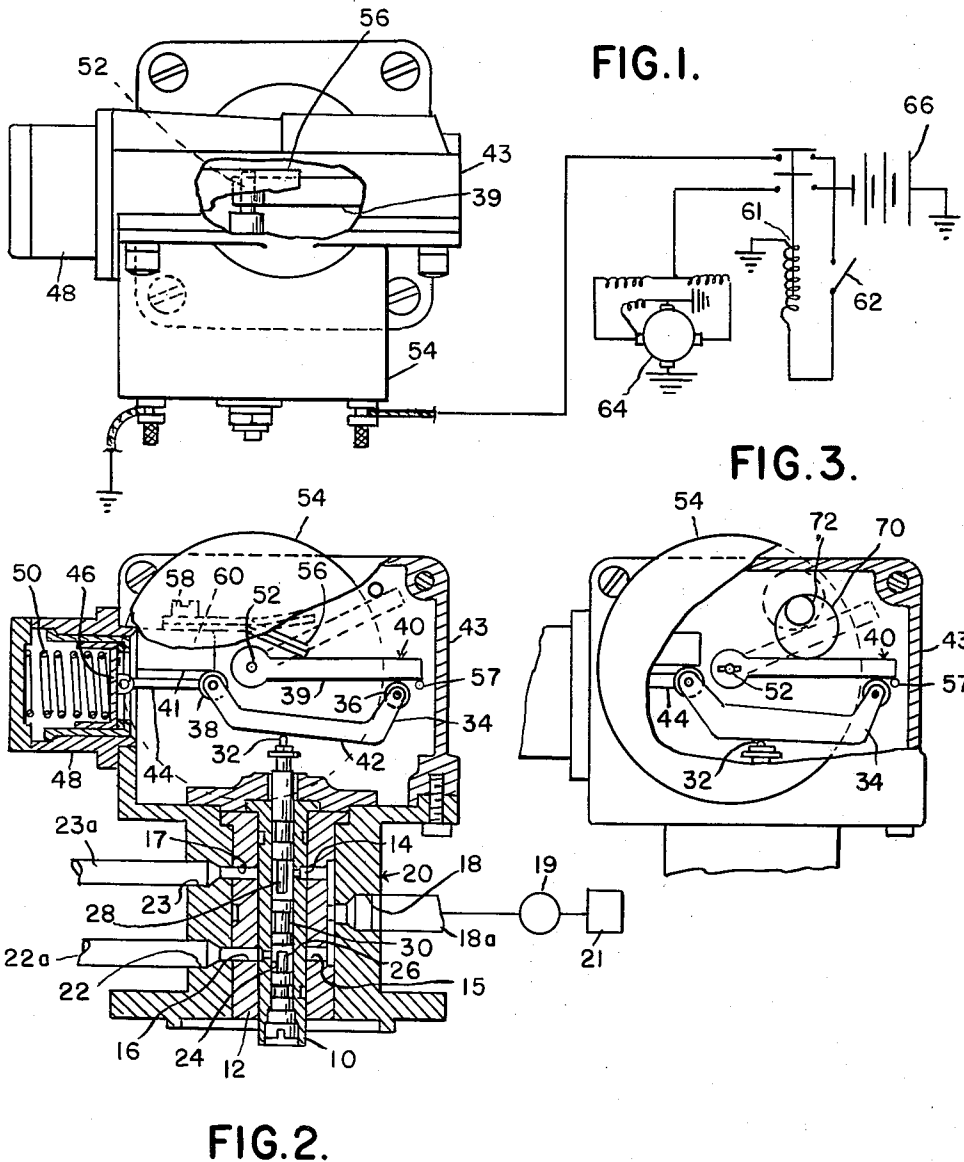
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FUEL METERING AND PUMPING SYSTEM FOR FUEL INJECTION

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## FUEL METERING AND PUMPING SYSTEM FOR FUEL INJECTION

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The present invention relates to a fuel metering and pumping system for fuel injection and particularly, to a system including a shuttle type fuel metering and pumping device.

It is an object of the present invention to provide means for regulating the quantity of fuel metered into each charge during starting of the engine in accordance with an engine temperature.

It is a further object of the present invention to provide fuel regulating means in a fuel injection system including a member movable to determine the quantity of metered fuel, and means operable as an incidence of operation of the engine starter to move the member to a position as determined by engine temperature to increase the metered fuel during starting.

More specifically, it is an object of the present invention to provide a movable regulating member for a fuel metering system for an internal combustion engine having an electric starter, solenoid actuated means for biasing said member in a direction to increase the flow of metered fuel during operation of the starter, and abutment means responsive to a temperature condition of the engine for limiting fuel increasing movement of said member.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating preferred embodiments of the invention, wherein:

Figure 1 is a plan view of the fuel metering and pumping device.

Figure 2 is a vertical section through the device shown in Figure 1.

Figure 3 is a fragmentary view similar to Figure 2 showing a different embodiment of the invention.

Referring first to Figures 1 and 2, the invention relates to fuel metering apparatus particularly designed for fuel injection. The present invention is applied to the type of injection apparatus illustrated in Downing Patent 2,731,175 to which reference is made for details of the metering and pumping system.

Described very generally, this construction comprises an elongated cylindrical element 10 rotatable at a speed determined by engine speed in a sleeve 12 having inlet passages 14 and 15 and outlet passages 16 and 17. The inlet passages 14 and 15 are in communication with a threaded opening 18 in a casing 20, and the outlet passages 16 and 17 are in communication with threaded outlet passages 22 and 23 located in the casing. Opening 18 is connected by conduit 18a to a fuel pump 19 which supplies fuel from a tank 21 to opening 18.

The element 10 has a longitudinally extending cylindrical opening 24 provided adjacent one end with a fixed abutment 26 and adjacent its other end with a movable abutment 28. Intermediate the abutments 26 and 28 is a shuttle 30.

By rotation of the element 10, pressure is admitted alternately to the cylinder 24 at opposite sides of the

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shuttle 30. With the parts in the position illustrated, it will be observed that fluid under pressure is admitted to the cylinder 24 above the shuttle 30 through the passage 14 and will accordingly move the shuttle downwardly expelling fluid through the outlet opening 22. The quantity of fuel discharged during movement of the shuttle is of course determined by the spacing between the fixed and movable abutments. At the same time, movement of the shuttle 30 downwardly admits a metered quantity of fuel into the cylinder above the shuttle, again as determined by the spacing between the abutments. Upon further rotation of the element 10, the pressure fluid supplied through the passage 18 enters the cylinder through the passage 15 and shifts the shuttle upwardly, thus expelling a metered quantity of fuel under pressure through the outlet passages 17 and 23. This operation is repeated and at each movement of the shuttle 30, a quantity of fuel metered in accordance with the position of the movable abutment 28 is expelled from one or the other of the outlet passages or ports 22 or 23. It will be understood that ports 22 and 23 are connected by conduits 22a and 23a to separate cylinders or groups of cylinders of an internal combustion engine.

From the foregoing it will be observed that the quantity of fuel discharged at each movement of the shuttle 30 is directly dependent upon the position of the movable abutment 28.

In accordance with the present invention novel means are provided for effecting a desired control of the adjustment of the abutment 28.

The means for effecting adjustment of the abutment 28 comprises a nose 32 on the end of the movable abutment or on an element connected thereto.

Associated with the movable abutment 28 is an elongated carriage 34 having rollers 36 and 38 movable along the surface 39 of a movable member 40, and a fixed surface 41. The carriage 34 has a camming surface 42 which may be straight or have some nonlinear modification, but which in any event is nonparallel to the surface 39 of the member 40. This structure is contained in housing 43.

Connected to the carriage 34 is a link 44 which in turn is connected to a piston 46 movable in a cylinder 48, the interior of the cylinder being connected to the manifold of the internal combustion engine by suitable conduit means (not shown). Accordingly, upon variation in engine load or density, the piston 46 is positioned by the joint action of the spring 50, the reduced pressure existing within the cylinder, and the atmospheric pressure acting on the outer surface of the piston. This in turn effects general longitudinal adjustment of the carriage 34. Inasmuch as its surface 42 is not parallel to the surface 39, movement of the carriage 34 effects an adjustment of the abutment 28 in a direction parallel to the cylinder 24.

Means are also provided for effecting an adjustment of the member 40 during the interval while the electric starter of the internal combustion engine supplied with fuel by the fuel injection system is being energized. Furthermore, the actual movement of the member 40 is determined by an engine temperature condition so that the fuel mixture may be suitably enriched during cold starting.

In order to accomplish the foregoing the member 40 is mounted for angular adjustment about the axis of a shaft 52 to which the member 40 is keyed or otherwise secured. The shaft 52 is in turn connected to the armature of a rotary solenoid indicated at 54. The rotary solenoid when energized is connected to the shaft 52 to apply a counterclockwise rotation thereto, thus effecting counterclockwise angular movement of the member 40.

The amount of movement which is permitted the member 40 when biased in a counterclockwise direction by energization of the rotary solenoid is determined by

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a movable abutment 56. The movable abutment may comprise a relatively heavy bi-metallic member as illustrated, secured at one end as by a screw 58 to a mounting block 60 located within the housing. The interior of the housing 43 is subjected to air at a temperature dependent upon an engine condition as is well understood in the art. Accordingly, during cold weather when the engine is cold the thermostatically adjustable abutment 56 moves to a position in which it allows more angular movement of the member 40 than when the engine is warm. After starting, member 40 is returned to position against stop 57 by a spring in the solenoid.

Conveniently, the windings of the solenoid 54 may be in series with the electric starter or as seen in Figure 1, actuated by a relay controlled by a starter switch 62 so that the rotary solenoid is energized only during and as an incidence of energization of the electric starter motor 64 from battery 66.

Referring now to Figure 3 there is illustrated a generally similar arrangement and only the points of difference will be described in detail, like reference numerals being applied to the figure where appropriate. In this case the movable member 40 as before, is keyed or otherwise secured to a shaft 52 of a rotary solenoid indicated generally at 54. However, instead of providing a bi-metallic abutment element such as shown at 56 in Figure 2, in this case angular movement of the member 40 is limited by an eccentric cam 70 carried by a shaft 72. The shaft 72 is rotated in accordance with temperature by suitable means such for example as a spirally wound bi-metallic strip. In other words, in this case the cam which operates as the abutment is positioned by a temperature responsive thermostatic device, whereas in the first embodiment of the invention, the temperature responsive thermostatic element itself constituted the abutment.

In either case, means responsive to the temperature of the engine operate to locate an adjustable abutment in a position to determine the quantity of fuel metered into each charge thereof during operation of the engine starter.

The present invention is particularly applicable to a fuel metering and pumping device such as shown in Figure 2, and fuel is ordinarily supplied to this fuel metering and pumping device at a relatively high pressure as for example 100 p.s.i. Inasmuch as the pressure of the fuel supplied to the metering and pumping device determines the pressure at which the fuel charges are pumped to the internal combustion engine, it will be observed that during starting fuel is supplied to the internal combustion engine in metered charges and that the quantity of fuel in these charges is increased in accordance with temperature to provide an enriched mixture. Inasmuch as the operation of the system requires fuel under relatively high pressure to be supplied during starting, it will of course be understood that the system includes a fuel pump and this conveniently may be an electric fuel pump whose operation is initiated to deliver fuel under the required pressure during starting of the engine.

The drawing and the foregoing specification constitute a description of the improved fuel metering and pumping system for fuel injection in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. In a fuel injector system for an internal combustion engine having a starter, fuel metering and pumping means comprising a member movable to determine the quantity of fuel metered thereby, cold start control means for said member adapted to be operatively connected to the engine starter and including engine temperature responsive means directly engageable with said member, said cold start control means being operable

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to move said member to a position during operation of said starter in accordance with a temperature condition of the engine as indicated by said temperature responsive means.

2. In a fuel injector system for an internal combustion engine having a starter, fuel metering and pumping means comprising a member movable to determine the quantity of fuel metered thereby, cold start control means for said member adapted to be operatively connected to the engine starter to move said member to a position during operation of said starter in accordance with a temperature condition of the engine, said cold start control means comprising first means operable during and as an incidence of operation of said starter to bias said member in a direction to increase the quantity of fuel metered, and engine temperature responsive second means effective to limit the amount of movement of said member by said first means.

3. In a fuel injector system for an internal combustion engine having a starter, fuel metering and pumping means comprising a member movable to determine the quantity of fuel metered thereby, cold start control means for said member to move said member to a position during operation of said starter in accordance with a temperature condition of the engine, said cold start control means comprising solenoid means energized only during operation of said starter operable to bias said member in a direction to increase metered fuel, and engine temperature responsive abutment means responsive to an engine temperature condition operable to limit the amount of movement of said member by said solenoid means.

4. Structure as defined in claim 3 in which said member is mounted for angular adjustment about a fixed pivot, and in which said solenoid means is connected thereto to move said member about said pivot.

5. Structure as defined in claim 3 in which said abutment means comprises a thermally responsive element directly engageable with said member.

6. Structure as defined in claim 3 in which said abutment means comprises a heavy bi-metallic element directly engageable with said member.

7. Structure as defined in claim 3 in which said abutment means comprises a cam abutment mounted for angular movement about a fixed axis, and thermally responsive means connected to said cam abutment to rotate it to a position determined by a temperature condition of said engine.

8. Fuel metering apparatus for an internal combustion engine having an electric starter, comprising an elongated movably mounted rail, a carriage movable longitudinally on said rail, said carriage having an elongated cam surface extending at an angle to said rail, a fuel control element having a portion engaging said cam surface to be positioned thereby, means responsive to manifold pressure connected to said carriage for moving it along said rail, first means responsive to energization of said starter to bias said rail in a direction to increase metered fuel, and means responsive to an engine temperature effective to limit movement of said rail by said first means.

9. Fuel metering apparatus for an internal combustion engine having an electric starter, comprising an elongated movably mounted rail, a carriage movable longitudinally on said rail, said carriage having an elongated cam surface extending at an angle to said rail, a fuel control element having a portion engaging said cam surface to be positioned thereby, means responsive to manifold pressure connected to said carriage for moving it along said rail, solenoid means responsive to energization of said starter to bias said rail in a direction to increase metered fuel, and abutment means responsive to an engine temperature effective to limit movement of said rail by said solenoid means.

10. Fuel metering apparatus for an internal combustion engine having an electric starter, comprising an elongated movably mounted rail, a carriage movable lon-

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gitudinally on said rail, said carriage having an elongated cam surface extending at an angle to said rail, a fuel control element having a portion engaging said cam surface to be positioned thereby, means responsive to manifold pressure connected to said carriage for moving it along said rail, first means responsive to energization of said starter to bias said rail in a direction to increase metered fuel, and abutment means responsive to an engine temperature effective to limit movement of said rail by said first means, said rail being mounted for angular movement about a fixed pivot support, said first means comprising a rotary solenoid.

11. Means for controlling metered fuel to an engine during cranking comprising a movable member operable to increase or decrease the supply of fuel, means responsive to cranking of the engine and temperature connected to said member to move it to a variable position dependent on engine temperature during cranking of the engine, and means to restore the member to running position after the engine starts.

12. In an engine driven fuel distributor unit, pressure responsive metering means adapted to deliver a controlled quantity of fuel per cycle, variably positioned abutment means for determining the said quantity of fuel, means for adjusting said abutment means in accordance with engine vacuum during all ranges of engine operation, and additional means operative only during cranking of the engine for variably determining the position of said abutment means in accordance with engine temperature.

13. In an engine driven fuel distributor unit, pressure responsive pumping means adapted to deliver a controlled quantity of fuel per cycle, said pumping means including a movable pumping element, variably positioned abutment means engageable by said element for determining the said quantity of fuel, means for adjusting said abutment means in accordance with engine vacuum during all ranges of engine operation, and additional means operative only during cranking of the engine for shifting the position of said abutment means to a position determined by engine temperature.

14. An internal combustion engine, a starter device for cranking said engine, a fuel supply system for supplying fuel to said engine including means responsive to engine demand effective to regulate the rate of fuel delivery during operation of said engine, and additional means directly responsive jointly to operation of said starter device and engine temperature for supplying fuel to said engine at a greater rate during cranking of said engine.

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15. An internal combustion engine, a starter device for cranking said engine, a fuel supply system including a fuel pump for supplying fuel to said engine, means responsive to engine demand to regulate said pump during operation of said engine to deliver fuel at a rate within a normal range, and means responsive jointly to operation of said starter device and to engine temperature to increase the rate of delivery of said pump during cranking of the engine.

16. A fuel metering and pumping device for an internal combustion engine having a starter comprising a cylinder, a shuttle piston movable in said cylinder between abutments in pumping and metering strokes, means for adjusting one of said abutments to vary the quantity of fuel delivered in each stroke of the piston comprising a movable member and means for effecting a first adjustment of said member in accordance with engine temperature when said starter is operating and a second different adjustment of said member when said engine is running and the starter is not operating.

17. Fuel metering and pumping apparatus for an internal combustion engine comprising a movable abutment member whose position determines the rate of fuel metering, direct adjusting means for said movable member comprising first means responsive directly to an engine temperature condition and second means responsive directly to starting and running conditions of the engine.

18. Fuel metering apparatus for metering charges for injection to an internal combustion engine, control means for said apparatus comprising first means directly responsive jointly to engine temperature and manifold vacuum and means operable to directly adjust the effectiveness of said first means in accordance with engine starting or running conditions.

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