Dec. 20, 1960 D. A. MUNYAN 2,965,091

COLD START AND WARM UP SYSTEM FOR FUEL INJECTION

Filed June 13, 1957

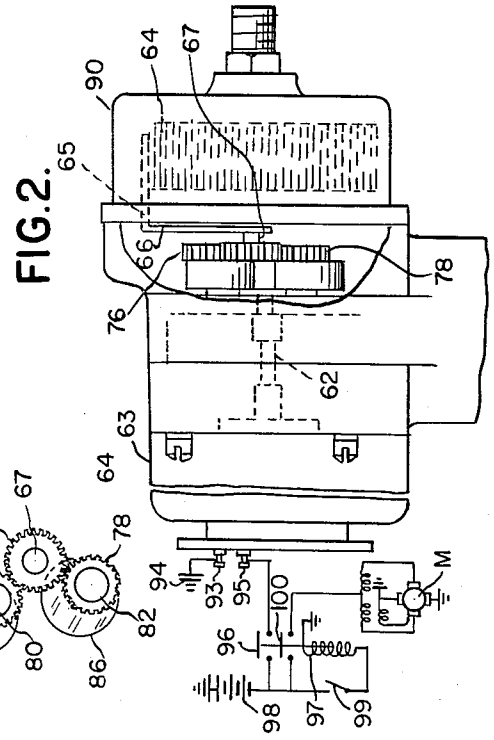


FIG. 2.

FIG. 3.

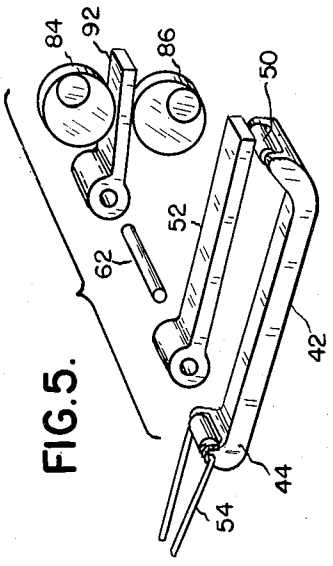


FIG. 5.

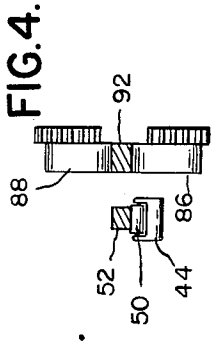


FIG. 4.

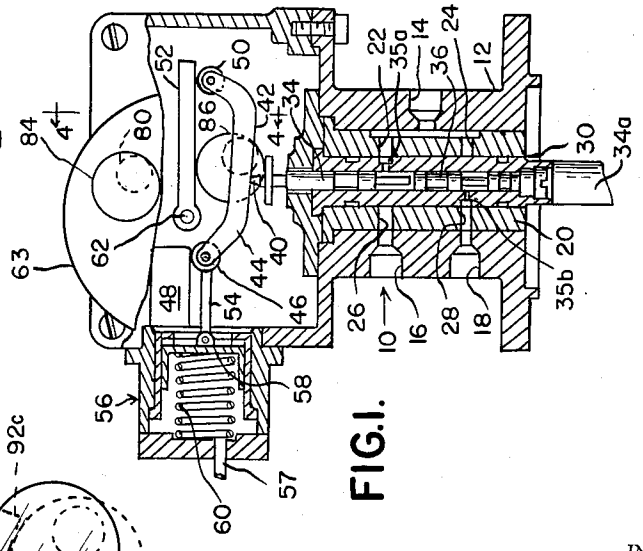


FIG. 1.

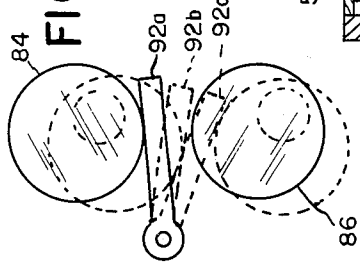


FIG. 6.

INVENTOR.
DONALD A. MUNYAN
BY Whittemore Hulbert & Belknap
ATTORNEYS

United States Patent Office 2,965,091 Patented Dec. 20, 1960

2,965,091

COLD START AND WARM UP SYSTEM FOR FUEL INJECTION

Donald A. Munyan, Royal Oak, Mich., assignor to Holley Carburetor Company, Van Dyke, Mich., a corporation of Michigan

Filed June 13, 1957, Ser. No. 665,509

14 Claims. (Cl. 123—179)

The present invention relates to a cold start and warm up system for fuel injection.

It is an object of the present invention to provide means associated with a fuel metering and pumping device operable to control the quantity of fuel metered into each charge in accordance with a temperature condition, and for varying the quantity of fuel metered in each charge dependent upon whether the engine is being cranked or is running under its own power.

More specifically, it is an object of the present invention to provide temperature responsive means for effecting adjustment of two abutments, fuel control means movable between said abutments, and means operable as an incidence of engine starting to move said member away from one abutment and into engagement with the other abutment.

More specifically, it is an object of the present invention to provide a movable fuel control member, a pair of eccentric cam abutments located on opposite sides of said member, temperature responsive means including gearing connected to both of said abutments, and means for selectively biasing said member into engagement with said abutments dependent upon engine operation.

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

Figure 1 is a side elevation with parts broken away of a device embodying the present invention.

Figure 2 is a side elevation taken 90 degrees from Figure 1, with parts broken away.

Figure 3 is a diagrammatic view of the positioning eccentric cams and the gearing interconnecting the same.

Figure 4 is a fragmentary sectional view on the line 4—4, Figure 1.

Figure 5 is an exploded view of parts of the apparatus.

Figure 6 is a diagrammatic view showing the parts in different operating positions.

The present invention is illustrated as applied to a fuel metering system for fuel injection to an internal combustion engine having an electric starter. For a description of a fuel distributing system of this general type reference is made to Downing Patent 2,731,175. More specifically, it is applied to a fuel metering and pumping device indicated generally at **10** which includes a support member **12** having a fuel inlet passage **14** and fuel outlet passages **16** and **18**. Fixed within the support member **12** is a sleeve **20** having fuel inlet passages **22** and **24** communicating with the fuel inlet passage **14**, and fuel outlet passages **26** and **28**. Rotatable within the sleeve **20** is a tubular member or cylinder **30** having a fixed abutment **32** at one end and a longitudinally movable abutment **34** at its opposite end. The rotatable member **30** is driven in rotation at a speed determined by engine speed by suitable drive means such for example as the shaft indicated diagrammatically at **34***a*. The rotatable tubular member **30** is provided with a passage **35***a* which during rotation of

the member **30** communicates alternately with inlet passage **22** and outlet passage **26**. Similarly, the rotatable member **30** is provided with a second passage **35***b* which communicates alternately with the inlet passage **24** and the outlet passage **28**.

Intermediate the two abutments is a fuel metering and pumping shuttle piston **36**. Fuel admitted to the inlet passage **14** communicates alternately through passages **22** and **24** with the interior of the cylinder **30** above and below the shuttle piston **36**. In the illustrated position fuel has flowed into the cylinder **30** above the piston **36** through passages **14**, **22** and **35***a* and fuel admitted under high pressure has forced the piston **36** downwardly, expelling a metered charge of fuel through passages **35***b*, **28** and **18**. At the same time, the fuel admitted to the cylinder above the piston **36** is metered in quantity dependent upon the spacing between the abutments. Further rotation of the member **30** establishes communication below the piston through the passage **24**, thus moving the piston upwardly, at which time a fuel outlet passage is brought into registration with the passages **26** and **16**. Thus, at each rotation of the cylinder **30** a charge of fuel is metered and expelled alternately from outlet passages **16** and **18**.

From the foregoing it will of course be apparent that the quantity of fuel metered into each charge depends upon the position of the movable abutment **34**. In accordance with the present invention means are provided for determining the position of the movable abutment **34** in accordance with various conditions.

As seen in Figure 1, the upper end of the movable abutment **34** includes a portion **40** engaging a surface **42** of a carriage **44**. At one end the carriage **44** is provided with a roller **46** movable against a stationary support **48**. At its opposite end the carriage **44** is provided with a roller **50** movable over an adjustable track or rail **52**. The carriage **44** is connected by a link **54** to an expansible chamber device indicated generally at **56** which may be connected to the manifold of the internal combustion engine by a conduit indicated diagrammatically at **57**. The device includes a piston **58** movable against a spring **60** and operates to shift the carriage **44** to the right or left as seen in the figure.

The surface **42** of the carriage **44** is not parallel to the surface of the member **52** engaged by the roller **50** and accordingly, movement of the carriage along the track **52** results in longitudinal adjustment of the adjustable abutment **34**.

In accordance with the present invention means are provided for determining the position of the track or rail member **52** under a plurality of different engine conditions.

In the first place, the internal combustion engine to which the fuel injection system illustrated herein is applied is supplied with an electric starter. It is desirable under starting conditions to enrich the supply of fuel mixture to the engine. It is further desirable to provide for a selective enrichment which is a function of engine temperature. Furthermore, it is desirable to provide for lesser but also selective enrichment of the fuel mixture during the initial running period of the engine before it has fully warmed up.

In accordance with the present invention the rail **52** is mounted for angular adjusting movement with a pivot support **62**. The pivot support **62**, as best seen in Figure 5, may constitute a shaft extending from a rotary electric solenoid indicated generally at **63**. The solenoid, which is available on the open market, includes spring means biasing the shaft **62** in one direction and when energized is operable to rotate the shaft **62** in the opposite direction.

Means are provided responsive to an engine temperature and this means is herein illustrated as comprising

a bi-metal coil 64 the inner end of which is fixed and having at its outer end an operating arm 65 connected by an arm 66 to a shaft 67 connected to a first gear indicated diagrammatically at 74 in Figure 3. The gear 74 is in simultaneous mesh with gears 76 and 78 which in turn are connected to shafts 80 and 82 respectively carrying eccentric abutment cams 84 and 86 respectively. The bi-metal coil 64 is contained in a housing 90 the interior of which may be subjected to air or other fluid whose temperature depends upon the engine temperature.

The shaft 62 on which the rail member 52 is fixed, also has fixed thereto an operating arm 92 which extends into the space between the cams 84 and 86. Conveniently, the arm 92 may extend from the shaft 62 in the same direction as the rail 52.

Referring now to Figure 6 there is shown the cams 84 and 86 in two limiting positions of adjustment and the arm 92 in three different operating positions. It will be recalled that the arm 92 and the rail 52 are coplanar and hence the position of the arm 92 in Figure 6 also indicates the position of the rail 52.

The cams 84 and 86 are illustrated in full lines in the position which they occupy when the engine is cold. The cams are illustrated in dot and dash lines in the position which they occupy when the engine is hot. The arm 92 (and hence the rail 52) occupies the full line position designated at 92*a* during cold starting. It occupies the broken line position indicated at 92*b* during cold drive away or the conditions existing following starting of the engine and before it has warmed up. The position indicated at 92*c* corresponds to the hot run position.

In the full line position of the cams and the position 92*a* of the rail it will be observed that the cams are spaced substantially apart and that the position 92*a* of the arm is caused by counterclockwise bias applied thereto by the solenoid 63. This condition exists during starting and is the result of simultaneous energization of the solenoid 63 and the starter circuit. When the engine starts and the starter circuit is interrupted suitable means such as the spring conventionally provided in the solenoid 63 swings the arm to the position 92*b* where it engages the cam 86. This condition prevails while the engine warms up and during the warm up period of the engine the cams 84 and 86 both rotate clockwise, eventually reaching the dotted line position shown in the figure. During this warm up period the arm moves gradually from the position 92*b* to the position 92*c* and it will be observed that in the final position the arm is engaged simultaneously by both of the cams 84 and 86. Thus, in the normal running position the arm 92 is maintained in position 92*c* by positive engagement between the two abutment cams 84 and 86.

It may be observed that if the engine is restarted while it remains in hot condition, the arm 92 of course remains in the hot position indicated at 92*c*.

The windings of the rotary solenoid 63 are connected in a circuit controlled by the starter switch as best seen in Figure 2. The solenoid terminal 93 is grounded as indicated at 94 and its other terminal 95 connects through contacts 96 of a relay whose windings are shown at 97 to the grounded battery 98. The starter switch 99 completes a circuit to the relay 97 and a circuit to the starter motor M is completed through relay contact 100.

As a result of the foregoing the fuel mixture is substantially enriched during cold starting and is given some enrichment during cold running, this latter enrichment being gradually diminished as the engine warms subsequent to starting.

In the system described in the foregoing it is assumed that fuel is delivered to the inlet passage 14 under relatively high pressure and conveniently, it will be supplied thereto by a separate fuel pump, for example, an electrically operated fuel pump, whose operation is initiated to supply the necessary fuel under pressure to the metering and pumping device to in turn supply starting fuel to the engine.

The drawing and the foregoing specification constitute a description of the improved cold start and warm up 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. A fuel metering and pumping device for injection of metered charges of fuel to an internal combustion engine having a starter, a member movable to regulate the quantity of fuel delivered in each metered charge, a pair of movable abutments between which said member is movable, means responsive to a temperature condition of the engine operatively connected to both of said abutments to effect simultaneous adjustment of both, means normally urging said member against one of said abutments, and means operable only during operation of the starter for moving said member against the other abutment.

2. A device as defined in claim 1 in which said abutments comprise eccentric cams, and gears interconnecting said cams for simultaneous angular movement.

3. A device as defined in claim 2 in which the temperature responsive means comprises a bi-metal coil.

4. A fuel metering and pumping device for injection of metered charges of fuel to an internal combustion engine having a starter, a rail member movable to regulate the quantity of fuel delivered in each metered charge, a carriage having a portion movable along said rail and having a surface inclined to the direction of movement thereof, means responsive to an engine condition for moving said carriage along said rail, metering means engaging said surface, a pair of movable abutments between which said member is movable, means responsive to a temperature condition of the engine operatively connected to both of said abutments to effect simultaneous adjustment of both, means normally urging said member against one of said abutments, and means operable only during operation of the starter for moving said member against the other abutment.

5. A device as defined in claim 4 in which said abutments comprise eccentric cams, and gears interconnecting said cams for simultaneous angular movement.

6. A device as defined in claim 5 in which the temperature responsive means comprises a bi-metal coil.

7. 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 movement limiting abutments in pumping and metering strokes, means for adjusting one of said abutments to vary the quantity of fuel pumped in each stroke of the piston comprising a movable member and means including a pair of separate cams 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 also in accordance with engine temperature when said engine is running and the starter is not operating.

8. 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 an adjustable rail, a carriage movable along said rail and having an inclined abutment positioning surface, a pair of rail abutments on opposite sides of said rail, means responsive to a first engine condition for moving both of said abutments, means responsive to a second engine condition for alternately biasing said rail toward said rail abutments, and means responsive to a third engine condition for moving said carriage along said rail.

9. A fuel metering and pumping device for an internal combustion engine having a starter comprising a cylinder, a shuttle piston movable in said cylinder be-

tween 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 an adjustable rail, a carriage movable along said rail and having an inclined abutment positioning surface, a pair of rail abutments on opposite sides of said rail, means responsive to engine temperature for moving both of said abutments, means responsive to operation of said starter to move said rail against one of said rail abutments, means operable upon de-energization of the starter to move the rail against the other of said rail abutments, and means responsive to manifold pressure of the engine for moving said carriage along said rail.

10. Fuel metering apparatus for an internal combustion engine comprising a movable fuel control member, a pair of adjustable abutments at opposite sides of said member, means responsive to engine temperature for effecting adjustment of both of said abutments, and means for moving said member against one or the other of said abutments dependent on the condition of said engine as regards starting and running.

11. Fuel metering apparatus for an internal combustion engine comprising a movable fuel control member, means responsive to manifold vacuum and cooperable with said member to regulate said apparatus, a pair of adjustable abutments at opposite sides of said member, means responsive to engine temperature for effecting adjustment of both of said abutments, and means for moving said member against one or the other of said abutments dependent on the condition of said engine as regards starting and running.

12. Fuel metering apparatus for an internal combustion engine comprising a movable fuel control member,

means responsive to manifold vacuum and cooperable with said member to regulate said apparatus, a pair of adjustable abutments at opposite sides of said member, means responsive to engine temperature to position said abutments in substantially spaced apart relationship when the engine is cold and to move said abutments into proximity with simultaneous lateral displacement when the engine is hot, and means for moving said member against one of said abutments during starting of the engine and for moving said member against the other of said abutments following starting and during running of the engine, said abutments being positioned to provide for substantial enrichment of the fuel mixture during cold start, and moderate enrichment of the fuel mixture during running of the engine until the engine reaches a predetermined normal operating temperature.

13. Fuel metering apparatus as defined in claim 12 in which the means for moving said member between said abutments comprises a solenoid energized during starting of the engine.

14. Fuel metering apparatus as defined in claim 12 in which said abutments are movable into a position when the engine is hot in which they simultaneously engage opposite sides of said member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,600,368	Winkler	June 10, 1952
2,664,872	Ericson et al.	Jan. 5, 1954
2,731,175	Downing	Jan. 17, 1956
2,785,669	Armstrong	Mar. 19, 1957
2,851,026	Dahl et al.	Sept. 9, 1958