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COLD START MEANS FOR AN INTERNAL COMBUSTION ENGINE

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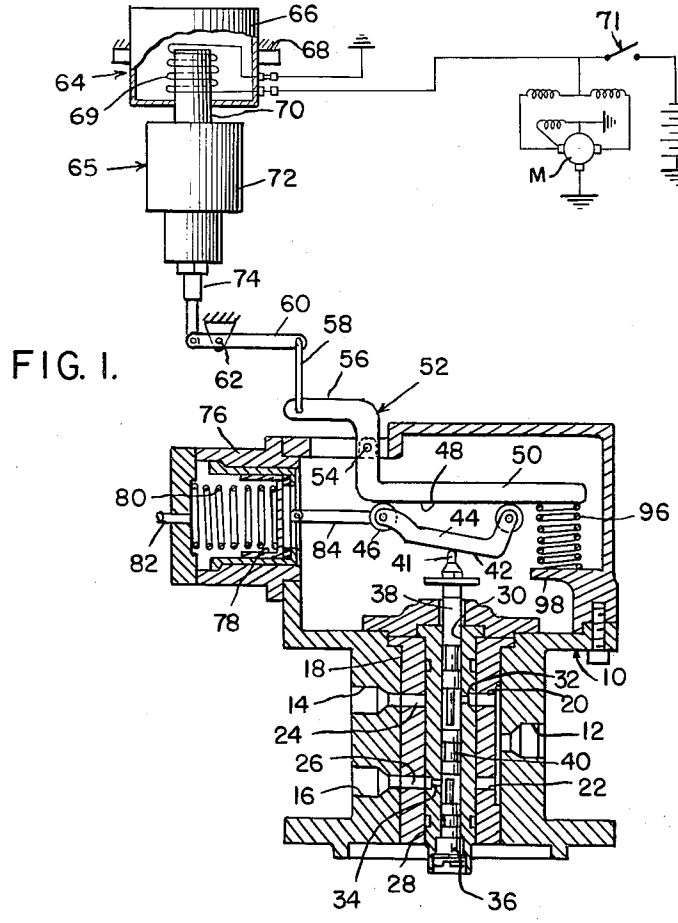


FIG. 1.

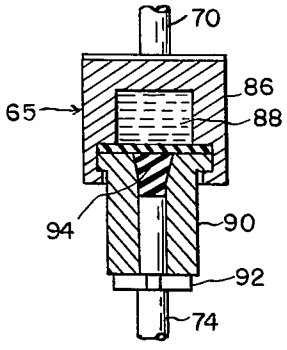


FIG. 2.

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COLD START MEANS FOR AN INTERNAL COMBUSTION ENGINE

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11 Claims. (Cl. 123—179)

The present invention relates to cold start fuel control means for an internal combustion engine.

It is an object of the present invention to provide a fuel metering apparatus for an internal combustion engine and control means therefor comprising a plurality of devices responsive to different engine conditions and operatively connected to regulate the fuel metering apparatus.

More specifically, it is an object of the present invention to provide fuel metering apparatus for an internal combustion engine comprising a member movable to regulate fuel supply to the engine, control devices responsive to different engine conditions each comprising a pair of relatively movable elements, and means connecting two such devices in series between a stationary support and said member.

It is a further object of the present invention to provide fuel supply means for an internal combustion engine including a member movable to regulate the supply of fuel to the engine, a control device in the form of a solenoid including relatively movable elements, a second control device responsive to engine temperature and comprising a pair of relatively movable elements, a third control device responsive to engine manifold vacuum and comprising a pair of relatively movable elements, a movable support, means connecting said solenoid and one of said other devices in series between a fixed support and said movable support, actuating means movable on said movable support effective to position said member, and means connecting said remaining device between a fixed support and said actuating means.

More specifically, it is an object of the present invention to provide fuel regulating apparatus responsive to engine temperature and engine manifold vacuum and operable to supply fuel to the engine at different rates during cranking of the engine and during normal running thereof comprising a solenoid energizable during cranking of the engine, and a control device responsive to an engine condition connected in series with said solenoid to said fuel regulating apparatus.

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

Figure 1 is a diagrammatic elevational view partly in section, of the fuel regulating apparatus.

Figure 2 is an enlarged sectional view of the temperature responsive control device.

The present invention is illustrated in conjunction with a fuel injection system for an internal combustion engine in which individually metered charges of fuel are supplied adjacent the intake port to the separate cylinders of the engine. It will of course be understood that in certain aspects, the invention is applicable to internal combustion engines generally.

However, in the illustrated embodiment of the invention the fuel supply apparatus comprises means for metering and pumping metered charges of fuel to the engine. The apparatus comprises a main support housing 10 having an inlet passage 12 and outlet passages 14 and 16. Fixed within a cylindrical bore in the housing 10 is a sleeve 18 having inlet passages 20 and 22 communicating with the inlet passage 12, and outlet passages 24 and 26 communicating respectively with the outlet passages 14 and 16. Mounted for rotation in the cylindrical bore of the sleeve 18 is a tubular rotor 28 having a cylindrical opening 30 extending therethrough. The cylindrical rotor 28 has a radial passage 32 adapted to communicate alternatively with the inlet passage 20 and the outlet passage 24 and a second radial passage 34 adapted to communicate alternatively with the inlet passage 22 and the outlet passage 26. A stationary abutment 36 is provided in one end of the cylindrical opening 30 and an adjustable abutment 38 is provided in its other end. Intermediate the abutments 36 and 38 is a shuttle type pumping piston 40.

With the parts in the relationship illustrated in Figure 1, fuel under high pressure passes through the passages 12, 20 and 32 into the cylinder 30 above the piston 40. This forces the piston downwardly and ejects fuel from beneath the piston through the passages 34, 26 and 16 to a cylinder of the engine. At the same time, downward movement of the piston 40 meters a quantity of fuel into the cylinder 30 above the piston 40. Continued rotation of the rotor brings the passage 34 into communication with the passage 22 and fuel entering the cylinder through these passages forces the piston upwardly, thus pumping a metered quantity of fuel through the outlet passage 14. It will of course be apparent that the quantity of fuel delivered by each stroke of the piston is determined by the spacing between the stationary abutement 36 and the movable abutment 38.

Means responsive to a plurality of engine conditions are provided for effecting an automatic adjustment of the spacing between the abutments. The outer end 41 of the adjustable abutment 38 engages the inclined surface 42 of a carriage 44 having rollers 46 movable along a surface 48 of a rail 50. The rail 50 constitutes one arm of a lever indicated generally at 52 which is pivoted at 54 and includes a second arm 56 connected by a link 58 to a lever 60. The lever 60 is pivoted as indicated at 62 and its position is determined by two engine condition responsive devices 64 and 65 as will now be described.

In the illustrated embodiment of the invention the condition responsive device 64 is an electric solenoid comprising relatively movable elements. One of the elements is the casing 66 thereof which is fixedly supported as diagrammatically indicated at 68 and which includes a winding 69 and a movable plunger or armature 70. The solenoid 64 is connected in the circuit of starter motor M, controlled by starter switch 71 and is adapted to be energized during cranking of the engine and is effective to move the plunger 70 upwardly as seen in the figure to effect a counterclockwise movement of the lever 52 which will have the effect of enriching the fuel mixture supplied to the internal combustion engine.

The plunger 70 of the solenoid 64 supports a control device responsive to engine temperature. This control device comprises relatively movable elements 72 and 74 which are connected between the solenoid plunger 70 and the lever 60. The control device 65 is expansible upon an increase in engine temperature and has the effect of producing clockwise rotation of the lever 52 upon increase in engine temperature with a consequent reduction in fuel supply to the engine.

The fuel supply apparatus also includes means responsive to engine manifold vacuum and this means comprises a cylinder 76 having a piston 78 movable therein against the action of a spring 80, the interior of the cylinder being connected to the engine manifold by a conduit diagram-

matically indicated at 82. A link 84 connects the piston to the carriage 44. It will be observed that the surface 42 of the carriage is inclined with respect to the surface 48 of the rail 50 so that movement of the carriage upon variation in engine manifold results in an appropriate adjustment of the adjustable abutment 38.

The details of the control device 65 form no part of the present invention since it may be purchased on the open market and is disclosed in Von Wagenheim Patent 2,714,759. In fact, any other suitable construction adapted to perform the required function may be employed. For completeness however, this particular device will be briefly described. The device comprises a generally cylindrical cup 86 containing a quantity of thermally expansible and contractable substantially incompressible material 88 disclosed in the patent as a mixture of wax and metal powder. The open end of the cup portion 86 is closed by a generally tubular extension 90 in which is slidably received a rod 74. The rod 74 is provided with an annular groove or lateral grooves receiving a ring 92. Suitable yielding sealing means 94 are provided at the inner end of the bore through the tubular extension 90 which permits expansion of the material 88 to move the rod 74 outwardly. Upon cooling of the thermally responsive material 88, inward movement of the rod and sealing means 94 is accomplished by external spring means. In the present invention this spring means may be the compression spring 96 disposed between a seat 98 and the movable end of the rail 50.

From the foregoing the operation of the structure described is believed apparent. However, described in general terms, it will be observed that the solenoid 64 is adapted to be energized during cranking of the engine and while energized superimposes an adjustment upon the fuel regulation normally accomplished by the temperature responsive control device 65 and the manifold vacuum responsive control device 76. Obviously of course, the temperature responsive device, whatever its construction may be, need not be interposed between the fuel control apparatus and the solenoid, but instead, the position of these devices might be reversed. Similarly, the solenoid might with appropriate design of the details be associated with the means responsive to engine manifold vacuum. Thus, in general, the arrangement is the connection of the solenoid and one of the engine responsive control devices in series to effect positioning of a movable support, the remaining control device including means movable on the support to effect adjustment of the member whose movement regulates the supply of fuel.

The drawing and the foregoing specification constitute a description of the improved cold start means for an internal combustion engine 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. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate the said metering apparatus, solenoid control means adapted to be actuated during starting of the engine and comprising a pair of relatively movable elements movable abruptly between only two relative positions, expansible control means responsive to engine temperature and comprising a pair of relatively movable elements, means for fixedly supporting one element of one of said control means, means connecting the elements of the other of said control means respectively to the other element of said one control means and to said member for movement thereby.

2. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate said apparatus, first, second and third control devices responsive to engine intake manifold pressure, temperature, and starter operating conditions respectively and each comprising a pair of relatively movable elements, a movable support, means for connecting both the elements of two of said devices in a single series between a fixed support and said movable support, and means for positioning said member actuated by the other of said devices and controlled by said movable support.

3. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate said apparatus, first, second and third control devices which are automatically responsive to engine intake manifold pressure, temperature, and starter operating conditions respectively and each comprising a pair of relatively movable elements, a movable rail, means for connecting both elements of two of said devices in a single series with each other between a fixed support and said rail, a carriage movable on said rail and connected to the other of said devices, said carriage comprising means for positioning said member.

4. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate said apparatus, a control device comprising a solenoid having a pair of relatively movable elements, a second control device responsive to engine temperature including a pair of relatively movable elements, a third control device responsive to engine manifold vacuum comprising a pair of relatively movable elements, a movable support, means for connecting said solenoid and both elements of one of said other control devices in a single series between a fixed support and said movable support, the other of said devices including member positioning means cooperating with said movable support.

5. Fuel metering apparatus for an internal combustion engine comprising a cylinder having fuel inlets and outlets adjacent its ends, a metering and pumping shuttle piston in said cylinder, means for alternately connecting a source of high pressure fuel to said inlets and closing said inlets in timed relation to engine operation, a fixed abutment at one end of said cylinder, an axially movable abutment at the other end of said cylinder to determine the stroke of said piston and hence the quantity of fuel delivered at each stroke thereof, said apparatus including a rail extending across the end of said cylinder at which said movable abutment is located, a carriage on said rail having an abutment surface engageable by said movable abutment which is inclined to said rail, means responsive to the intake manifold pressure of the engine to effect movement of said carriage on said rail, and cold start mechanism comprising a solenoid connected in the engine starter circuit and an expansible and contractable temperature responsive link connected at opposite ends thereof between said solenoid and said rail to effect an adjustment of said rail away from said cylinder to increase the fuel supply to the engine during cranking only by an amount dependent on temperature.

6. Fuel metering apparatus for an internal combustion engine comprising a cylinder having fuel inlets and outlets adjacent its ends, a metering and pumping shuttle piston in said cylinder, means for alternately connecting a source of high pressure fuel to said inlets and closing said inlets in timed relation to engine operation, a fixed abutment at one end of said cylinder, an axially movable abutment at the other end of said cylinder to determine the stroke of said piston and hence the quantity of fuel delivered at each stroke thereof, said apparatus including a rail extending across the end of said cylinder at which said movable abutment is located, a carriage on said rail having an abutment surface engageable by said movable abutment which is inclined to said rail, means responsive to the intake manifold pressure of the engine to effect movement of said carriage on said rail, said rail being pivoted adjacent one end and having an operating arm, and cold start mechanism comprising a solenoid connected in the engine starter circuit and an expansible and contractable temperature responsive link connected at opposite ends thereof between said solenoid and the operating arm of said rail to effect an adjustment of said rail

away from said cylinder to increase the fuel supply to the engine during cranking only by an amount dependent on temperature.

7. Fuel metering apparatus for an internal combustion engine having an electric starter system comprising a solenoid connected in the starter system and including a pair of elements one of which is movable abruptly into either of two positions relative to the other dependent on energization of said starter system, a temperature responsive device responsive to engine temperature and including a pair of elements movable gradually through a range of relative positions in accordance with engine temperature, a pressure responsive device responsive to an engine pressure variable during normal engine operation, and including a pair of elements movable gradually through a range of relative positions in accordance with the said engine pressure, a fuel control member, means connecting both elements of said solenoid and temperature responsive device together in a single series between a fixed support and said member, and means connecting the elements of said pressure responsive device in series between a fixed support and said member, to effect regulation of fuel supply in accordance with engine temperature and the engine pressure condition and effect a substantially constant increase in the regulated fuel supply during cranking of the engine.

8. Fuel metering apparatus for an internal combustion engine having an electric starter system for cranking the engine, said metering apparatus comprising pump means, means responsive to engine temperature and a variable engine pressure to effect continuous regulation of said pump in accordance with variable engine temperature and pressure and solenoid means connected to the starter system to superimpose a substantially constant increase in the amount of fuel delivery as regulated by engine temperature and pressure independently of engine temperature and pressure during cranking of the engine.

9. Fuel metering apparatus for an engine or similar device comprising a member movable to regulate the metering device, first control means for said member adapted to be actuated during starting of the device and comprising a pair of elements one of which is movable abruptly to provide only two relative positions therebetween, second control means for said member also comprising a pair of movable elements, means for fixedly supporting one element of one of the control means, means connecting both the elements of the other of said control means in series between the other element of said one control means and said member.

10. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate the metering apparatus, solenoid control means adapted to be actuated during starting of the engine and comprising a pair of relatively movable elements one of which is movable abruptly to provide only two relative positions therebetween, second control means for said member also comprising a pair of movable abutments, means for fixedly supporting one element of one of the control means, means connecting the elements of the other of said control means to the other element of said one control means and to said member.

11. Fuel metering apparatus for an internal combustion engine comprising a member movable to regulate the said metering apparatus, solenoid control means adapted to be actuated during starting of the engine and comprising a pair of movable elements one of which is movable to provide only two relative positions therebetween, expansible control means responsive to engine temperature and comprising a pair of relatively movable elements, means for fixedly supporting one element of one of said control means, means connecting the elements of the other of the control means to the other element of the one control means and to said member.

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