United States Patent

Hughes et al.

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[54] **FUEL CONTROL APPARATUS**

[72] Inventors: **Ronald William Hughes,** Birmingham; **Alan Boyse,** Solihull, both of England

[73] Assignee: **Joseph Lucas (Industries) Limited,** Birmingham, England

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[51] **Int. Cl.**.....**F02n 17/00**

[58] **Field of Search** .....123/139, 139 AM, 140, 123/140 MC, 179 A, 179 L

[56] **References Cited**

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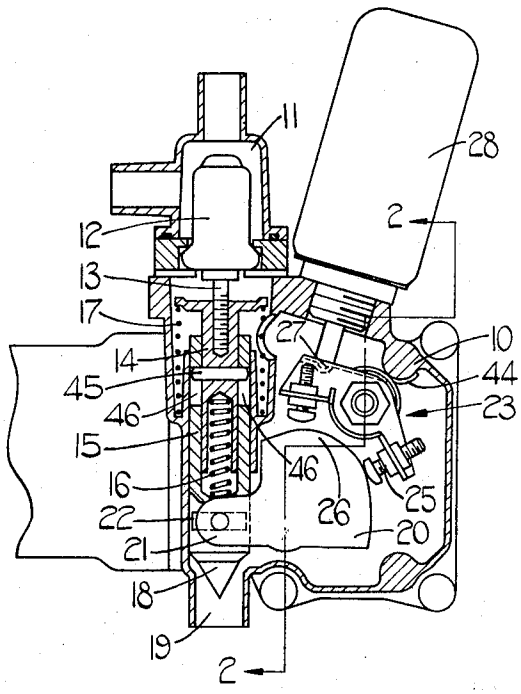
Primary Examiner—Laurence M. Goodridge
Attorney—Holman & Stern

[57] **ABSTRACT**

An apparatus for controlling a fuel injection system for an engine includes a cam rotatable in response to engine temperature and a cam follower selectively engageable with different portions of the cam. The output of the cam follower provides one input of an arrangement for varying the position of a control stop on a metering pump for the system, and the said selective engagement is operated during engine starting to provide an increased fuel supply.

10 Claims, 3 Drawing Figures



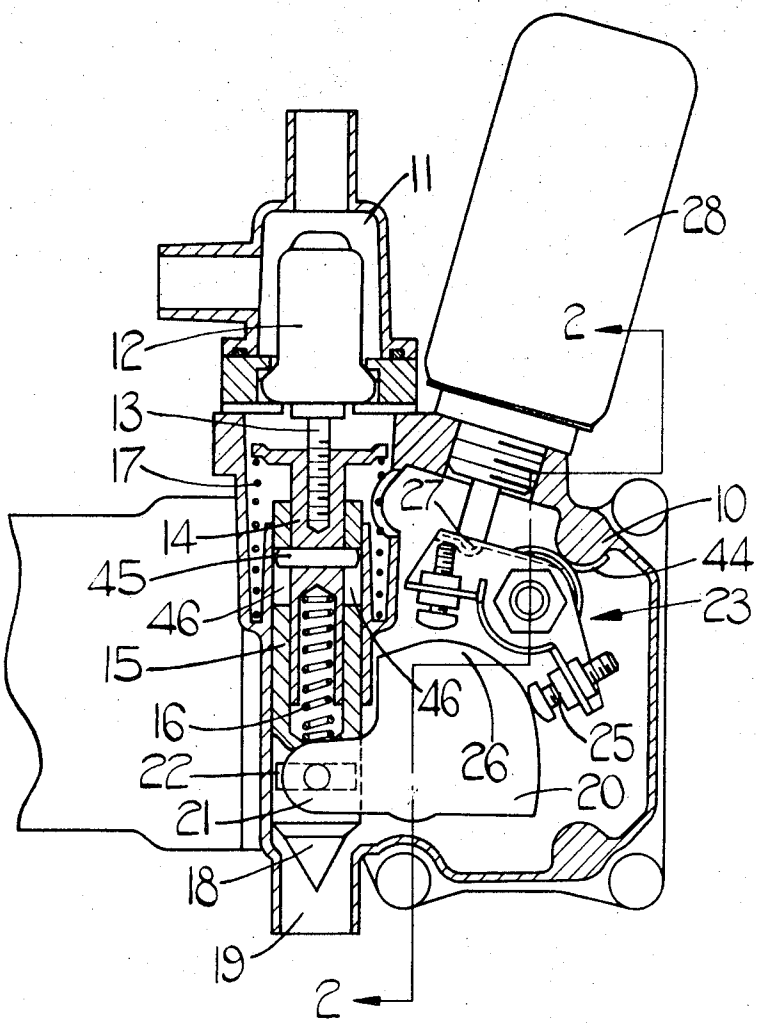


FIG. 1.

INVENTOR
Ronald William Hughes & Alan Boyse
Watson & Stern
ATTORNEYS

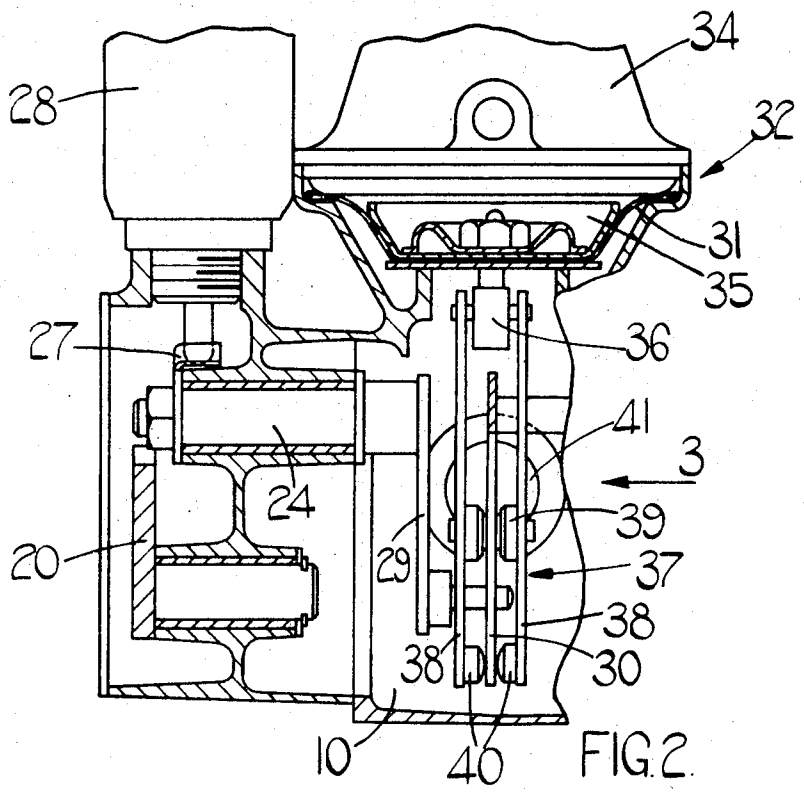


FIG. 2.

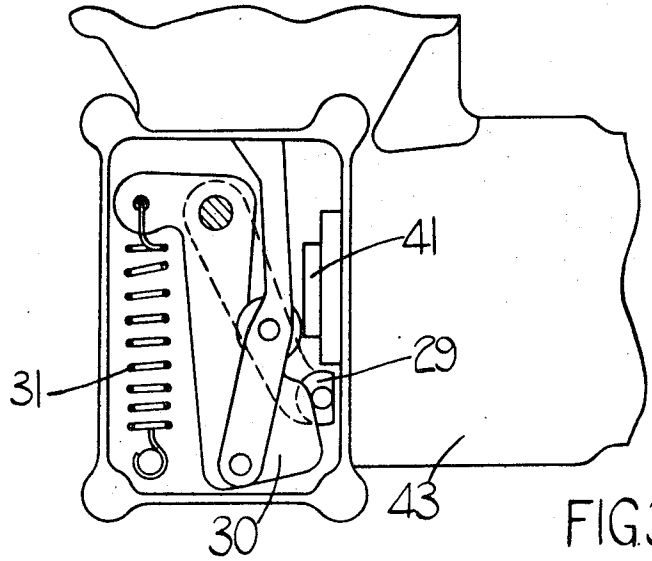


FIG. 3.

INVENTOR
Ronald William Hughes & Alan Boyse
Cowan & Stern
ATTORNEYS

FUEL CONTROL APPARATUS

This invention relates to an apparatus which controls a fuel injection system for an engine by varying the position of a control stop on a metering pump for the said system.

According to the invention, an apparatus of the foregoing kind comprises a first cam means for moving the first cam in response to the temperature of the engine, a first cam follower co-acting with the first cam, means actuated during engine starting for varying the response of the first cam follower to movement of the first cam, a second cam movable by the first cam follower, a second cam follower engaged with the second cam and movable relative thereto in response to an engine operating condition and means for transmitting the resultant position of the second cam follower to the control stop.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 shows, somewhat diagrammatically, a section through a control apparatus,

FIG. 2 is a section on lines 2—2 in FIG. 1, and,

FIG. 3 is a view on arrow 3 in FIG. 2.

The apparatus has a body **10** which includes a chamber **11** through which passes, in use, a coolant for an associated engine. Within chamber **11** is a capsule **12** having a stud **13** axially movable in response to changes in temperature of capsule **12** and threadedly engaging a plunger **14**. Plunger **14** is biased towards capsule **12** by a spring **17**. Plunger **14** is slidable within a further plunger **15** which is in turn slidable in body **10**. A pin **45** extends through plunger **14** into a pair of slots **46** in plunger **15**. A spring **16** urges plungers **14**, **15** apart so that pin **45** engages one end of slots **46**.

The end **18** of plunger **15** is formed as a valve control member and combines with a port **19** in the body **10** to provide a metering orifice through which, an additional air supply may reach the engine.

An edge cam **20** is rotatably mounted in the body **10** and includes an arm **21** which engages a slot **22** in plunger **15**. A cam follower **23** is supported on a spindle **24** mounted in body **10**. Cam follower **23** includes follower members **25**, **26** engageable with different portions of edge cam **20** and also includes a portion **27** engageable by the plunger of a solenoid **28**. Also supported on spindle **24** is a crank **29** which engages a cam plate **30** pivotally mounted in body **10**. A torsion spring **44** engages body **10** and cam follower **23** to bias the latter in a clockwise direction, as seen in FIG. **1**, and a spring **31** biases cam plate **30** in an anticlockwise direction, as seen in FIG. **3**, into engagement with a crank **29**. Cam follower **23** thus controls the angular position of cam plate **30**.

A diaphragm assembly **32** includes a diaphragm **33** sealingly engaged between a part of the body **10** and a cover member **34**. The diaphragm assembly also includes a number of reinforcing members **35** with which is engaged an eye bolt **36**. Pivoted on the bolt **36** is a cam follower **37** in the form of a pair of arms **38** supporting between them a roller **39** which engages the cam plate **30**. A pair of inwardly directed abutments **40** on the arms **38** engage the cam plate **30** to steady the cam follower **37**.

The roller **39** abuts one end of a piston-like member **41** which is slidable in the casing **10** and whose other

end abuts a control stop forming part of a known type of fuel injection pump **43**. The member **41** is biased towards the cam plate **30** by the pressure of fuel within the pump **43**.

In use a rise in the temperature of the engine coolant in the chamber **11** causes the stud **13** to move the plunger **14**, against the bias of spring **17** and, since spring **16** is sufficiently strong to overcome frictional forces in the apparatus, also moves plunger **15**, so as to rotate the cam **20** in an anticlockwise direction as shown in FIG. **1**. Follower member **25** is in engagement with cam **20**, under the influence of spring **44**, and cam follower **23** rotates clockwise, also as shown in FIG. **1**. The corresponding movement of crank **29** and cam plate **30** moves member **41** to the right, as shown in FIG. **3**, resulting in a reduction of the stroke of the metering pump **43**. The side of the diaphragm assembly **32** remote from the cam plate **30** is subjected to the pressure at the inlet manifold of the engine. Decreasing pressure in the manifold causes the cam follower **37** to move upwards as shown in FIG. **2**, also resulting in a reduction in the stroke of the metering pump **43**. The solenoid **28** is energized to extend the plunger thereof only during engine starting. At all other times fuel supply to the engine is responsive to manifold depression and to a function of coolant temperature dependent on the profile of the cam **20** engaged by the follower member **25**. During starting, however, the cam **20** is engaged by the follower member **26** resulting in an increased fuel supply which is a different function of coolant temperature.

During cold starting an additional air supply is available to the engine via the port **19**. As engine temperature rises this air supply is reduced by downward movement of plunger **15**, as seen in FIG. **1**. When port **19** is fully closed continued movement of stud **13** and plunger **14** is accommodated by spring **16**, slots **46** being sufficiently long to prevent this movement from causing damage to the apparatus.

Having thus described our invention what we claim as new and desire to secure by Letters patent is:

1. An apparatus for controlling a fuel injection system for an engine by varying the position of a control stop on a metering pump in said system comprises a first cam, means for moving the first cam in response to the temperature of the engine, a first cam follower including first and second cam follower elements selectively engageable with the first cam, means actuated during engine starting for moving said first cam follower to engage one of said elements with the first cam and dis-engage the other of said elements to vary the response of the first cam follower to movement of the first cam, a second cam movable by the first cam follower, a second cam follower engaged with the second cam and movable relative thereto in response to an engine operating condition and means for transmitting the resultant position of the second cam follower to the control stop.

2. An apparatus as claimed in claim 1 in which the means for moving the first cam comprises a temperature sensitive capsule mounted in a chamber through which, in use, passes a coolant for the engine.

3. An apparatus as claimed in claim 2 in which the means for moving the first cam includes a plunger arrangement engaged with the capsule and with the first cam.

4. An apparatus as claimed in claim 3 in which the plunger arrangement provides a control member for a metering orifice through which, in use, air can flow to the engine.

5. An apparatus as claimed in claim 4 in which the plunger arrangement includes means for permitting relative movement between the control member and the remainder of the plunger arrangement when said metering orifice is fully closed.

6. An apparatus as claimed in claim 1 in which said means actuated during engine starting comprises an electro-magnetic actuator.

7. An apparatus as claimed in claim 1 in which movement of the first cam follower is transmitted to the second cam by means of a crank rotatable by the first cam follower.

8. An apparatus as claimed in claim 1 which includes means for biasing the second cam against movement imparted thereto by the first cam followers.

9. An apparatus as claimed in claim 1 in which the second cam follower is movable relative to the second cam in response to the pressure in the engine inlet manifold.

10. An apparatus as claimed in claim 1 in which the means for transmitting the position of the second cam follower to the control stop comprises a piston member engaging both the second cam follower and the control stop.

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