Jan. 17, 1956 E. W. DOWNING 2,731,175

LIQUID FUEL INJECTION APPARATUS

Filed Aug. 5, 1952 2 Sheets-Sheet 1

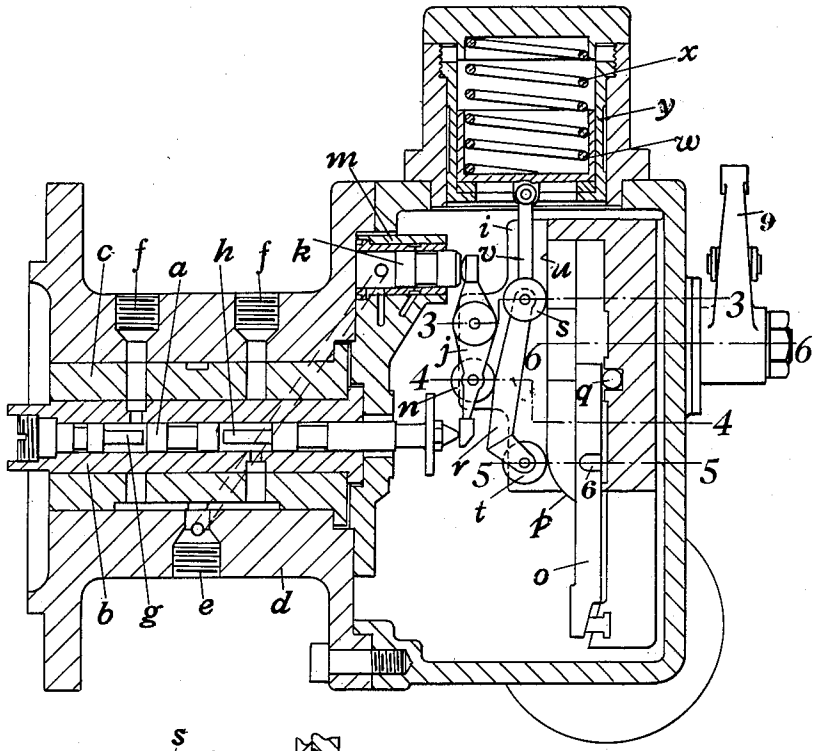


Fig.1

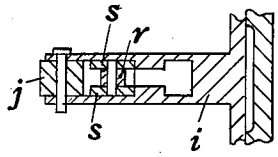


Fig.3

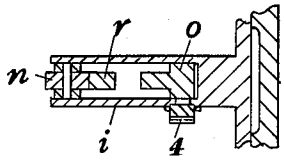


Fig.4

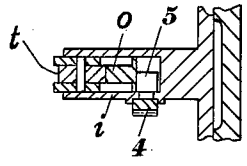


Fig.5

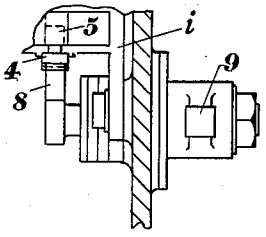


Fig.6

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LIQUID FUEL INJECTION APPARATUS

Filed Aug. 5, 1952 2 Sheets-Sheet 2

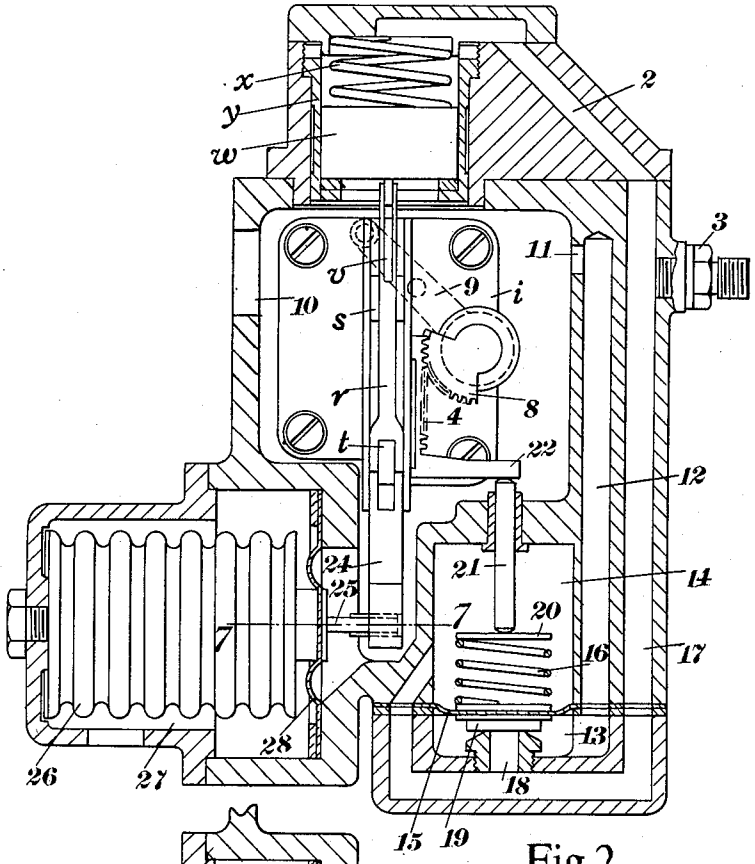


Fig.2

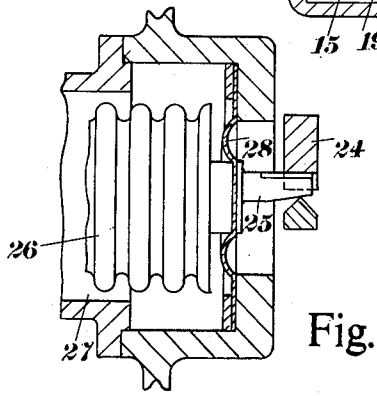


Fig.7

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LIQUID FUEL INJECTION APPARATUS

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Application August 5, 1952, Serial No. 302,797

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7 Claims. (Cl. 222—250)

This invention relates to a liquid fuel metering device of the shuttle-type to which the fuel is supplied from a pump, and from which the fuel is discharged intermittently to an internal combustion engine.

The range of movement of the shuttle of the metering device (and hence the quantity of fuel discharged in each movement of the shuttle) is determined by a pair of end-stops, and to enable the said quantity to be varied, one of the stops is made adjustable, either manually, or automatically in response to, for example, variation of pressure in the air-intake manifold of the engine.

When the engine is cold, its fuel requirement is greater than that which exists when the engine is hot, and the object of the present invention is to enable both of these and other requirements to be met in a satisfactory manner.

The invention comprises a liquid fuel metering device of the shuttle-type in which the means for determining the position of the adjustable shuttle-stop, comprises a contoured and endwise movable abutment, means for effecting endwise movement of the abutment, a rocker co-operating with the abutment, and means responsive to the air pressure in the engine air-intake manifold for imparting endwise movement to the rocker relatively to the abutment.

In particular the invention comprises a stop-positioning means as specified in the preceding paragraph, in which the abutment is adapted to receive also a pivotal movement, and in which there are provided independently operable means for imparting endwise and pivotal movements to the abutment.

In the accompanying drawings:

Figures 1 and 2 are respectively sectional side and end elevations of an apparatus embodying the invention.

Figures 3, 4, 5 and 6 are fragmentary sectional plan views on the lines **3.3**, **4.4**, **5.5**, **6.6** in Figure 1.

Figure 7 is a fragmentary sectional plan on the line **7.7** in Figure 2.

Referring to the drawings, the fuel metering device is of known form, and consists of a slidable shuttle *a* contained in a rotary hollow cylindrical and ported valve *b*, the latter being adapted to be driven by the engine. The valve is contained in a ported barrel *c* secured in the body part *d*. Fuel is supplied to the metering device by a feed pump connected by a pipe to the inlet *e*, and is delivered to the engine cylinders through pipes connected to the outlets *f*. The shuttle *a* is movable alternately in opposite directions by the pressure of liquid fuel admitted to the interior of the valve *b*. With the valve *b* in the position shown in Figure 1, liquid fuel from the inlet *e* has access to the interior of the valve at the right hand side of the shuttle, and moves the shuttle to the left, this movement of the shuttle serving to discharge through the left hand outlet *f* liquid fuel previously admitted to the interior of the valve at the left hand side of the shuttle. Rotation of the valve *b* then permits access of liquid fuel from the inlet *e* to the interior of the valve at the left hand side of the shuttle *a*, and the latter is moved thereby to the right for discharging through the right hand outlet *f* liquid fuel previously admitted to the interior of the valve at the right hand side of the shuttle. Rotation of the valve *b* permits the above sequence of operations to be successively repeated. One of the end-positions of the shuttle is determined by the fixed stop *g*. The other end-position is determined by the axially adjustable stop *h* which consists of a plunger extending through one end of the rotary valve *b* into the adjacent chambered portion of the body part.

The liquid fuel is usually supplied to the metering device at high pressure, and as the means employed for determining the position of the stop *h* must be sensitively responsive to relative small forces, it is desirable that only an appropriate fraction of the fuel-pressure acting on the said stop shall be transmitted to the adjusting means. To meet this requirement there is pivoted on a bracket *i* in the body part, a lever *j* which at one end abuts against the stop and which at the other end abuts against a plunger *k* contained in a cylinder *m* to which fuel is admitted from the inlet *e*, so that the liquid pressure exerted on the lever by the stop *h* is partially counterbalanced by the liquid pressure exerted through the plunger *k*. On the lever *j* is mounted a roller *n* which co-operates with the stop adjusting means.

The stop adjusting means comprises an abutment *o* in the form of a bar which is carried by and is endwise slidable on the bracket *i*. The operative edge of the abutment is contoured as shown, and comprises two straight portions in parallel relationship, the junction between these straight portions being curved as indicated at *p*. Also the said bar is pivotally movable, its fulcrum being provided by a roller *q* carried by the bracket *i*.

Between the abutment *o* and the lever *j* is arranged a rocker *r* which is shaped as shown and at one edge is in contact with the roller *n*. At its ends the rocker carries a pair of rollers *s*, *t*. The roller *s* is supported on and is movable along a straight edge *u* on the bracket *i*, and the roller *t* is supported on the contoured edge of the abutment *o*. It will be apparent that endwise movement of the rocker relatively to the abutment, or endwise movement of the abutment relatively to the rocker, will result in an angular movement of the rocker and a corresponding axial movement of the stop *h*.

In the example illustrated by the drawings, the rocker *r* is connected at one end by a link *v* to a piston *w* loaded by a spring *x* and slidable in a cylinder *y*. One end of the cylinder is in communication with a passage **2** in the body part (Figure 2) leading to a connection **3** for a pipe attached to the air-intake manifold of the engine. At atmospheric pressure, the piston occupies the position shown in the drawings, but with appropriate reduction of air-pressure in the manifold the piston will be moved in opposition to the spring, causing the rocker to impart movement to the lever *j* and thence to the stop *h*. Moreover, endwise movement of the abutment *o* will also effect movement of the rocker, and stop.

The drawings show the abutment in the position which it normally occupies when the engine is hot. In this condition variation of the position of the stop *h* is determined by linear endwise movement of the rocker (under the action of the piston *w*) along the bracket and the upper part of the abutment, and the movement imparted by the rocker to the lever *j* and stop *h* is determined by the inclination of the edge of the rocker in contact with the lever roller *n*.

When the engine is cold, and an increased amount of fuel is required by the engine, the abutment is moved to

its upper position. In this condition the roller *t* lies in contact with the lower part of the abutment, and in so moving the abutment, the rocker receives an angular movement which allows the stop *h* to move outwardly to the required extent. While the abutment is in this condition, the amount of extra fuel supplied to the engine is also variable under the action of the piston *w*.

For imparting endwise movement to the abutment *o*, there is mounted on the bracket *i* a slidable rack 4 (Figure 2) from which extends a peg 5 (Figure 5) which occupies a gap 6 (Figure 1) in one side of the abutment. The rack is engaged by a toothed segment 8 which is operable by a lever 9. The lever is adapted to be actuated manually. Alternatively, or in addition, it may be operable by a thermostatic device of any convenient form. For example, there may be arranged in the cooling-water system of the engine an elastic extensible capsule responsive to the temperature of the water. The capsule is connected by linkage or other means to the said lever 9, so that when the water is cold the abutment *o* is moved to its upper position, and when the temperature reaches a predetermined amount the capsule causes the abutment to be moved to its normal lower position shown in the drawings.

When starting a cold engine it may be desired to admit additional air temporarily to the engine manifold, the intake throttle being wholly or partially closed. To meet this requirement, the chambered portion of the body part of the apparatus above described (to which air is admitted through an air inlet 10, Figure 2), is provided with a port 11 leading to a passage 12 which leads to a compartment 13. The latter is separated from an adjacent compartment 14 by a flexible diaphragm 15 which is loaded by a spring 16. The compartment 14 communicates with the manifold-connection 3 by way of a passage 17, and this passage communicates with the compartment 13 through an orifice 18 which is normally closed by a valve 19, on the diaphragm. Further the spring 16 is supported at one end by an abutment 20 on which bears a thrust rod 21, the latter being held by an arm 22 extending from the rack 4. When the engine is working normally and the abutment *o* is in its lower position, as shown in the drawings, the valve 19 is held on its seating at the entrance to the orifice 18 by the spring 16. But when the abutment *o* is raised to its upper position, the arm 22 of the rack 4 is also in its upper position, and in this condition the spring 16 exerts little or no pressure on the diaphragm. Consequently the depression of pressure in the air-intake manifold, which is communicated along the passage 17 to the compartment 14, allows the atmospheric pressure in the compartment 13 to raise the valve 19 off its seating and permits air to pass from the said compartment to the pipe connection 3 and thence to the intake manifold. On return of the abutment *o* to its normal position the rack-arm 22 again brings the spring 16 into action and so causes the valve 19 to be returned to and held in its closed position.

To enable the position of the stop *h* to be adjusted in response to a condition other than the condition existing in the intake manifold, such as a change of atmospheric air pressure, or the speed of the engine, the angular freedom of the abutment is utilised. In the arrangement shown in the drawings, there is supported on a tail piece 24 depending from the bracket *i*, a laterally slidable wedge piece 25 against which the abutment *o* bears when in its normal power position. On movement of the wedge piece, the abutment *o* is given an angular movement on its fulcrum *q*, so causing the rocker *r* by its action on the lever *j* to vary the position of the stop *h*. In the example shown the wedge piece is operable by an evacuated elastic bellows 26 contained in a chamber 27 which is open to the atmosphere. One end of the capsule is fixed and the wedge piece is attached to the free end of the capsule. Variation of atmospheric air pressure causes variation of the length of the capsule and consequent movement of the wedge, this resulting in an angular movement of the abutment. Preferably the chamber 27 is isolated from the chamber containing the stop-positioning means by a flexible diaphragm 28.

Instead of arranging the wedge piece to be movable with a change of atmospheric pressure, a centrifugal governor responsive to the speed of the engine may be used for actuating the wedge. Alternatively any other device responsive to a variable condition associated with or affecting the normal action of the engine and requiring corresponding regulation of the rate of fuel supply, may be used.

By this invention, adjustment of the position of the movable stop of the fuel metering device, to meet different engine-working conditions can be effected in a convenient manner.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A shuttle-type liquid fuel metering device comprising in combination a hollow and ported cylindrical rotary valve, a shuttle slidable in said valve, an inlet for supplying liquid fuel under pressure to the interior of said valve at opposite sides of said shuttle alternately, outlets through each of which fuel from the interior of said valve at one side of said shuttle is dischargeable by said shuttle under the pressure of liquid fuel admitted to the interior of said valve at the opposite side of said shuttle, a pair of stops for limiting the extent of the sliding movement of said shuttle, one of said stops being adjustable, a contoured and endwise movable abutment, a rocker cooperating with said abutment for determining the position of said adjustable stop, means for effecting endwise movement of said abutment to cause said rocker to vary the position of said adjustable stop, and additional means responsive to air pressure for effecting endwise movement of said rocker relatively to said abutment to vary the position of said adjustable stop independently of endwise movement of said abutment.

2. A shuttle-type liquid fuel metering device according to claim 1, in which said contoured and endwise movable abutment is also capable of pivotal movement for causing said rocker to vary the position of said adjustable stop independently of endwise movements of said abutment and rocker, and in which means are provided for cooperating with said abutment to effect the said pivotal movement thereof.

3. A shuttle-type liquid fuel metering device according to claim 1, in which said abutment is supported by a fixed part, and in which said rocker is provided at its opposite ends with a pair of rollers, the latter being arranged to bear respectively against said abutment and fixed part so that rocking movement can be imparted to said rocker by endwise relative movements of said rocker and abutment.

4. A shuttle-type metering device according to claim 1 and having a lever through the medium of which the said adjustable stop is movable by said rocker, and means responsive to the pressure of liquid fuel supplied to said ported cylindrical rotary valve for exerting on said lever a force opposing that transmissible to said lever through the medium of said adjustable stop, so that only a fraction of the fuel pressure acting on said adjustable stop is transmissible to said rocker.

5. A shuttle-type metering device according to claim 1, in which the means for effecting endwise movement of said abutment comprise in combination a slidable rack operatively connected to said abutment, a rotary toothed member engaging said rack, and means for actuating said rotary toothed member to impart movement through said rack to said abutment.

6. A shuttle-type liquid fuel metering device according to claim 1, in which said contoured and endwise movable abutment is also capable of pivotal movement for causing said rocker to vary the position of said adjustable stop independently of endwise movements of said abutment and rocker, and in which a laterally slidable wedge piece

having operating means associated therewith is provided for co-operating with said abutment to effect the said pivotal movement thereof.

7. A shuttle-type liquid fuel metering device according to claim 1 and having in combination therewith a valve responsive to air pressure, and a spring through the medium of which said valve is loaded under the control of the means for effecting endwise movement of said abutment.

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