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(54) **Fuel pumping apparatus.**

(57) A rotary distributor fuel pumping apparatus has a sleeve movable axially on the distributor to adjust the amount of fuel supplied by the apparatus. The sleeve is coupled to one end of a first lever 46 pivotally mounted about an axis 47. The first lever is biased by a governor spring in one direction and can be moved in the opposite direction by a speed responsive device. The other end of the first lever 46 can engage a second pivotal lever 50 near its pivot axis 51 to form a maximum fuel stop. The position of the second lever 50 can be adjusted by a third lever 54 which is engaged by the second lever, intermediate its ends. The ends of the third lever are connected to fluid pressure operable devices responsive to engine operating parameters thereby to adjust the maximum fuel stop in accordance with those parameters.

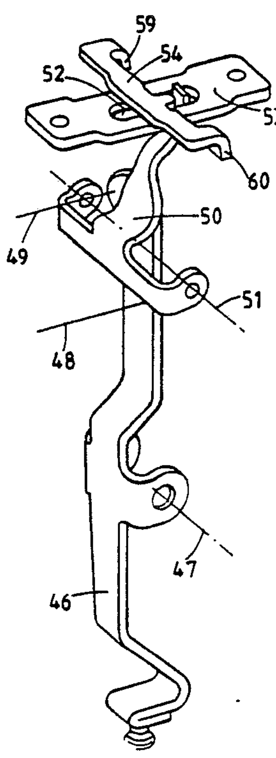

FIG.2.

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FUEL PUMPING APPARATUS

This invention relates to a fuel injection pumping apparatus for supplying fuel to an internal combustion engine, the apparatus comprising a housing, a rotary distributor member mounted in a bore in the housing, the distributor member in use being rotated in synchronism with the associated engine, a transverse bore in the distributor member and a plunger slidable therein, a cam follower at the outer end of the plunger, an annular cam ring surrounding the distributor member, the cam ring defining cam lobes for engagement with the cam follower to effect inward movement of the plunger as the distributor member is rotated, passage means for supplying fuel to the transverse bore to effect outward movement of the plunger, a plurality of outlet ports in the housing said outlet ports in use being connected to the injection nozzles respectively of the associated engine and receiving fuel in turn during successive inward movements of the plunger, stop means for limiting the outward movement of the plunger, said distributor member being axially adjustable to determine the outward movement of the plunger, resilient means biasing the distributor member in one axial direction, a variable volume chamber defined in part by an end face of the distributor member or a further member movable axially therewith, the resilient means biasing the distributor member in the direction to reduce the volume of said chamber, an axially movable sleeve mounted on said member, said sleeve in conjunction with a control passage in said member which communicates with said chamber, acting to control the volume of liquid in said chamber and governor means operable to adjust the axial position of the sleeve.

An example of such an apparatus is seen in specification GB 2069722B. The governor means shown therein comprises a centrifugal weight mechanism which opposes the action of a governor spring to position the sleeve. An adjustable, but fixed during the use of the apparatus, maximum fuel stop is provided. For some applications it is necessary to be able to adjust the setting of the maximum fuel stop depending upon one or more engine operating parameters. For example, in a turbo supercharged engine it is necessary to allow an increase in the maximum quantity of fuel which can be supplied to the engine as the pressure in the air inlet manifold of the engine increases. In addition it may be necessary to adjust the maximum amount of fuel in accordance with the speed of the associated engine.

The object of the invention is to provide an apparatus of the kind specified in a simple and convenient form.

According to the invention in an apparatus of the kind specified said governor means comprises a first lever which is pivotally mounted intermediate its ends in the housing, one end of the first lever being coupled to said sleeve, a governor spring connected to the first lever, a centrifugal weight mechanism acting on the first lever in opposition to the force exerted by the spring, the force produced by the weight mechanism tending to move the sleeve to reduce the amount of fuel supplied to the engine, a second lever pivotally mounted at one end in the housing, the other end of said first lever being engageable with said second lever intermediate the ends thereof in order to limit the movement of the first lever under the action of the spring, and fluid pressure operable means for positioning a stop engageable by the other end of the second lever.

According to a further feature of the invention said stop is defined intermediate the ends of a third lever, and the ends of said third lever are connected to pressure responsive devices respectively.

In the accompanying drawings:-

Figure 1 is sectional side elevation of part of one example of an apparatus in accordance with the invention,

Figure 2 is a perspective view of part of the apparatus of Figure 1 showing additional parts,

Figure 3 is a view to an enlarged scale of part of the apparatus seen in Figure 2, and

Figure 4 is a plan view of further parts of the apparatus.

Referring to Figure 1 of the drawings the apparatus comprises a multipart housing 10 which includes a sleeve 11 defining a bore in which is mounted a rotary cylindrical distributor member 12. The distributor member 12 projects from the sleeve 11 and is provided with a transverse bore 13 in which is mounted a pair of plungers 14. The bore 13 communicates with an axial passage 15 formed in the distributor member and which connects with a delivery passage 16 terminating on the periphery of the distributor member in an axial groove. The groove registers in turn and as the distributor member rotates, with outlet ports 17 which in use are connected to the injection nozzles respectively of the associated engine, and with inlet passages 18, the inner ends of the inlet passages 18 and the ports 17 lying in the same radial plane. The inlet passages 18 communicate with a circumferential groove 19 which is formed in the peripheral surface of the sleeve 11 and this communicates by way of an on/off valve 20, with the outlet of a fuel supply pump which is generally indicated at 21. The supply pump draws fuel from an inlet not shown and its output pressure is controlled by a valve also not shown, so that the pressure varies in accordance with the speed at which the pump is driven.

The rotary part of the supply pump 21 is carried on a drive shaft 22 which is journalled in the housing and is in use driven in timed relationship with the associated engine. The drive shaft mounts a dished gear wheel 23 and has an enlarged head portion 24 which surrounds the end of the distributor 12. The head portion 24 defines a pair of slots 25 in which are located shoes 26 which at their inner ends engage the plungers 14 respectively and which at their outer ends are provided with grooves which carry rollers 27. The shoes and rollers constitute cam followers. In addition, located in the slots 25 are drive plates 28 which are connected to the distributor member and the drive plates couple the distributor member to the drive shaft but at the same time, allow axial movement of the distributor member.

The internal surface 24A of the enlarged portion 24 of the drive shaft is flared outwardly and the shoes 28 are provided with complementary surfaces 26A whereby the extent of outward movement of the plungers 14 will depend upon the axial setting of the distributor member.

The drive shaft defines a chamber in which is located a coiled compression spring 29 which acts upon the adjacent end of the distributor member to urge it towards the right as seen in the drawing. A chamber 30 is defined in part by the end surface of the distributor member and in part by a cover 31, the cover having a skirt portion which locates over the reduced end portion of the sleeve 11. A fluid seal is defined between the cover 31 and the sleeve whereby fuel under pressure in the groove 19 cannot enter into the chamber except by means to be described.

The rollers 27 engage the internal peripheral surface of an angularly adjustable cam ring 32 on the internal peripheral surface of which are formed pairs of cam lobes. The lobes are positioned such that inward movement of the plungers can only take place whilst the groove at the outer end of the passage 16 is in communication with an outlet 17. When the groove moves into register with an inlet passage 18, fuel is supplied to the bore 13 and the plungers 14 are moved outwardly. The extent of outward movement of the plungers is limited by the abutment of the surfaces 26A on the shoes 26 with the flared surface 24A defined by the enlarged portion 24 of the drive shaft. The axial setting of the distributor member therefore determines the amount by which the plungers 14 can move outwardly and thereby the amount of fuel which is delivered by the apparatus at each delivery stroke. In the example as the distributor member is moved towards the right the amount of fuel which is delivered to the associated engine increases.

Formed in the distributor member is a passage 33 which opens into the chamber 30 at one end and which at its other end, communicates with a port 34 on the periphery of the distributor member. Moreover, mounted about the portion of the distributor member between the sleeve 11 and the drive plate 28 is an axially movable sleeve 35. This is coupled to a governor mechanism to be described. In addition, a further passage 37 is formed in the distributor member and at one end communicates with the chamber 30. The other end of the passage 37 communicates with a radially disposed drilling 38 the ends of which open onto the periphery of the distributor member at a position to register with a port 39 formed in the sleeve and communicating with the aforesaid groove 19. As the distributor member rotates and one end of the drilling 38 communicates with the port 39, fuel will flow through the drilling into the chamber 30 resulting in an increase in the pressure in the chamber. The increase in pressure will result in movement of the distributor member against the action of the spring 29. However, for a fixed axial setting of the sleeve 35 the port 34 will be exposed beyond the end of the sleeve by an increasing amount. As a result fuel will flow out of the chamber 30 and in practice, an equilibrium position is established with the sleeve and the distributor member acting as a follow up servo system. The port 34 constitutes a variable orifice of a fluid potentiometer the fixed orifice of which is constituted by the drilling 38 and the port 39.

The governor means comprises a centrifugal weight unit 40 the cage 41 of which is secured to an end face of a gear wheel 42 mounted about a shaft 43. The teeth of the gear wheel 42 mesh with the teeth of the gear wheel 23 and since the wheel 42 is smaller than the wheel 23 the cage will be driven at a speed greater than that of the drive shaft 22. The shaft 43 carries an axially movable sleeve 44 which is provided with a flange engaged by the toe portions of the weights 45. As the speed increases the weights move outwardly and thereby impart axial movement to the sleeve 44. As shown the sleeve and the weight unit are shown in the rest position. However, the sleeve 35 together with the remaining portion of the governor mechanism are shown in an engine idling position.

The governor mechanism further includes a first pivotal lever 46 and this is pivotally mounted intermediate its ends about a pivot 47 carried by the housing. One end of the lever 46 mounts a projection 53 which is engaged within a recess in the sleeve 35 and the other end of the lever 46 is connected to one end of a coiled tension spring 57 which constitutes the governor spring. The other end of the spring 57 is connected to an arm 58 which can be adjusted by the engine operator, to determine the force exerted by the spring 57 on the lever 46. The sleeve 44 which is moved by the governor weights, is engageable with the lever 46 and as the engine speed increases the weights will move outwardly to urge the lever against the action of the spring 57 thereby to move the sleeve 35 towards the left to reduce the amount of fuel supplied by the apparatus to the associated engine.

Turning now to Figures 2, 3 and 4, the lever 46 is shown in perspective with the line of action of the sleeve 44 being indicated by the arrow 48 and the line of action of the spring 57 being indicated by the arrow 49. The governor mechanism includes a second lever 50 which is pivotally mounted at one end about an axis indicated at 51, in the housing. The upper end of the lever 50 extends into a slot 52 which is formed in a plate member 53A secured within the housing. The lever 50 intermediate its ends, is provided with a projection 54A which is engageable by the upper end of the lever 46. The projection is shown in Figure 3 and as will be seen, it is closer to the pivot axis 51 than to the opposite end of the lever which is slidable within the slot 52. The projection 54A acts to limit the movement of the lever 46 under the action of the spring 57 and it therefore serves to determine the maximum amount of fuel which can be supplied by the apparatus to the associated engine. The position of the lever 50 is adjustable and for this purpose there is provided a third lever 54 which intermediate its ends is secured as by welding or a rivet, to a cylindrical guide piece 55 slidable within the slot 52. The guide piece 55 is engaged by the upper end of the lever 50 and the outer ends of the lever 54 are turned downwardly to define projections 59, 60 respectively.

The projections 59, 60 engage pegs 61, 62 respectively which are mounted on respective abutment plates 63 and these are engaged by respective coiled compression springs 64, 65. The pegs 61, 62 are movable against the action of the springs 64, 65 respectively by fluid pressure operable devices 66, 67 respectively. The device 66 comprises a fluid pressure operable piston 68 slidable within a cylinder the closed end of which is connected to the outlet of the supply pump 21. The piston 68 has an integral tubular push piece 69 which engages the abutment plate 63 and as the outlet pressure of the supply pump increases the piston will move the abutment plate 63 and the peg 61 against the action of the spring 64. In so doing the lever 54 will tend to pivot about the point of contact between the peg 62 and the projection 60 although the movement of the lever will be guided by the guide piece 55. The guide piece however will move downwardly as shown in Figure 4 to permit further anticlockwise movement of the lever 50 and thereby anticlockwise movement of the lever 46 under the action of the governor spring 57. The maximum amount of fuel which can be supplied to the engine will therefore be increased.

The fluid pressure operable device 67 is not shown in its entirety but it includes a diaphragm one side of which is subjected to the pressure in the air inlet manifold of the associated engine. The diaphragam is coupled to a push pin 70 which engages a slidable push piece 71 engaging the respective abutment plate 63. As the air pressure within the inlet manifold of the engine increases the diaphragm will urge the abutment plate 63 downwardly against the action of the spring 65 and the lever 54 will pivot to permit an increase in the maximum amount of fuel which can be supplied to the associated engine. In practice the piston 68 and the diaphragm may effect movement of the lever at the same time but the practical effect is that the amount of fuel which can be supplied to the engine will increase in accordance with the engine speed and also the pressure in the air inlet manifold of the engine.

The point of contact of the lever 46 with the projection 54A is close to the pivot axis 51 of the lever 50 whereas the point of contact of the guide piece 55 is some distance removed from the pivot axis 51. As a result the force acting on the guide piece 55 due to the governor spring is considerably reduced. In addition, the reaction force which has to be developed by the springs 64, 65 is further reduced by the lever ratio produced by the lever 54 and the springs 64, 65 can be sufficiently strong to withstand the reaction forces thereon due to the governor spring while at the same time the fluid pressure operable devices 66, 67 do not have to be large to effect movement of the respective pegs 61, 62 against the action of the springs.

The sleeve 35 may be mounted about a cylindrical member which is coupled to the distributor member at its end remote from th drive shaft as is shown in Figure 4 of the specification of GB 2069722B.

Claims

1. A fuel injection pumping apparatus having a rotary and axially movable distributor member (12) carrying a pumping plunger (14) actuable by cam lobes on the internal surface of a cam ring (32), inclined surfaces (24A, 26A) operable to limit the outward movement of the plunger (14) the axial position of the distributor member (12) determining the extent of outward movement, a chamber (30) to which liquid under pressure can be supplied to

move the distributor member (12) against the action of a spring (29), a sleeve (35) movable axially to determine the pressure of liquid in said chamber (30) a first pivotal lever (46) coupled at one end to said sleeve (35), resilient means (57) acting on said lever (46) in a direction to urge the lever and said sleeve to increase the amount of fuel supplied by the apparatus, governor means (40) acting on the lever (46) in opposition to said resilient means, and stop means operable to limit the maximum amount of fuel which can be supplied by the apparatus, characterised in that said stop means comprises a second lever (50) pivotally mounted at one end and engageable intermediate its ends by the other end of the first lever (46), and fluid pressure operable means (66, 67) for positioning a stop (55) engageable by the other end of the second lever (50).

2. An apparatus according to Claim 1 characterised in that said stop (55) is mounted intermediate the ends of a third lever (54), the ends of the third lever being connected to fluid pressure operable devices (66, 67) respectively.

3. An apparatus according to Claim 2 characterised in that said stop (55) is of cylindrical shape and is slidable within a slot (52).

4. An apparatus according to Claim 2 characterised in that the point of contact between the first and second levers (46, 50) is located close to the pivot axis (51) of the second lever (50).

5. An apparatus according to Claim 2 in which the fluid pressure operable device (66) comprises a spring loaded piston (68) which is subjected to a speed dependant fuel pressure and the fluid pressure operable device (67) includes a diaphragm responsive to air pressure.

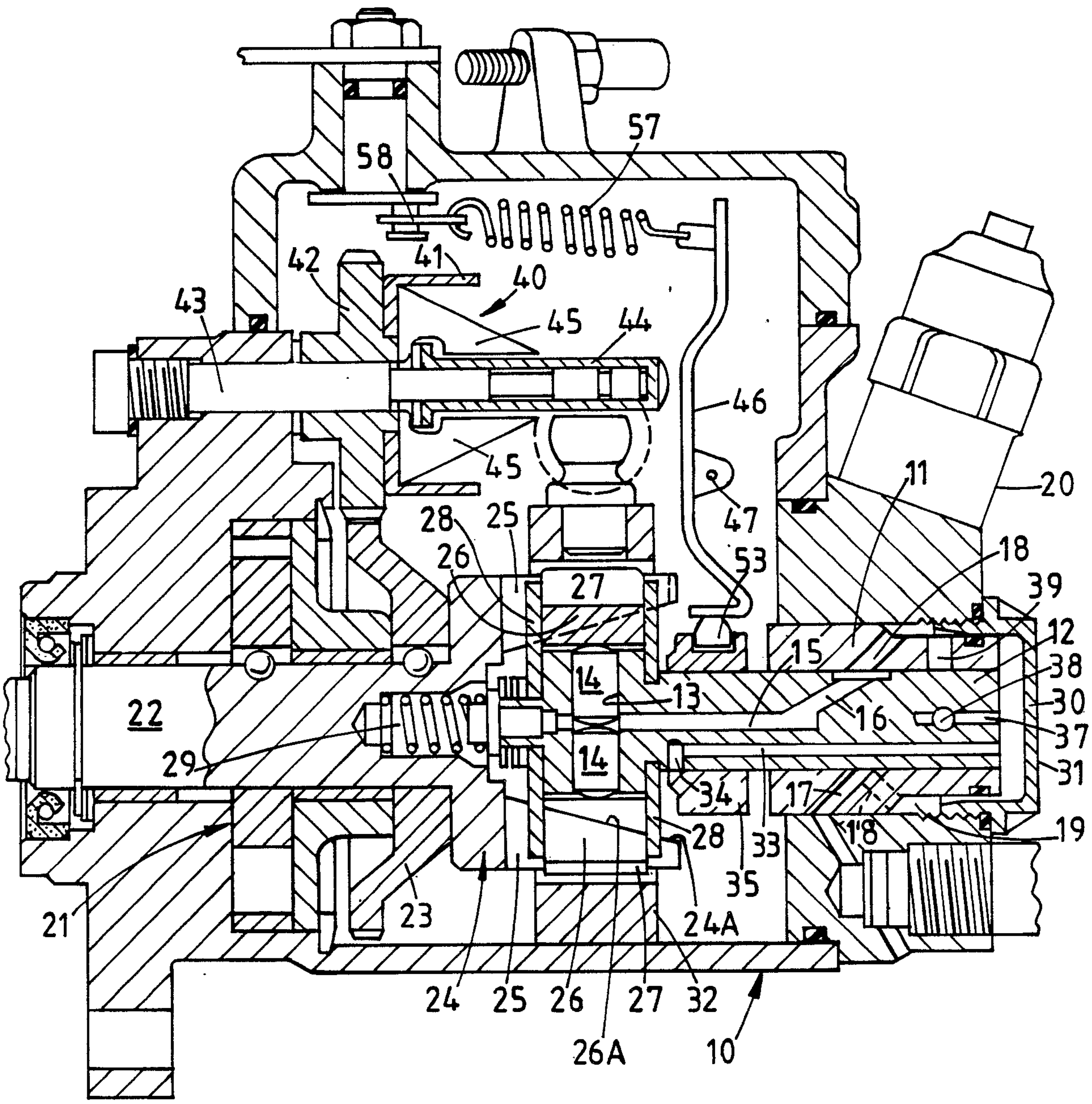
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FIG.1.

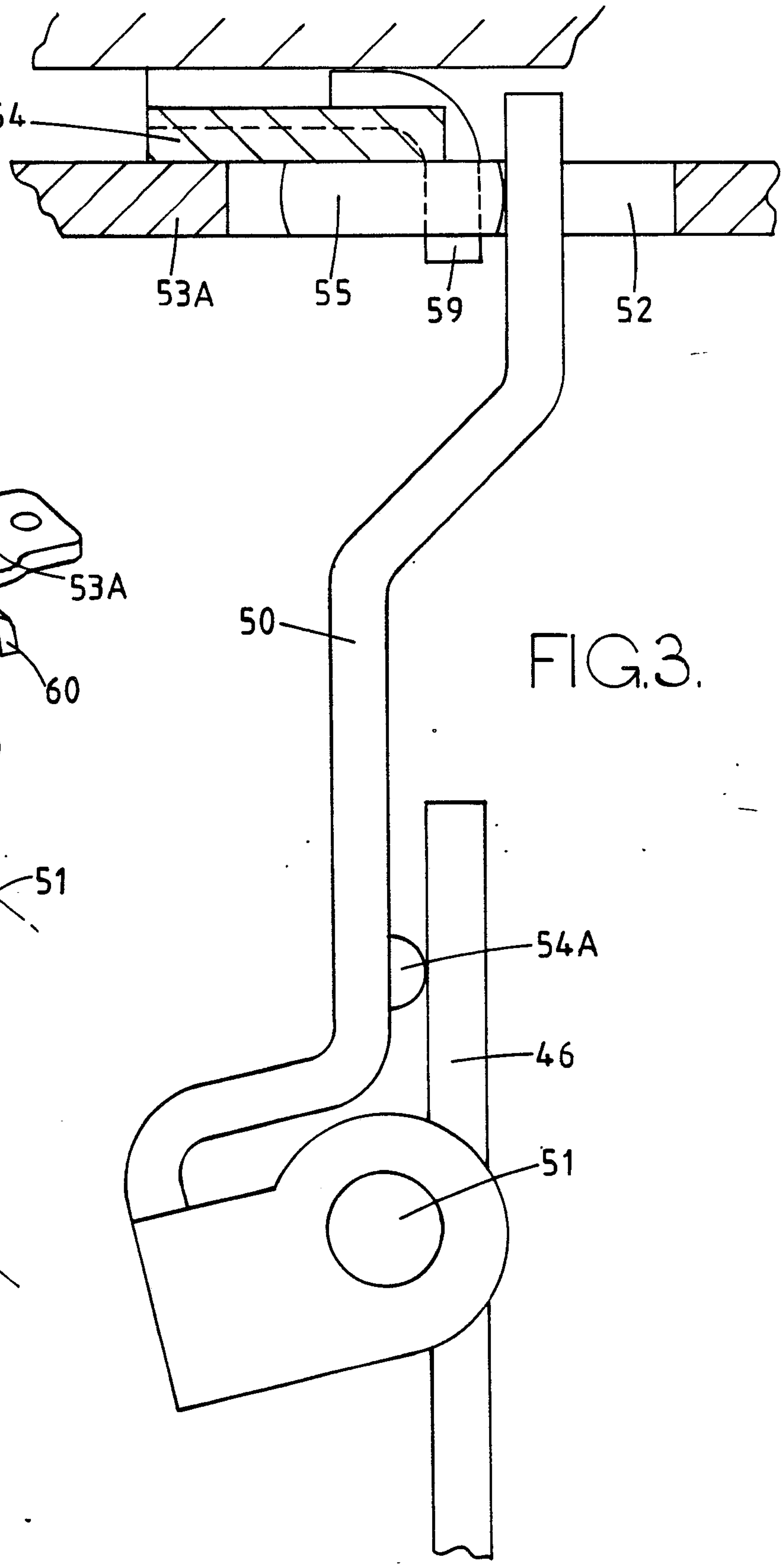

FIG.3.

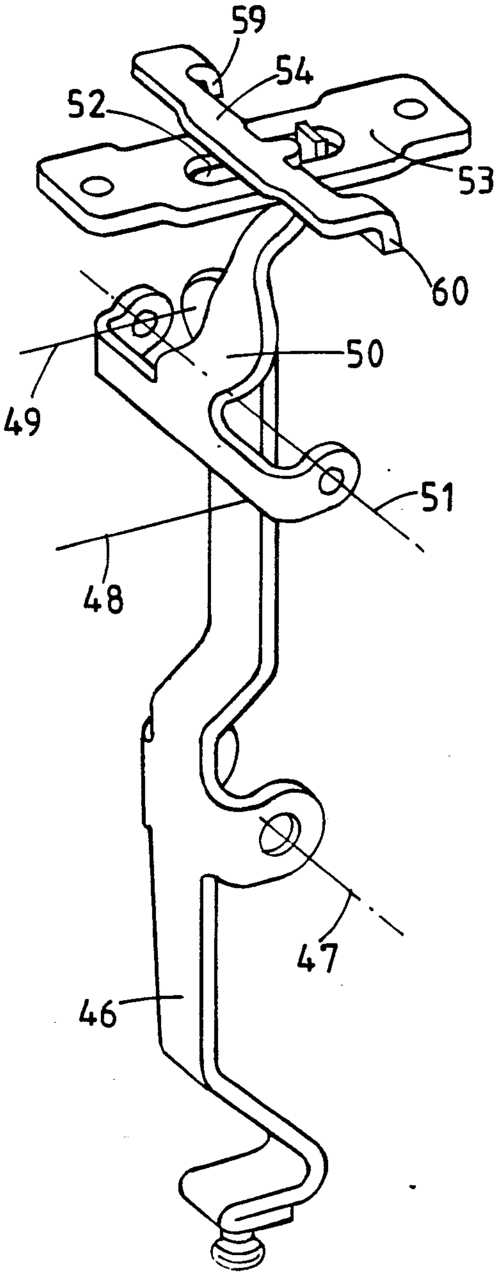

FIG.2.

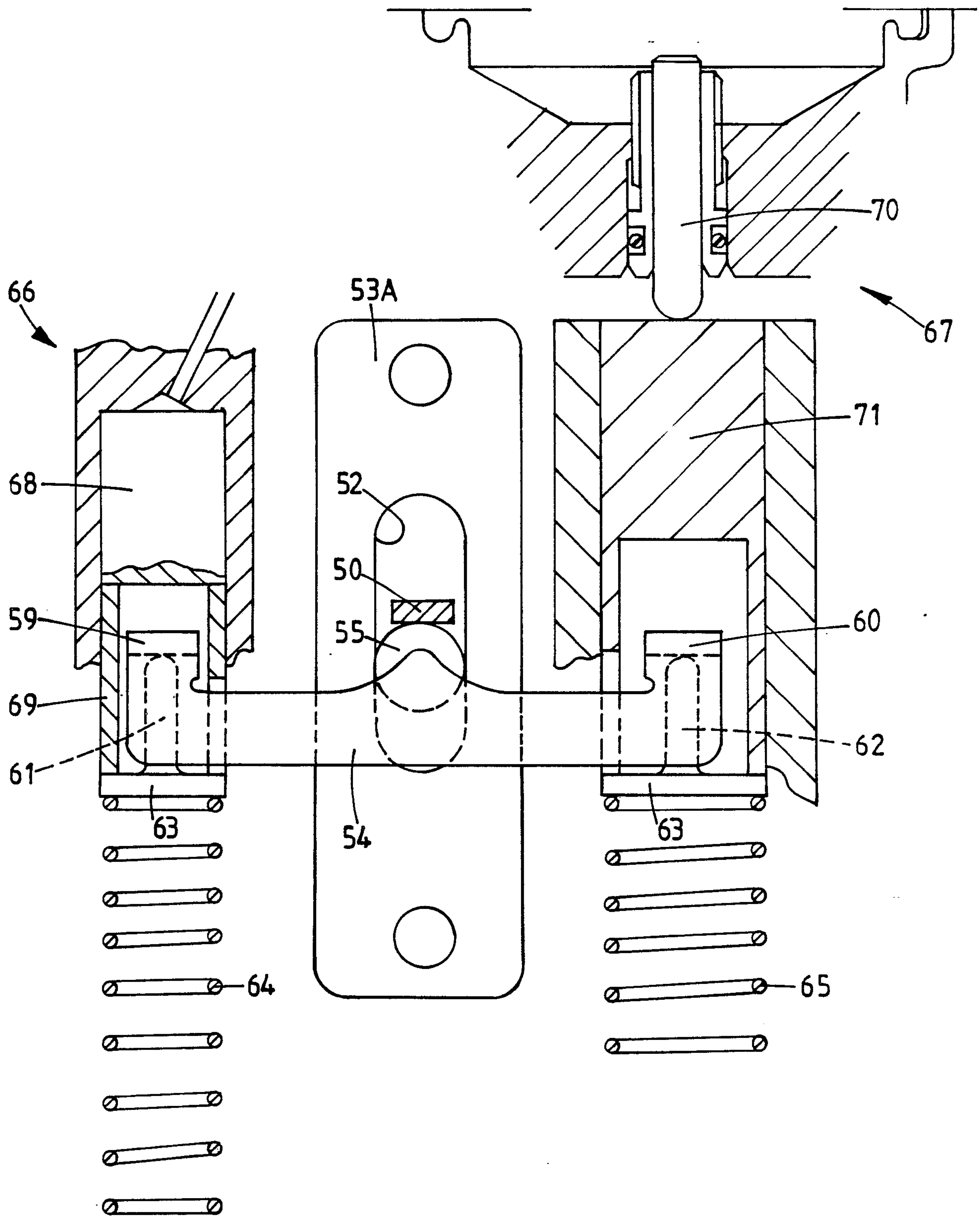

FIG. 4.