March 23, 1954 W. FRIEDLANDER 2,672,816

FUEL INJECTION PUMP

Filed June 16, 1950 2 Sheets-Sheet 1

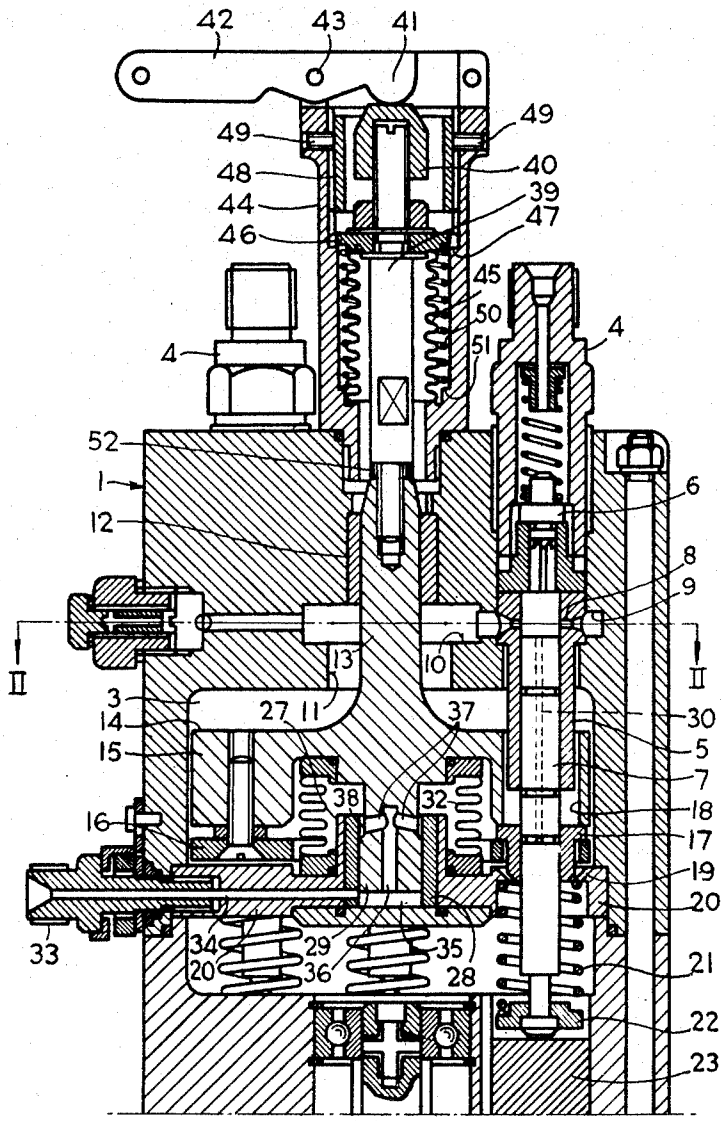


FIG. 1A

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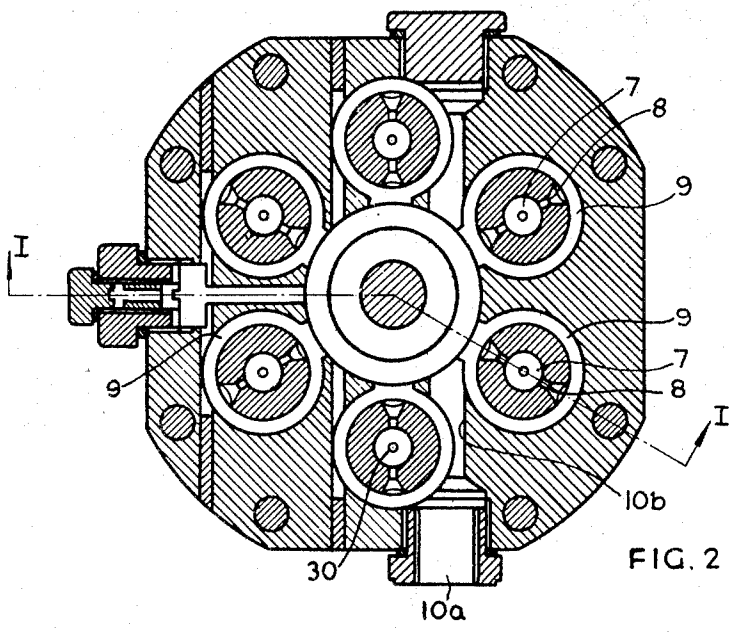


FIG. 2

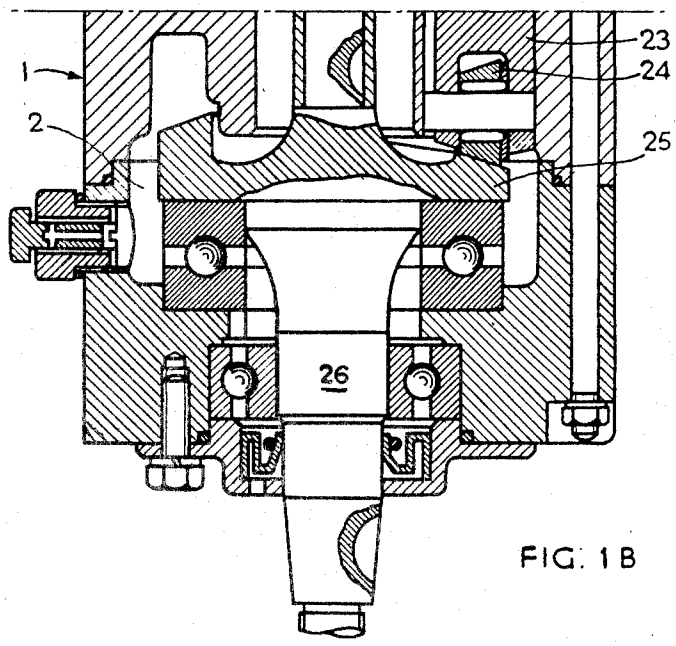


FIG. 1B

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UNITED STATES PATENT OFFICE

2,672,816

FUEL INJECTION PUMP

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Application June 16, 1950, Serial No. 168,508

Claims priority, application Great Britain June 17, 1949

7 Claims. (Cl. 103—2)

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This invention relates to fuel injection pumps for internal combustion engines, particularly though not exclusively, compression-ignition engines. It is concerned with improvements in pumps of the kind (hereinafter referred to as "the kind specified") in which the effective length of the delivery strokes of the respective pistons is similarly controlled simultaneously for all the pump cylinders by actuation of a common regulating member which adjusts, for each cylinder, the position of an element which determines at what point in the delivery stroke fuel will be spilled from the cylinder into a chamber or passage in communication with the inlet side of the pump, the fuel tank or a like low-pressure region, the common regulating member being a plate or disc and the elements adjusted thereby being sleeves fitted over the pump pistons or plungers to control the outlet ends of spill passages which run through the pistons or plungers from the operative end faces thereof to the cylindrical surfaces thereof.

Various proposals have heretofore been made for controlling the delivery of pumps of the kind specified automatically in accordance with the speed and loading of the engines supplied thereby, so that a certain speed governing action will be secured which will prevent the engine speed from varying to any substantial extent from the value thereof corresponding to the setting for the time being of the manual or other control normally employed for actuating the common regulating member.

The object of the present invention is to provide an improved automatic delivery-controlling device for a pump of the kind specified which shall be sensitive, efficient and of relatively simple construction.

According to the invention, in a pump of the kind specified, the common regulating member is connected to a rigid or immovable part of the pump housing by means of a pressure-responsive element entirely disposed within the housing, and means is provided for exposing the said element to the variable pressure in one of the manifolds of the engine being supplied by the pump in such a sense as to cause the pressure-responsive element to move the regulating member in the direction for reducing the delivery of the pump as the engine speed increases above the value for which it is set by the normal control means.

It is preferred to utilise the reduced pressure in the intake manifold of the engine but the pressure in the exhaust manifold may instead be utilised in the case of supercharged engines.

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In order that the nature of the invention may be clearly understood, an example of the way in which it may be carried into effect will now be described in greater detail with reference to the accompanying drawings.

In this example, the pump chosen for illustrative purposes is constructed substantially in accordance with the invention forming the subject matter of application Serial No. 687,368, now Patent No. 2,517,483, but the present invention may be applied also to other constructions of pumps of the kind specified above without difficulty.

In the drawings:

Fig. 1A is the upper part of a section taken on the line I—I of Fig. 2,

Fig. 1B is the lower part of the section, and

Fig. 2 is a section taken on the line II—II of Fig. 1A.

The pump, as shown in Fig. 1A, comprises a generally cylindrical housing 1 having a cam chamber 2 (Fig. 1B) at one end, a spill chamber 3 intermediate its length and a series of delivery connections 4 at its other end which are each connected to the fuel injection device of the respective engine cylinder. At this end of the housing there are the appropriate pump cylinders 5 disposed around and parallel with the axis of the housing and each communicating through a delivery valve 6 with the corresponding delivery connection 4. The cylinders 5 and the respective pistons or plungers 7 are all identical and only one set of these parts need be described here. The cylinder wall is formed with radial bores 8 near its outer end and is surrounded at this location by an annular fuel supply passage 9. This is in permanent communication with a central annular chamber 10 (supplied from an inlet 10a through a bore 10b) formed by a recess in the cylindrical wall of the enlarged inner end 11 of an axial bore 12 in the housing 1 provided to admit the passage of a stem 13 attached to a common regulating member 14 located in the spill chamber 3. The regulating member 14 is of disc form with a thickened edge 15 on to which is clamped a ring 16 serving to position controlling sleeves 17 which are a close sliding fit on the pistons 7 working in the cylinders 5. Each piston 7 is a close sliding fit in its cylinder 5 which projects, with play, part-way into an aperture 18 in the thickened edge 15 of the regulating member, the corresponding controlling sleeve 17 being mounted on the latter in such a manner that it may move laterally (e. g. radially or circumferentially of the member) without being capable

of any appreciable motion relative to the member in the axial direction.

The piston 7 continues beyond the sleeve 17, through an oversize hole 19 in a partition member 20 secured transversely of the spill chamber 3, to be surrounded by a compression spring 21 bearing at its ends upon the partition member 20 and upon a collar 22 secured on the end of the piston, respectively. The end of the piston 7 bears upon one end of a reciprocable push rod 23 the other end of which (see Fig. 1B) carries a roller 24 co-operating with a face cam 25 rotatable within the cam chamber 2 by means of a shaft 26 extending axially through the end of the housing 1 to be driven from the engine crank-shaft at an appropriate speed.

Centrally of the partition member 20 (see Fig. 1A) is formed an axially extending cylindrical wall 27 surrounding a liner 28 within which slides a spigot part 29 secured on the regulating member 14. Axial adjustment of this member varies the position of the controlling sleeves 17 relative to the length of the pistons 7 which are formed with axial bores 30 leading from their operative end faces to radial bores 31 the opening of which occurs as they move out of the controlling sleeves 17 during the delivery strokes of the respective pistons.

The pump thus far described operates in exactly the same manner as that described in application Serial No. 687,368 rotation of the face cam 25 causing reciprocation of the pistons 7 and the consequent delivery, per working stroke, of a quantity of fuel determined by the spacing for the time being of the controlling sleeves 17 from the cylinders 5.

While the pump is operating, a certain proportion of the fuel initially drawn into each cylinder 5 is spilled into the chamber 3 containing the regulating member 14, the proportion thus spilled increasing as the quantity of fuel supplied to the engine per stroke of each piston decreases.

In the example of this invention which is illustrated, use is made of the sub-atmospheric pressure prevailing in the intake manifold of the engine for producing automatic variation of the delivery of the pump in accordance with the speed and loading of the engine.

Within the annular space which is defined between the thickened edge 15 of the regulating member 14 and the cylindrical wall 27 of the partition member 20 is disposed a flexible metallic bellows 32 having its ends attached in a fluid-tight manner to the partition member 20 and to the regulating member 14, respectively. A connection is made, at 33, from the engine intake manifold to a radial bore 34 formed in the partition member 20, this bore opening through the liner 28 to the space 35 bounded by the latter within the cylindrical wall 27. The spigot portion 29 on the regulating member 14 is itself formed with an axial bore 36 (from its free end) which communicates with substantially radial bores 37 formed in the spigot portion and normally having their mouths just covered by the free edge of the liner 28. The spigot portion 29 is however slightly reduced in diameter at this location (as shown at 38) so that the pressure variations in the engine manifold can act upon the interior of the pressure responsive bellows 32. The arrangement is such that an increase in the suction in the manifold will collapse the bellows 32 to a smaller axial length and thus draw the regulating member 14 towards the partition member 20. This has the effect of moving the controlling sleeves 17 away from the pump cylinders 5 so that the spill passages 31 in the pistons 7 are uncovered at an earlier stage in the working strokes of the pistons. This results in a smaller delivery of fuel to the engine so that the suction in the intake manifold will tend to drop. Consequently, the increase in pressure within the bellows 32, assisted by a suitable spring if necessary, will allow the bellows to expand again so that the regulating member 14 will then move in the direction for increasing the supply of fuel to the engine.

In order that the regulating member 14 may normally be adjusted by hand or other means, particularly for the purposes of stopping the engine and determining the maximum fuel delivery, the stem 13 thereof is extended by a screwed-on rod 39 which carries at its free end a head 40 adapted to be contacted by one arm 41 of a two-armed actuating lever 41, 42 pivoted at 43 on a tubular extension 44 secured on the pump housing 1. The rod 39 is sealed in the housing by means of a flexible bellows 45 connected at one end to the wall of the passage through the extension 44 and at the other end to a collar 46 secured on the rod. This collar 46 also serves to limit the movement of the regulating member 14 by working between two stops, the inner one of which is constituted by a shoulder 47 formed in the extension 44 and the outer one of which is the inner end of a sleeve 48 adjustably screwed into the outer end of the extension 44 and locked in position by grub-screws 49. The collar 46 also acts as an abutment for one end of a compression spring 50 the other end of which bears against a shoulder 51 in the passage through the extension 44. This spring is provided to limit the movement of the control member towards minimum delivery under the influence of suction in order to reduce erratic variations of idling speed. It will be seen that the bellows 32 which responds to the pressure variation in the engine manifold may nevertheless act to reduce the supply of fuel to the engine at any setting of the actuating lever 41, 42.

The pressure of the spring 50 acting on the regulating member 14 may be varied to suit requirements by interposing spacing collars or washers 52 between the stem 13 of the member and the screwed-on rod 39 which forms the extension thereof.

The required engine speed is selected by varying the free orifice of the engine manifold with the aid of a butterfly valve in accordance with known practice.

It will be understood that, when the pressure prevailing in the exhaust manifold of the engine is to be utilised for controlling the position of the regulating member, the pressure-responsive bellows will then be arranged to act upon the regulating member in the opposite sense, i. e. an increase in the pressure will produce a reduction in the supply of fuel to the engine.

What I claim is:

1. A fuel injection pump comprising a housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve-controlled connection from said end of each cylinder to a respective delivery conduit, a pump plunger reciprocable within each cylinder, a cam for reciprocating the plungers, a spill passage in each plunger, a spill chamber located in the housing entirely between said ends of the

cylinders and said cam, an element slidable on each plunger to determine the point in the stroke of the plunger at which the spill passage therein will be placed in communication with the spill chamber, a regulating member displaceably mounted within the spill chamber and operatively connected to each of the slidable elements, an abutment fixedly mounted within the spill chamber, a flexible bellows disposed within the chamber and operatively connected at one end to the regulating member and at the other end to the abutment, an inlet connection on the exterior of the housing and a passage leading from the inlet connection to the interior of the bellows.

2. A fuel injection pump comprising a housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve-controlled connection from said end of each cylinder to a respective delivery conduit, a pump plunger reciprocable in each cylinder, a common cam for reciprocating the plungers, a spill passage in each plunger having an outlet end, a spill chamber located in the housing entirely between said ends of the cylinders and said cam such that the outlet ends of the spill passages will be moved through the chamber by the reciprocation of the plungers, an element slidable on each plunger to determine for what proportion of each stroke of the respective plunger the outlet end of the spill passage therein will be in communication with the spill chamber, a common regulating member displaceably mounted within the spill chamber, operative connections between the said member and the elements slidable on the plungers for causing these elements to move in unison with the regulating member, movement of the latter in one direction therefore resulting in a reduction in the output of the pump and movement in the opposite direction resulting in an increase in said output, an abutment fixedly mounted within the spill chamber at a distance from that side of the regulating member which leads when the member is moved in the said one direction, a flexible bellows entirely located within the spill chamber and operatively connected at one end to the regulating member and at the other end to the abutment, an inlet connection on the exterior of the pump housing, and a passage leading from the inlet connection to the interior of the bellows.

3. A fuel injection pump comprising a housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve-controlled connection from said end of each cylinder to a respective delivery conduit, a pump plunger reciprocable within each cylinder, cam means for reciprocating the plungers, a spill passage in each plunger, a spill chamber located entirely between said ends of the cylinders and said cam means, an element slidable on each plunger to determine the point in the stroke of the plunger at which the spill passage therein will be placed in communication with the spill chamber, a regulating member displaceably mounted within the spill chamber and operatively connected to each of the slidable elements, a partition member fixedly mounted within and transversely of the spill chamber, a flexible bellows disposed within the chamber and directly connected at one end to the regulating member and at the other end to the partition member, an inlet connection on the exterior of the housing and a passage leading from the inlet connection to the interior of the bellows.

4. A fuel injection pump comprising a housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve-controlled connection from said end of each cylinder to a respective delivery conduit, a pump plunger reciprocable within each cylinder, cam means for reciprocating the plungers, a spill passage in each plunger, a spill chamber located entirely between said ends of the cylinders and said cam means, an element slidable on each plunger to determine the point in the stroke of the plunger at which the spill passage therein will be placed in communication with the spill chamber, a regulating member displaceably mounted within the spill chamber and operatively connected to each of the slidable elements, a partition member fixedly mounted within and transversely of the spill chamber, a flexible bellows directly connected at one end to the regulating member and at the other end to the partition member to define a secondary chamber located entirely within the spill chamber, an inlet connection on the exterior of the housing and a passage leading from the inlet connection to said secondary chamber.

5. A fuel injection pump comprising a housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve-controlled connection from said end of each cylinder to a respective delivery conduit, a pump plunger reciprocable within each cylinder, cam means for reciprocating the plungers, a spill passage in each plunger, a spill chamber located entirely between said ends of the cylinders and said cam means, an element slidable on each plunger to determine the point in the stroke of the plunger at which the spill passage therein will be placed in communication with the spill chamber, a regulating member displaceably mounted within the spill chamber and operatively connected to each of the slidable elements, a partition member fixedly mounted within and transversely of the spill chamber, a flexible bellows directly connected at one end to the regulating member and at the other end to the partition member to define a secondary chamber located entirely within the spill chamber, an inlet connection on the exterior of the housing and a radial bore through said partition member communicating at one end with said inlet connection and at the other end with said secondary chamber.

6. A fuel injection pump comprising a housing, a plurality of fuel delivery connections on the exterior of the housing, a plurality of pump cylinders located within the housing with their one ends adjacent to one end of the housing, a valve connecting said end of each cylinder to its respective delivery connection, a pump plunger reciprocable within each cylinder, a cam for reciprocating the plungers, a spill passage in each plunger, a spill chamber located entirely between said ends of the cylinders and said cam, an element slidable on each plunger to determine the point in the stroke of the plunger at which the spill passage therein will be placed in communication with the spill chamber, a regulating member displaceably mounted within said spill chamber and operatively connected to each of the slidable elements, a partition member fixedly mounted within and transversely of the spill

chamber, a flexible bellows directly connected at one end to the regulating member and at the other end to the partition member to define a secondary chamber located entirely within the spill chamber, a guide formation on said regulating member, a complementary formation on said partition member, said two formations being capable of sliding engagement with each other, an inlet connection on the exterior of said housing and a radial bore through said partition member communicating at one end with said inlet connection and at the other end with said secondary chamber.

7. A fuel injection pump for an internal combustion engine comprising a pump housing, a plurality of fuel delivery conduits, a plurality of pump cylinders located within the housing, valve-controlled connections leading from corresponding ends of the cylinders each to a respective delivery conduit, a piston reciprocable within each cylinder, a cam for reciprocating the pistons, a spill passage in each piston, a spill chamber located within the housing entirely between said ends of the cylinders and said cam, for receiving fuel ejected through the spill passages, an element associated with each piston for determining the point in the delivery stroke of the piston at which the spill passage therein will be placed in communication with the spill chamber and a common regulating member displaceable within said chamber for adjusting said elements simultaneously, a part fixedly mounted within the spill chamber, a fluid pressure-responsive element connecting the common regulating member to said part and exposed on one side to the pressure prevailing within the spill chamber and adapted to respond to variations in a fluid pressure to the action of which its other side is exposed and a fluid pressure-conducting connection extending from the exterior of the pump housing to the said other side of said element.

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