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FUEL INJECTION PUMP

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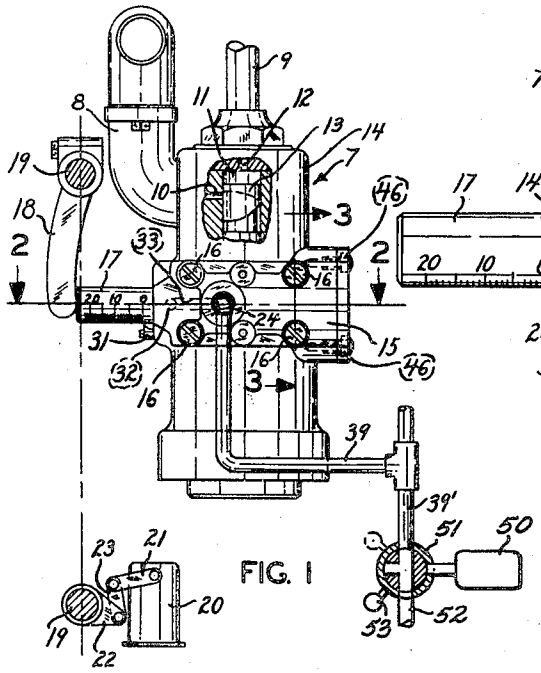


FIG. 1

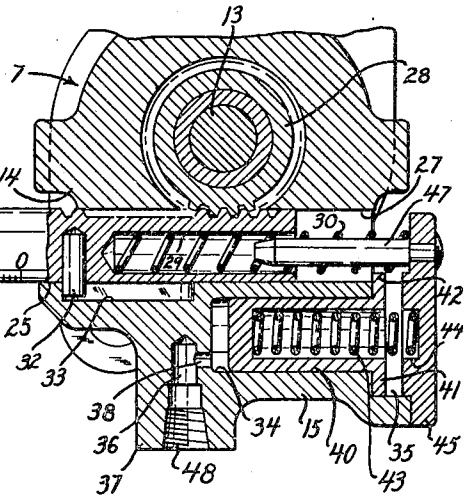


FIG. 2

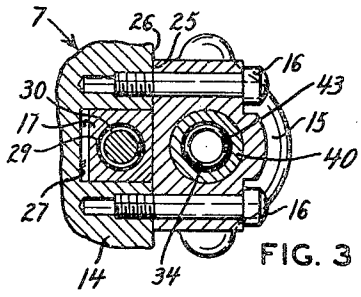


FIG. 3

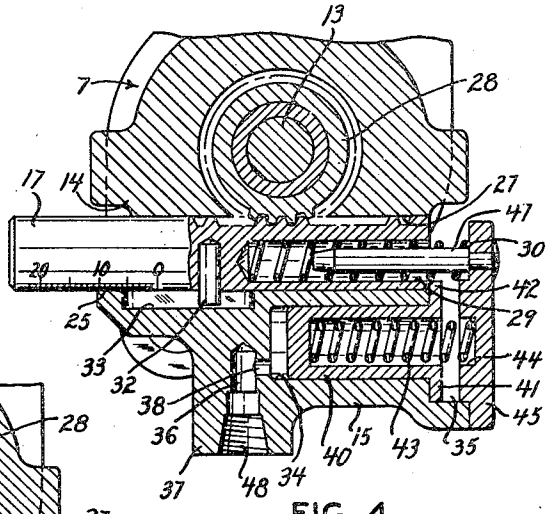


FIG. 4

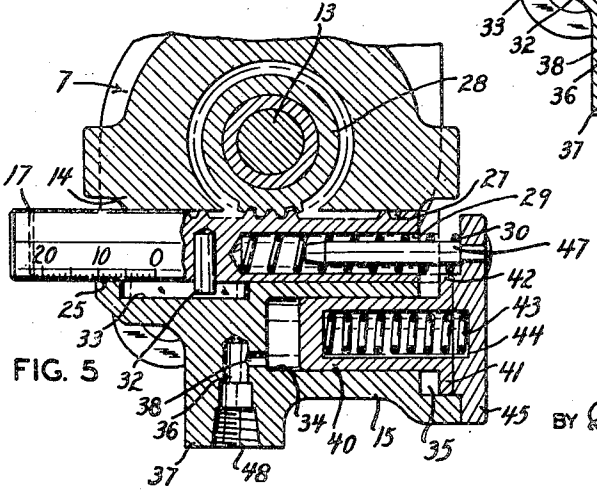


FIG. 5

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FUEL INJECTION PUMP

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6 Claims. (Cl. 123—179)

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This invention relates generally to fuel injection pumps for internal combustion engines.

The principal purpose of this invention is to enable fuel injection pump operation at greater than maximum fuel load delivery when the engine is being cranked for starting, but to protect the engine against an excess delivery of fuel beyond that normally required for running at full load conditions.

More specifically, the invention contemplates the provision, in connection with a fuel injection pump of the variable delivery type, of fuel delivery limiting means normally effective to prevent pump delivery operation at greater than the predetermined maximum full load fuel requirements of the engine and in which the limiting means is responsive to an externally applied force, such as the pressure of the air in the starting air system of the engine, for permitting fuel delivery in excess of the normal maximum during the starting period only.

Other objects are to be found in the form, construction, operation and arrangement of a fuel pump delivery control agency which will carry out the foregoing objects to best advantage.

The following description relates to only a preferred embodiment of the invention as disclosed in the accompanying drawing, wherein:

Fig. 1 is an elevational view of a typical fuel injection pump in which a portion of the housing is broken away to show the working plunger therein, and in which the engine starting air pump system, the pump control means and schematic governor control system have been indicated;

Fig. 2 is an enlarged, transverse section through the pump showing the details of the limiting means at line 2—2 in Fig. 1;

Fig. 3 is an enlarged and fragmentary sectional detail view as seen at line 3—3 in Fig. 1;

Fig. 4 is a view similar to that of Fig. 2, but showing the normal maximum fuel injection setting of the pump as determined by the limiting means, and

Fig. 5 is also a similar view in which the pump limiting means is shown in its position of displacement coincident with the engine starting condition to permit delivery of a greater than normal maximum fuel supply at engine starting upon movement of the pump control means into position shown by dotted outline.

In the fuel injection type of internal combustion engine, to which the present invention relates, it is well known that the fuel displacing or working plunger of the pump is adapted to be

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reciprocated by an engine driven cam in timed relation with the crankshaft rotation. It is believed too well known to show such plunger actuating structure, and accordingly none has been indicated in the drawing.

Proceeding to Fig. 1, the fuel injection pump 7 of the cam operated, reciprocable plunger type, is provided with a fuel supply connection 8 and a fuel delivery line 9, connected in fuel flow relation through an inlet passage 10 to the working chamber 11 of the pump and an outlet passage 12. The variable delivery pump plunger 13 is shown in Fig. 1, while a sectional view thereof is disclosed in Fig. 2 for a purpose which will appear presently. At one side of the pump casing 14 there is mounted an auxiliary housing 15 which is detachably secured by cap screws 16. This housing encloses a pump plunger control rack member 17 having its outer free end directed into the path of swinging movement of a pump fuel delivery control lever 18. Lever 18 is secured to a shaft 19 which in turn, is rotated in response to an applied force generated by an engine driven governor 20. The governor has a control arm 21 connected to the lever 22 on shaft 19 by an intermediate link 23, such that movement of governor arm 21 may be transmitted to shaft 19 and thence to the rack control lever 18 whereby fuel delivered by the pump may be varied in accordance with the force developed by the governor in response to the fuel demands of the engine.

In Figs. 2 and 3, the flat mounting face 25 of the auxiliary housing 15 seats against the matching face 26 of the pump housing 14 in position to close a control rack channel 27 formed therein. This channel 27 is rectangular in section to match the shape of the rack 17, but may be any other shape as desired. Thus, housing 15 encloses and positions the rack 17 for operative engagement with a plunger rotating pinion gear 28 through meshing rack teeth, as shown. The inner portion of the control rack member 17 is counter-bored at 29 to receive spring means 30 which acts at all times to urge the rack to a zero fuel delivery setting as will appear presently. The projecting rack portion is suitably marked with position indicating indicia so that the fuel delivery setting of the pump plunger 13 may be ascertained visually. The zero position of the rack 17 is determined through the cooperative arrangement of a stop pin 32 in the rack body and movable into and out of engagement with one end of a slot 33 formed in the face 25 of the auxiliary housing 15 (Fig. 2). A cooperating

rack pointer 31 may be employed if desired (Fig. 1).

The auxiliary housing 15 is formed with a bore 34 which opens into an enlarged recess 35 at its open end. Bore 34 is directed substantially parallel with and laterally spaced from the rack channel 27 in the pump housing 14. The closed rearward end of the bore is adapted to communicate with a transverse passage 36 in housing boss 37 by means of a passage 38. A stop means in the form of a thimble plunger 40 is slidably mounted in the bore 34 and the open end thereof is provided with an outer flanged portion 41 of such lateral dimension as to have one marginal portion 42 projecting into the rack channel 27 to intercept and engage the inner end of the rack 17 (Fig. 4). The flange 41 also acts to position the thimble 40 against the inward urging of a yieldable spring means 43, one end of which is seated within the thimble. The opposite end of spring 43 is retained in a suitable recess 44 in the end closure plate 45 which is removably mounted on the auxiliary housing 15 by means of cap screws 46 (Fig. 1). This closure plate also carries a fixed guide element 47 for the rack spring 30, and in this regard the element 47 is axially located to project into channel 27 within the coils of the spring 30.

As previously noted, the bore 34 in auxiliary housing 15 has a passage 38 communicating with a transversely directed passage 36. This latter passage, formed in boss 37, opens outwardly through a tapped seat 48. The seat 48 receives a threaded fitting 24 (Fig. 1) of an air pressure supply line 39 which is associated with the compressed air supply system 39' for the engine, whereby an externally applied force such as the engine starting air at line pressure is admitted to the bore 34 for displacing the thimble plunger 40 against its return spring 43. The engine starting air system has been shown in schematic outline in Fig. 1 as it is thought to be otherwise well known to those skilled in the art. However, it should be understood that during air start, the air from the supply tank 50 flows to the three-way control valve 51 and by way of line 39' and 39 to the passage 36 and into bore 34, and when shut off the air in the bore is bled away at the discharge line 52 of valve 51, to relieve the air load on the thimble plunger 40 so that the return spring may act. The control lever 53 for valve 51 is shown (Fig. 1) in normal shut-off position (full line), its air starting position being that shown by broken lines.

Normal pump operation during running of the engine is under the control of governor 20 so that fuel requirements may be constantly adjusted through governor actuation of the control rack member 17 to rotate the working plunger 13 by means of the gear 28. When the engine is stopped, the governor will return to its zero setting and the rack spring 30 may then move the rack member 17 (Fig. 2) outwardly to its zero setting, as determined by the stop pin 32 abutting the outer end of the slot 33. At normal full load engine operation, the governor will move the rack member 17 to its full in-position (Fig. 4) against the action of the spring 30 and until the inner end of the rack abuts the stop projection 42 of the thimble plunger flange 41. The combined forces of springs 30 and 43 will then act to prevent further inward movement of the rack member 17 to increase fuel delivery of the pump 7.

At engine start it is very desirable to permit the fuel pump 7 to deliver an excess of fuel over that normally required to operate the engine at full load. The excess fuel supply assures a rapid and positive starting operation with a minimum consumption of the starting air supply. Accordingly, the fuel delivery limiting or stop means 40 associated with auxiliary housing 15 affords a very simple, inexpensive and positive means for temporarily increasing the fuel delivery capacity of the pump. In effect, when the starting air system is turned on by shifting the lever 53 of valve 51 to its broken line position (Fig. 1), a supply of air is admitted to bore 34 behind the plunger 40 to displace the latter against its return spring 43 until the flange 41 abuts the inner surface of closure plate 45 (Fig. 5). When this occurs, the stop projection 42 is moved away from its normal limiting position such that the rack member 17 is free to move beyond its normal maximum fuel delivery setting by a predetermined amount. Thus in Fig. 5, the rack member 17 may move beyond its normal maximum setting by the extent of the displacement of the stop projection 42, as shown. The amount of rack movement has been indicated by the dotted outline, and this represents the control movement to provide the excess supply of fuel over that normally possible.

When the engine starting air is shut off, the air in bore 34 is bled away through valve 51 and line 52, and the plunger 40 may return under the action of its spring 43 so that the stop projection 42 again assumes its normal limiting position, as in Fig. 4. The strength of the spring 43 is so chosen that it will predominate over the governor loading on the rack member 17 and positively force the latter to move outwardly to its normal maximum setting for full load engine operation.

From the foregoing detailed description of structure and operation it is believed that the objects and operation of the present embodiment of the invention now will be fully understood. A principal advantage to be derived from the present arrangement resides in the fact that the means for limiting the fuel pump control member to its normal maximum setting is directly responsive to engine starting conditions whereby a short period of excess fuel delivery operation may obtain. In making the stop means responsive to the pressure of the starting air system, it is definitely assured that the fuel pump will be permitted to supply excess fuel only during the starting period, that a failure of the air supply will not result in malfunctioning of the pump, and that under normal operation when the starting air is shut off the stop means will automatically over-ride the force applied by the governor 20 and return the pump to its normal maximum setting.

It will, of course, be fully understood that the present exemplary disclosure may be altered, modified and rearranged in certain particulars without departing from the underlying principle of its operation as the same is defined by the appended claims.

I claim:

1. In a fuel pump for internal combustion engines, the combination of a control member to vary the quantity of fuel delivered by the pump, resilient means acting on said control member to urge the latter in a fuel delivery decreasing direction at all times, movable stop means engageable by said control member and normally positioned to limit the fuel delivery regulating

action of the latter to a predetermined maximum delivery, resilient means adapted for retaining said stop means in said normal position, and a source of air under pressure connected into the pump for applying a force on the stop means for urging the same against said resilient means to a position permitting fuel delivery regulation by said control member in excess of the predetermined maximum.

2. In a fuel pump for engines of the fuel injection type, a pump plunger arranged for rotational movement to effect variable fuel delivery to the engine, a plunger adjustment control member movable into and out of a position of zero fuel delivery plunger adjustment, spring means constantly urging said control member into its zero fuel delivery position, stop means movably mounted in the pump for engagement by said control member upon the latter attaining a position of plunger adjustment corresponding to a predetermined engine operating condition, said stop means being yieldably retained in said position of control member engagement but movable in a direction to permit increased fuel delivery plunger adjustment during engine starting, and a source of starting air for the engine connected into said pump and acting to effect movement of said stop means in said direction to permit increased fuel delivery.

3. In a fuel pump for engines of the fuel injection type, a fuel delivery plunger arranged for rotational movement to effect variations in the quantity of fuel delivered to the engine, a plunger rotating control member, an engine governor, means operatively connecting said governor and control member for effecting plunger fuel delivery variations in response to said governor, stop means operatively carried by the pump for engagement by said control member to prevent the latter rotating said plunger to a position of fuel delivery in excess of a predetermined quantity, said stop means being yieldably retained in said last mentioned position but movable in a direction to permit movement of said control member to increase plunger fuel delivery in response to the governor operation during engine starting, and a source of air under pressure for engine starting purposes including a connection into said fuel pump to supply pressure air, during starting, against said stop means for effecting yielding movement thereof.

4. In a fuel pump for air start engines of the fuel injection type, a fuel delivery plunger rotationally adjustable to effect fuel delivery variations, an engine governor, a control member operatively connected to said plunger for adjusting the latter, means connecting said control member and governor for effecting control member movement in response to governor actuation, spring means constantly urging said control member in a direction to reduce the delivery of fuel, stop means movably mounted in the pump for engagement by said control member, said stop means being yieldably retained in a position effective to stop operation of said control member upon attainment of a plunger adjustment corresponding to full load

fuel requirements of the engine, and a source of aid under pressure connected to the pump to supply air under pressure for moving said stop means out of said position during air starting of the engine to permit operation of said control member to effect plunger adjustment for fuel delivery at engine starting in excess of the full load requirements of the engine.

5. In a fuel injection pump, the combination comprising a control member for varying the fuel delivery, means supporting said control member and provided with a bore having a passage opening to the exterior thereof, a plunger slidably mounted in the bore and providing a projecting portion against which said control member abuts, spring means constantly urging said plunger to a position in which the projecting portion thereof is contacted by said control member to prevent fuel delivery in excess of a predetermined maximum quantity, a source of fluid under pressure connected to said passage for supplying pressure fluid to the bore thereby slidably displacing said plunger against said spring means to a position permitting control member movement to effect fuel delivery in excess of the predetermined maximum, and means controlling the supply of pressure fluid to determine the period of excess fuel delivery.

6. In a fuel pump, a pump housing, a plunger reciprocably mounted therein and arranged for angular movement to effect fuel delivery variations, a control member movably mounted in said housing and operatively arranged for adjusting the angular position of the plunger, said housing providing a bore and a passage communicating with the bore and opening from the housing for connection with a source of pressure fluid, a plunger element slidably mounted in said bore and formed with a flange adapted to project into the path of movement of and be engaged by said control member, and a pair of spring means carried by the housing, one of said spring means acting on said control member for urging the latter at all times in a direction to decrease the pump fuel delivery, and the other of said spring means acting on said plunger element to retain the latter in position, for opposing movement of said control member to increase the fuel delivery above a predetermined quantity, but yielding under the pressure of the fluid applied to said plunger element from the pressure source for permitting displacement of the plunger element to a position enabling control member movement to increase pump fuel delivery in excess of said predetermined quantity.

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