

March 23, 1971

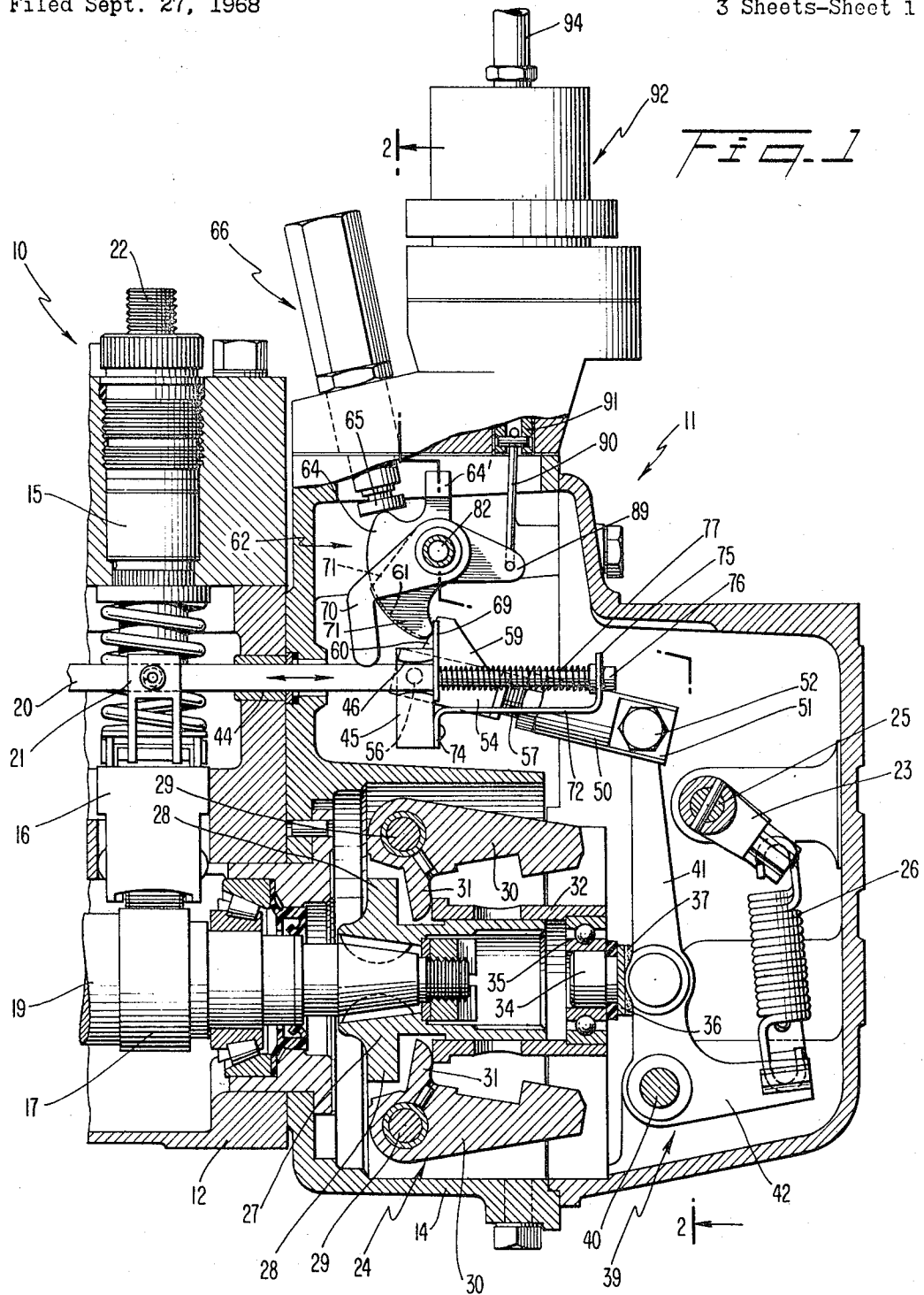
P. BECKER ET AL

3,572,304

FUEL INJECTION PUMP

Filed Sept. 27, 1968

3 Sheets-Sheet 1



INVENTORS  
PHILIPP BECKER  
DOUGLAS A. LUSCOMB

BY

*Bauer and Seymour*  
ATTORNEYS

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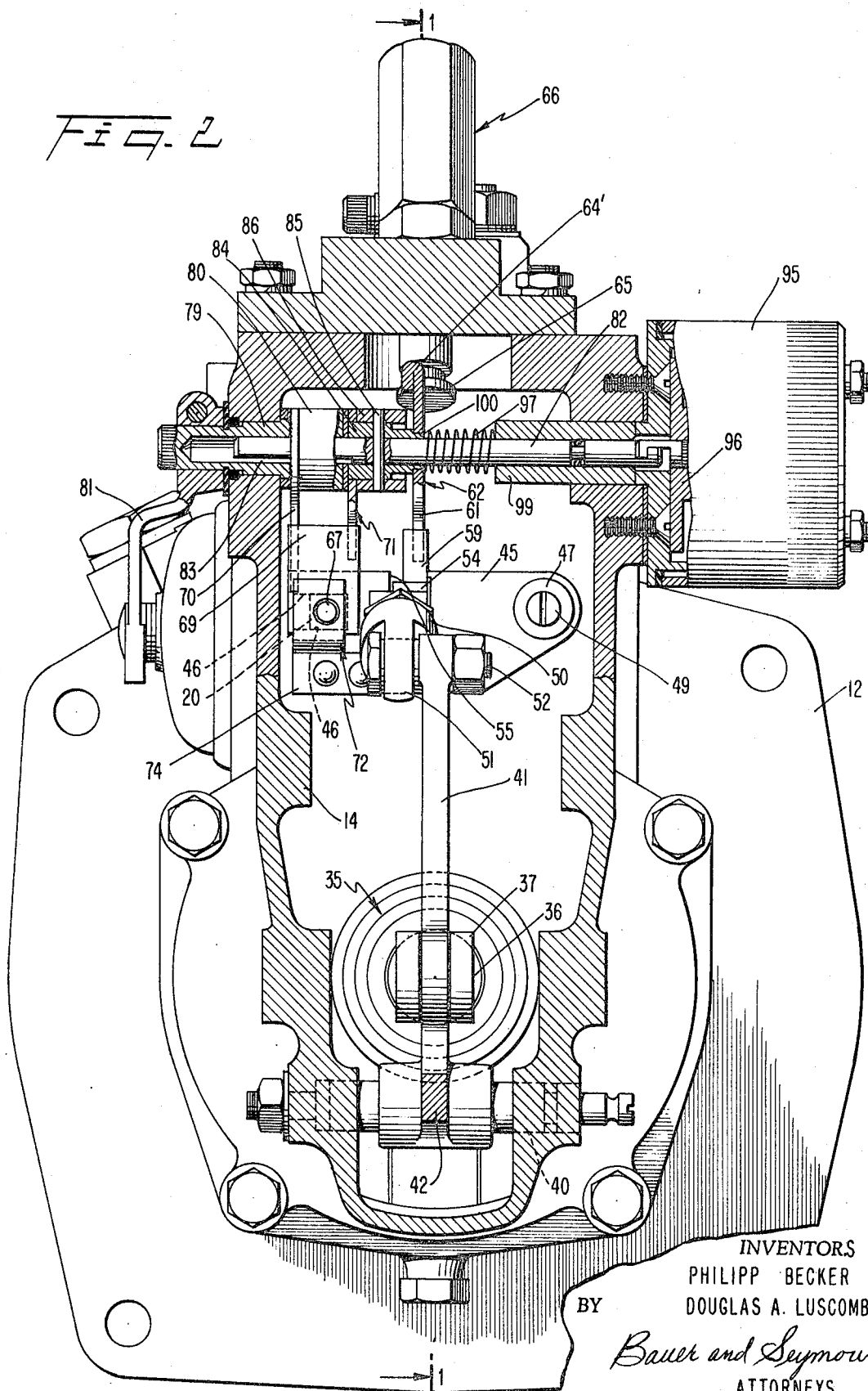
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3,572,304

## FUEL INJECTION PUMP

Philipp Becker and Douglas A. Luscomb, Sidney, N.Y.,  
assignors to The Bendix Corporation  
Filed Sept. 27, 1968, Ser. No. 763,068  
Int. Cl. F02d 1/04

U.S. Cl. 123—140

7 Claims

### ABSTRACT OF THE DISCLOSURE

A fuel injection pump wherein the rate of fuel delivery is determined by a pump control rod which is adjusted by a governor acting upon a movable pump controlling member in opposition to a heavy spring variably tensioned by the engine throttle. The pump includes a connecting unit interposed between the pump control rod and a linkage extending from the movable member, the connecting unit having a slide which is connected to the control rod by spring means whereby the latter transmits motion from the slide to the control rod in the fuel quantity increasing direction while permitting motion of said rod in fuel decreasing direction relative to the slide. Means rigidly connected to the linkage ahead of the slide cooperates with a maximum fuel lever. Means rigidly connected to the control rod, but yieldably connected to the slide through said spring means, selectively cooperates with a fuel shut off lever and with a boost rack control lever, whereby both such latter levers need overcome only said spring means in order to move the control rod in its fuel decreasing direction. The pump is also provided with means for temporarily disabling the maximum fuel stop lever and the boost rack control lever when the engine is to be started, so that excess fuel may be supplied to the engine.

This invention relates to a fuel injection pump adapted for use with an internal combustion engine, and more particularly relates to improved pump control mechanism. Such mechanism permits the control rod for the pump readily to be moved to its engine shutoff position, while providing for maximum fuel stop, torque backup, and boost rack control functions of the pump. The pump of the invention also provides for the temporary disabling of the maximum fuel stop and boost rack control, whereby an excess of fuel may be supplied to the engine when it is to be started.

The invention has among its objects the provision of a fuel injection pump having an improved control mechanism therefor.

A further object of the invention lies in the provision of a fuel injection pump having a novel fuel quantity controlling mechanism which provides for the ready shutting down of the engine by the application of a small force to the mechanism.

Another object of the invention is the provision of fuel pump controlling mechanism of the type above indicated which additionally provides for a maximum fuel stop, a torque back-up, and a boost rack control.

A still further object of the invention lies in the provision, in a fuel injection pump of the above indicated type, of mechanism for disabling the maximum fuel stop and the boost rack control to permit the pump to deliver excess fuel upon the starting of the engine.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

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In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a fragmentary view in vertical axial section through an illustrative embodiment of a pump in accordance with the invention, certain of the parts being shown in elevation, the parts of the pump being shown in the positions which they occupy when the pump is in its normal maximum fuel condition, the section being taken along the line 1—1 of FIG. 2;

FIG. 2 is a view in vertical transverse section through the pump, the section being taken along the broken section line 2—2 of FIG. 1;

FIG. 3 is a fragmentary somewhat enlarged view in side elevation of the control linkage and levers of the pump, the parts being shown in the same relative positions which they occupy in FIG. 1;

FIG. 4 is a fragmentary view of the control levers, control rod, and connecting means cooperating therewith shown in the upper portion of FIG. 3, the parts being shown in the position which they occupy when the control rod has been thrust into its fuel shut-off position; and

FIG. 5 is an exploded view in perspective of the three levers in the control section of the illustrated pump which selectively determine the position of the control rod of the pump, the levers being shown in the positions which they occupy in FIGS. 1-3, inclusive.

Turning now to FIGS. 1-5, inclusive, there is fragmentarily shown an in-line injector pump for a multi-cylinder engine. Such pump has a portion 10 which includes a plurality of aligned pump cylinders (only one shown), and a pump control portion 11 in which there is disposed mechanism for controlling the positioning of the common control rod 20 for the pistons in the pump cylinders. The pump section 10 has a housing portion 12 to which is secured the housing 14 of the control section 11. Housing 12 mounts a plurality of pump cylinders of which one is shown at 15, the piston of each cylinder having a cam follower 16 connected thereto and cooperating with a cam 17 on the main shaft 19 of the pump, shaft 19 being driven in synchronism with the engine. The common control rod 20 is connected to each of the pump pistons by fittings 21, turning of the pistons by axial movement of the control rod varying the amount of fuel injected by each piston during its fuel injecting cycle.

The positioning of the control rod 20 of the pump, and thus the amount of fuel injected by each of the pump pistons, is determined by a centrifugal governor 24, which is affixed to the shaft 19, and a throttle spring means 26 which acts in opposition to the governor and is variably tensioned by a throttle lever 23 which is mounted upon a throttle shaft 25. The governor 24 is provided with a body in the form of a sleeve 27 which is secured to the rear end of shaft 19 for rotation therewith, as shown. Member 27 has oppositely disposed radially extending brackets 28 thereon, such brackets being axially slotted to receive the roots of flyweights between the arms of the bracket. The flyweights are secured to the bracket by transversely disposed stub shafts 29 which extend through the flyweights and the arms of the brackets. The forward arms 30 of the flyweights are weighted as by being thickened so that as the speed of the shaft 19 increases the rear ends of such arms tend to move apart. The flyweights are also provided with generally radially inwardly extending arms 31, the inner ends of which engage the forward end of an outer sleeve 32 which is reciprocally mounted upon the rear, circular cylindrical portion of the member 27. It will be evident that as the rear ends of arms 30 of the flyweights move apart the sleeve 32 is thrust rearwardly or to the right (FIG. 1), and that as the rear ends of such arms

are moved toward each other by spring 26 the sleeve 32 moves to the left.

The rear end of the sleeve 32 extends beyond the rear end of member 27. Mounted within the rear end of sleeve 32 by a thrust bearing 35 is a stub shaft 34 having an enlarged rear head portion 36. Head portion 36 forms the base of a U-shaped bracket, the parallel arms of which are disposed upon opposite sides of a boss on a lever arm 41 and function to guide the lever relative to sleeve 32. Arm 41 forms one part of a bell crank 39, the root of which is pivotally mounted within the lower end of the housing 14 by a transverse stub shaft 40. The other arm 42 of the bell crank 39 extends rearwardly (FIG. 1) and generally horizontally. The rear end of arm 42 is connected to the lower end of the spring means 26, as shown in FIG. 1, the upper end of such spring means being connected to the throttle lever 23 as shown. In a preferred construction the spring means 26 includes two coil tension springs, one such spring being mounted on each side of the lever arm 42 and the lever 23.

The control rod 20, which is of square cross section in its main forward portion, is mounted in guide means in the housing portion 12, one such guide means being shown at 44 in FIG. 1.

A longitudinally reciprocable slide 45 having a sleeve 47 disposed parallel to the control rod 20 secured thereto, such sleeve accurately fitting upon a horizontal guide rod 49 which is affixed to the housing portion 14. The slide 45 is thus accurately guided for reciprocation axially of the control rod 20. The slide is connected to the sleeve member 32, by means to be described, so the slide moves in the same direction as but through a greater distance than such member. The slide 45 has a slot 46 in the left-hand edge thereof (FIG. 2), slot 46 having rounded upper and lower edges which permit free sliding of the control rod in the slot without danger of binding therebetween.

The upper end of the lever arm 41 of the bell crank 39 is pivotally connected to a first link 50 by means of a ball joint comprising a pivot pin 52 which extends through a tongue 51 on link 50 and through the upper end of the arm 41. The forward or left-hand end of a second link 54 (FIG. 1) is in the form of a tongue which is received within a generally central vertical slot 55 in the slide 45 and is connected thereto by a horizontal transverse pivot pin 56. Adjustment between links 50 and 54 is provided by a threaded shank 57 on link 54, such shank being received within a threaded bore in link 50 and held in adjusted position by a lock nut, as shown. The slide 45 is thus connected in a fixed relationship to the reciprocable member 32, the slide 45 being urged to the right (FIG. 1) in a fuel decreasing direction by the governor 24 upon an increase of engine speed, and being urged to the left, in a fuel increasing direction, upon increased tensioning of the spring means 26 by the turning of the throttle shaft 25 by the throttle lever 23 counterclockwise (FIG. 1).

The link 54 has an upstanding abutment or wing 59 integrally connected thereto. The forward surface 60 of the wing 59 is inclined in an upwardly and rearwardly direction, as shown in FIG. 1. In the normal engine running position of a maximum fuel stop lever 62, the lower arm 61 of such lever is disposed in alignment with the wing 59 as shown in FIG. 2. The upper arm 64 of lever 62 (FIG. 2) is disposed in alignment with a yieldable stop 65 which forms a part of a torque back-up control capsule 66. The stop 65 is yieldable in an upward direction against the action of spring means (not shown) within the capsule 66. When a predetermined torque is exerted upon the throttle shaft 25 with the engine running at a predetermined speed, the link 54 and the slide 45 are stopped in their travel in the fuel increasing direction to the left (FIG. 1) by the described interaction between the wing 59, the lever 62, and the stop 65. When the throttle shaft 25 is subjected to increased torque, an in-

creased forwardly directed thrust from the link 54 is imposed upon the wing 59, the lever 62, and the yieldable stop 65. Link 54 is then permitted to move an added amount in the fuel increasing direction by the yielding of the stop 65. The capsule 66 thus provides the pump with a torque back-up function. For details of the capsule 66, as well as those of the air pressure responsive unit 92 to be described, reference may be had to the copending application of Becker and Fuller, Ser. No. 754,686, filed Aug. 22, 1968, which is assigned to the assignee of the present application.

The rear end 67 of the control rod 20 is of circular cylindrical shape. Affixed to the control rod at the junction between its forward square portion and its rear round portion and forming a part thereof is an upstanding transverse plate 69. A bracket 72 is secured at its forward end 74 to the slide 45; the rear end 75 of the bracket 72 is bent upwardly and carries a guide bushing 76 within which the rear end of the portion 67 of the control rod 20 is slidably received. A coil compression spring 77 telescoped over portion 67 of the control rod acts between the rear surface of the plate 69 and the forward end of the bushing 76 so as constantly to urge the plate 69 and the control rod 20 forwardly with respect to the slide 45 and toward the terminal relative position of such parts shown in FIG. 1. It will be seen that if forward travel of the control rod 20 and the plate 69 is unopposed, as the slide 45 is thrust forwardly by the lever 39 and the linkage 50, 54, spring 77 causes the plate 69 and the control rod 20 to follow the slide 45 in the same position relative thereto as that shown in FIG. 1. The plate 69 and the control rod 20 may, however, be thrust rearwardly or to the right in FIG. 1 relative to the slide 45 by a fuel shut-off lever 70 and by a boost rack control lever 71 which coact with the upper, wing portion of the plate 69. In FIG. 4 the control rod 20 and plate 69 are shown thrust rearwardly with respect to the slide by the fuel shut-off lever 70.

A sleeve 79 which is journaled in the upper left-hand (FIG. 2) portion of the housing 14 has an enlarged portion 80 inwardly of the housing to which the fuel shut-off lever 70 is fixedly secured. An external fuel shut-off lever 81 is secured to the outer end of the sleeve 79 as shown in FIG. 2. A reciprocable horizontal shaft 82 has its left-hand end journaled in a central bore in sleeve 79 and its right-hand end journaled in a bore in a sleeve 99 affixed to the housing portion 14. To prevent the trapping of air within the bore in the sleeve 79 the left-hand end of shaft 82 may be flatted at one zone thereof as shown at 83.

A first or inner hub 84 is fixedly secured to the shaft 82 by means of a cross pin 85 which extends through the walls of the hub and the shaft in the position of the parts shown in FIG. 2. The left-hand end of hub 84 abuts a washer which is interposed between it and portion 80 of the sleeve 79. The right-hand end 100 (FIG. 2) of the hub 84 is of reduced diameter and has the maximum fuel stop lever 62 fixedly secured thereto. Journaled upon the hub 84 is a second outer hub 86, hub 86 having two elongated oppositely disposed transverse slots 87 there-through which receive the outer ends of the pin 85. The pin 85 thus prevents movements of the hub 86 longitudinally of the shaft 82 while permitting substantial angular motion therebetween.

The hub 86 has a boost rack control lever 71 fixedly connected thereto, the lower arm of such lever confronting the upper portion of the plate 69 when the parts are disposed as shown in FIG. 2. Lever 71 is under the control of an intake air pressure responsive unit 92, such unit having a chamber therewithin which is connected by a conduit 94 to the intake air manifold of a supercharged engine. An air pressure responsive reciprocable element (not shown) within unit 92 is thrust downwardly against the opposition of a spring within the unit into a lower terminal position shown in FIG. 1 when the pres-

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sure of air within conduit 94 equals or exceeds a predetermined value. Such reciprocable element is connected at the bottom end 91 thereof through a link 90 to an operating arm 89 on the boost rack control lever 71. When the parts are in the position shown in FIG. 1 the boost rack control lever 71 is removed from active cooperation with the plate 69. When, however, there is insufficient air delivered to the intake manifold of the engine and thus the air pressure in conduit 94 falls below a predetermined value, the lower end 91 of the reciprocable element in unit 92 rises, the lever 71 is rotated counterclockwise (FIG. 1) and the lever 71 engages the plate 69 so as to thrust it and the control rod 20 to the right relative to slide 45 so as to decrease the amount of fuel fed to the engine.

The injection pump shown is provided with means whereby the maximum fuel stop lever 62 and the boost rack control lever 71 are removed from active cooperation with their respective wings 59 and 69 when the engine is to be started. A solenoid 95 is provided with a reciprocable armature 96, the armature being connected to the right-hand end (FIG. 2) of the shaft 82. When the solenoid is deenergized the shaft 82, the hubs 84, 86, and the levers 62, 71 are thrust to the left into the position of FIG. 2 by a coil compression spring 97 acting between the right-hand end of the hub 84 and the left-hand end of the sleeve 99 which journals the shaft 82. When the engine is to be started, the solenoid 95 is energized so as to pull the shaft 82 to the right (FIG. 2) and to move the levers 62, 71 to the right out of the paths of the wings 59, 69. At this time the governor 24 exerts no thrust upon the sleeve 32 so that upon turning of the throttle shaft 25 in its fuel increasing direction the slide 45, now carrying with it the plate 69 and the control rod 20, may move in a fuel increasing direction (to the left in FIG. 1) to an increased fuel terminal position which is determined by the inner position of governor weights 30 against sleeve 32 thereby forming stop means for the control rod 20. When the lever 62 is moved laterally out of the path of wing 59 on the link 54, lever 62 may rotate counterclockwise (FIG. 1) until a bent-over arm 64' on the lever engages the rear edge of stop member 65.

The engine is then started; as the engine picks up speed, the governor 24 exerts progressively increasing thrust to the right (FIG. 1) against the sleeve 32 thereby to turn the lever 39 clockwise against the opposition of the spring 26. When the engine has come up to a predetermined speed and solenoid 95 has been de-energized, the force exerted upon the lever 39 by the governor 24 is sufficient to move the slide 45 and the control rod 20 to the right to a position at which the wing 59 on the link 54 and the upper portion of the plate 69 on the control rod 20 permit the respective lower arm 61 of the maximum fuel stop lever 62 and the boost rack control lever 71 to be moved to the left (FIG. 2) with shaft 82 by spring 97. The parts thus return to the positions thereof shown in FIGS. 1 and 3.

The engine may be shut off at any time by use of the shut-off lever 81 to turn the sleeve 79 and the internal shut-off lever 70 so that the latter thrusts the plate 69 to the right against the opposition of spring 77 as shown in FIG. 4, where the control rod 20 is shown in its fuel delivery shut off position.

If the pressure of the air delivered by the supercharger of the engine does not at least equal a predetermined value, indicating that insufficient air is available for the effective combustion of the fuel delivered, the pressure responsive unit 92 functions to thrust the lower arm of the boost rack control lever 71 against the plate 69, thereby to limit the travel of the control rod in its fuel increasing direction and to limit the amount of fuel which can be delivered to the engine under such condition. When the engine speeds up to deliver air at a requisite rate thereto, the lower arm of the lever 71 is removed from

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cooperation with the plate 69. As above mentioned, the torque back-up capsule 66 permits the stop 65 to yield from its normal extended position so as to deliver additional fuel to the engine as demanded by the engine speed for a given position of the throttle lever 23.

The fuel pump controlling mechanism of the present invention is particularly characterized by its simplicity and dependability. As will be apparent in FIG. 2, the slide 45 is slidably supported at widely spaced axes adjacent its respective side edges, at one such edge by rod 49 and sleeve 47 and at the other edge of the control rod 20 within the slot 46 in the slide. Such mounting of the slide insures its smooth and easy reciprocation by the sleeve 32. The arm 61 of the maximum fuel stop lever 62 engages the wing 59 on link 54 at a location which is close to the line of thrust imposed upon the lever 62 by the lever 39 acting through links 50 and 54. Thus there is no tendency for the slide 45 to be tipped or canted by the thrust of lever 39 even when the wing 59 is thrust forwardly with a substantial force, as when the links 50, 54 is thrust by the throttle spring into torque back-up position. The above described rounding of the upper and lower surfaces of the slot 46 in the slide 45 insures that the control rod 20 will be free for movement relative to slide 45 despite some tipping of the slide in the place of the paper in FIG. 1.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be expressly understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art.

The embodiments of the invention in which an exclusive property, or privilege, is claimed are defined as follows:

1. A fuel injection pump having a reciprocable fuel control rod, a movable member acted upon by an engine governor in opposition to a throttle tensioned spring, and means connecting the movable member to the control rod so that under normal engine running conditions the position of the control rod is controlled by the movable member, the connecting means comprising a slide reciprocable parallel to and relative to the control rod and positively connected to the movable member to be reciprocated thereby, stop means on the control rod and slide to determine the terminal position of the control rod relative to the slide in a fuel increasing direction and yieldable means constantly urging the control rod toward such terminal position, a maximum fuel stop member disposed in the path of and engageable by a portion of said slide to limit the travel of the slide and control rod in the fuel increasing direction by said movable member to a predetermined maximum fuel position during normal engine operation, and a fuel shut-off lever which selectively engages a part of the control rod to move the control rod against the opposition of the yieldable means in its fuel shut-off direction relative to the slide.

2. A pump according to claim 1 wherein the maximum fuel stop member and the portion of said connecting means which engages the same are disposed substantially in a plane containing the line of thrust imposed upon the slide by the means which connects the slide to the movable member.

3. A pump according to claim 2, comprising an abutment engaged by the maximum fuel stop member when the slide and control rod are in their normal maximum fuel positions, said abutment being yieldable under increased throttle spring pressure imposed upon the connecting means to provide the pump with a torque back-up function.

4. A pump according to claim 1, comprising a boost rack control member disposed in the path of and selectively engaging a portion of the control rod to move the

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control rod against the opposition of said yieldable means in its fuel shut-off direction relative to the slide, and means responsive to the intake air pressure of the engine to actuate the boost rack control member to move the control rod in its fuel shut-off direction when the pressure of such intake air is less than a predetermined minimum value.

5 5. A pump according to claim 4 wherein the maximum fuel stop member and the boost rack control member are levers, and comprising a shaft disposed transversely of the control rod mounting the maximum fuel stop and boost rack control levers, and means for selectively moving such levers out of the paths of said portions of said connecting means and control rod, respectively, so that the control rod may be moved to an excess fuel position when the engine is to be started.

10 6. A pump according to claim 1, wherein the slide is of substantial length in a direction transversely to the length of the control rod, the means positively connecting the movable member to the slide is connected to the

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slide generally centrally of the length of the slide, and the slide is slidably and guidingly mounted upon the control rod adjacent one end of the slide, and comprising means disposed adjacent the other end of the slide for guiding such other end for movement parallel to the path of reciprocation of the control rod.

7. A pump according to claim 6 wherein the maximum fuel stop member and the portion of said connecting means which engages the same are disposed generally centrally of the slide and substantially in a plane containing the line of thrust imposed upon the slide by the means which connects the slide to the movable member.

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