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(54) CONTROL DEVICE FOR DIESEL FUEL-INJECTION INTERNAL COMBUSTION ENGINES

(71) We, ROBERT BOSCH GMBH, a German Company of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a control device for a diesel fuel-injection internal combustion engine, and more particularly to a control device for a fuel injection pump in such engines.

A control device is already known whose adjusting member displaces a regulating rod of the injection pump from its position controlling the maximum fuel quantity into its zero fuel delivery position under the influence or pressure of fuel which is flowing back from the injection pump and whose outflow is shut off by a solenoid valve. The position of the adjusting member, assumed when the solenoid valve is not actuated, determines the either starting quantity or the full load quantity of the injection pump, by determining the position of the regulating rod which acts as a delivery quantity adjusting member and which can be displaced from this position only into the stop or zero fuel delivery position, an intermediate position not being possible by virtue of the control device, but only by the influence of the governor.

Fuel injection pumps have also already been proposed in which, in addition to a control device determining the starting quantity and stop position, an electromagnetically operable reduced quantity stop intervenes in the governor of the injection pump by means of corresponding actuating members and urges the regulating rod from its full load position back into the desired reduced quantity position. An additional device of this type is very expensive and must be arranged so as not to obstruct the shut-off movement of the control device and requires the associated speed governor to be special construction.

In accordance with this invention there is provided a control device for a diesel fuel injection internal combustion engine, which device comprising a hydraulically-operated adjusting member constituting a fuel quantity limiting abutment for a governor controlled fuel quantity regulating rod of a fuel injection pump, a first solenoid-operated valve controlling a supply of hydraulic medium to an admission chamber associated with the adjusting member, and allowing the medium to exhaust when the solenoid is energised so that the abutment adopts a retracted position allowing the rod to be moved to a full maximum fuel delivery position but retaining the medium in the chamber when de-energised, whereby the adjusting member is displaced from its retracted position towards an abutment position in which the rod is moved into a zero fuel delivery position, and a second solenoid device adapted on actuation to limit the movement of the adjusting member from its retracted position, whereby the adjusting member provides an abutment for an intermediate or reduced maximum fuel delivery position for the rod.

In contrast to the prior constructions therefore, the control device in accordance with the invention has an advantage that, in addition to the starting or full load and stop position of the regulating rod, an intermediate position of the control member can be controlled and acts either as a normal full load or reduced quantity abutment for the delivery quantity adjusting member of the injection pump. Since the control member of the second solenoid also acts upon the adjusting member of the control device, no additional components are required and it is possible to obtain a compact type of construction. The function and the type of construction of the associated speed governor is in no way influenced or impaired when this control device is fitted to the side of the injection pump remote from the governor.

The invention is further described hereinafter, by way of example, with reference to the accompanying drawings, in which:–

Fig. 1 is a simplified section of a first embodiment of a control device according to the present invention fitted to an injection pump;

Fig. 2 is a longitudinal section, through a second embodiment, taken on the line II-II of Fig. 3;

Fig. 3 is a fragmentary plan view of the embodiment shown in Fig. 2, taken on the line III-III of Fig. 2;

Fig. 4 is a detail of Fig. 2 shown to a larger scale;

Fig. 5 is a longitudinal section through a third embodiment of this invention; and

Fig. 6 is a similar section through a fourth embodiment of this invention.

The first embodiment illustrated in Fig. 1 shows a control device 11 which is fitted to a fuel injection pump 10 and whose housing 12 is bolted to a housing 14 of the injection pump 10 in alignment with a regulating rod 13, which acts as a fuel delivery quantity adjusting member of the injection pump 10. The housing 12 has a cylindrical bore 15 which accommodates an adjusting piston 16 of an adjusting member 17. The adjusting piston 16 and the housing 12 define an admission chamber 18 which is formed by a portion of the cylindrical bore 15 and to which is admitted fuel acting as an hydraulic medium. This fuel flows from a suction chamber 22 of the injection pump 10 to the admission chamber 18 by way of an overflow valve 19 and a feed line 21. The feed line 21 incorporates a solenoid valve 23 whose control valve spool 24, which acts as a valve member, is urged into its illustrated position by a return spring 26. In this position the control valve spool 24 shuts off communication between the feed line 21 and a return-flow line 27. When a solenoid 25 of valve 23 is energised, the control valve spool 24 is depressed downwardly against the force of the return spring 26 and opens an annular groove 28 to the line 27. The feed line 21 then communicates, via the return-flow line 27, with a tank 29 which acts as a non-pressurized chamber of the entire apparatus. When the control valve spool 24 is in the depressed position (not illustrated), fuel overflowing from the suction chamber 22 of the injection pump 10 flows into the tank 29. Furthermore, a compression spring 31, which constitutes a restoring means for the piston 16 and which acts, in this embodiment, between the housing 12 of the control device 11 and one end of member 17, displaces the adjusting member 17 into its extreme left-hand position (as viewed) whereby fuel from the chamber 18 also flows to the tank 29 and the maximum possible stroke of the regulating rod 13 is permitted. The adjusting member 17 maintains this position when the engine is not running and when the injection pump 10 is non-pressurized.

A stop pin 33 is secured in position in a bore 32 in the adjusting piston 16 and the end face 34 of member 17 remote from the admission chamber 18 acts as an abutment for the regulating rod 13 of the injection pump 10. A sealing ring 35, inserted into an annular groove of the stop pin 33, seals the bore 32 in the adjusting piston 16, and thus the admission chamber 18 from a chamber 30 which accommodates the compression spring 31. Furthermore, this stop pin 33 is provided with a spring abutment plate 36 for the compression spring 31, and is screwed by means of a screw-threaded portion 33*a* into the adjusting piston 16 so as to be adjustable within a limited range and is secured in the adjusted position by means of a lock nut 37. The range of adjustment of the stop pin 33 is dependent, on the one hand, upon the spring abutment plate 36 which is limited in its movement by the piston 16 and, on the other hand, upon a disc 38, which is attached to the screw threaded portion 33*a* by a screw 39, and which is limited in its movement by the lock nut 37.

A control member, in the form of a sliding stop 41 of a second solenoid 42, is mounted in the housing 12 so as to be displaceable at right angles to the longitudinal axis of the adjusting piston 16 against a restoring force of a spring 43. The stop 41 is actuable against the spring 43 by the solenoid 42 and, when the solenoid is switched off, only extends to a level substantially equal to that of a flat portion 44*a*, which is part of a longitudinal groove 44 in piston 16. When in the position illustrated in Fig. 1, the stop 41 serves only to secure the adjusting piston 16 against rotation. However, when the solenoid 42 is energised, the stop 41 is projected further into the longitudinal groove 44, against the force of the spring 43, and co-operates with a shoulder 45 of the longitudinal groove 44 incorporated in the outer surface of the adjusting piston 16. The shoulder 45 is located at the transition from the longitudinal groove 44 to its flat portion 44*a* and, together with the stop 41, acts as a reduced quantity limiting stop when the adjusting piston 16 is arrested by the abutment of the shoulder 45 against the stop 41. This occurs when the admission chamber 18 is subjected to fuel pressure and the shut-off movement is thereby effected against the force of the compression spring 31, so that the end face 34 of the stop pin 33 prevents movement of the regulating rod 13 beyond the position thereby established.

If the governor of the injection pump 10 has no means for limiting the full load position, the reduced quantity stop, essentially comprising the stop 41, the solenoid 42 and the shoulder 45, may constitute a full load stop.

The fuel injection pump is equipped with a feed pump 46 which, when the injection pump is operating, draws fuel from the tank 29 by way of a filter 48 and a suction line 47 and feeds it to the suction chamber 22 by means of a feed line 49.

The second embodiment of a control device 11', iilustrated in Figs. 2 to 4, continues a practical embodiment of the control device 11 illustrated in a simple form in Fig. 1, the same parts therefore being provided with the same reference numerals and different parts being provided with an index mark.

Thus, in contrast to the valve spool 24 of the first embodiment of Fig. 1, a valve spool 24' of the control device 11' accommodates in a longitudinal bore 51 of the latter a safety and overflow valve 52, as can be clearly seen from the enlarged illustration of the valve spool 24' in Fig. 4. When the valve spool 24' is in any position, the annular pressure surface 53 of the safety and overflow valve 52 is subjected to the feed pump pressure of the fuel flowing from the suction chamber 22 of the injection pump 10 into the feed line 21 by way of the overflow valve 19. This pressure surface 53 communicates, by way of bores 54 in the wall of the valve spool 24', with the annular groove 28 which is incorporated in a bore 55, accommodating the valve spool 24', and which is to be regarded as a portion of the feed line 21.

The admission chamber 18, in the form of a portion of the cylindrical bore 15, is externally closed in a pressure-tight manner by means of a closure screw 56, and the adjusting member 17' has an adjusting piston 16' whose periphery incorporates an annular groove 57 which acts as a recess and whose boundary nearer to the admission chamber 18 forms a shoulder 58 which, together with the stop 41 of the second solenoid 42, acts as a reduced quantity stop (see Fig. 3).

The stop pin screwed into the adjusting piston 16' is designed 33' and carries at the end of its screw-threaded portion 33a' a spring ring 59 acting as a member for limiting the change in the relative positions of the stop pin 33' and the adjusting piston 16'. The lock nut securing the adjusted position of the stop pin 33' in the adjusting piston 16' is designated 37' and is in the form of a sleeve and, when in the illustrated position, abuts against the closure screw 56 under the force of the compression spring 31.

In contrast to the position illustrated in Fig. 1, the stop 41 of Fig. 3 is in the projected position which it assumes when the second solenoid 42 is switched on. Thus, it extends into the recess 57 and, when the admission chamber 18 is pressurized, limits the stroke of the adjusting piston 16' to an amount of travel after which the adjusting member 17' acts as a reduced quantity abutment for the regulating rod 13 of the injection pump 10.

The third embodiment illustrated in Fig. 5 comprises a control device 61 which accommodates, in a housing 62 and coaxially of the regulating rod 13, a cylindrical sleeve 63. The sleeve 63 is adjustable in the direction of the longitudinal axis and is screwed into the housing 62. It is fixable in its predetermined position by means of a lock nut 64. A groove 65, for receiving a screw driver, is incorporated in the end face of the cylindrical sleeve 63 outside the housing 62. A cylindrical bore 66 in the cylindrical sleeve 63 receives an adjusting piston 67 which, together with an adjusting diaphragm 68, forms part of an adjusting member designated 69. In contrast to the two embodiments previously described with reference to Figs. 1 and 2 to 4, an admission chamber 71 of the adjusting member 69 in the third embodiment of Fig. 5 is of two-part construction and comprises a piston chamber 72 and a diaphragm chamber 73 which communicate with one another by way of a bore 74 within the adjusting piston 67. The fuel flowing from the suction chamber 22 of the injection pump 10 by way of the overflow valve 19 is fed to the admission chamber 71 by way of the feed line 21 and acts upon the adjusting member 69 when, as is illustrated in Fig. 5, the solenoid valve 23" (shown diagrammatically) prevents the fuel from flowing from the admission chamber 71 to the tank 29 by way of the outlet line 27.

A second solenoid valve 77 provided with a second solenoid 76 is incorporated in a return-flow line 75 and its valve member 78, acting as a control member, is displaceable by the solenoid 76 to open the flow-through cross section of the return-flow line 75. Referring to Fig. 5, the valve member 78 is shown in a position in which the return-flow line 75 is open. When the outlet line 27 is at the same time closed by the solenoid valve 23", the fuel flowing to the admission chamber 71 has to flow off to the tank 29 by way of the return-flow line 75. In order to flow to the line 75 the pressure of the fuel must first move the adjusting piston 67 to the right into the illustrated position, against the force of the compression spring 31. When in this position the piston opens the way to the line 75 by the separation of an end face 79 of the piston from a control edge 79*a* of the bore 66. Fuel can then flow through the annular gap produced and flow via an annular groove 81 to the line 75 and hence to the tank 29. Furthermore, it is in this position that the adjusting member 69 forms an hydraulically positioned abutment for a reduced quantity or full load position of the regulating rod 13 of the injection pump 10.

After the lock nut 64 has been loosened, the cylindrical sleeve 63 can be adjusted within the housing 62 for the purpose of adjusting this full load or reduced quantity abutment position of the adjusting member 69.

As in the previous embodiment, fuel is fed into the suction chamber 22 of the injection pump 10 by means of the feed pump 46 which is driven together with the injection pump 10 and which is provided with a pressure-limiting valve 82 for the purpose of limiting the pressure occurring in the suction chamber 22. The two solenoid valves 23″ and 77 are only shown by their switching symbols in the drawings and, it will be appreciated, may be fitted into the housing 62 of the control device 61 in a practical embodiment. In the event of installation difficulties, it will be appreciated that it is also possible to fit these valves at any other desired location in the lines 27 and 75.

The fourth embodiment illustrated in Fig. 6 differs only slightly from the third embodiment illustrated in Fig. 5. In this fourth embodiment only one other control line 91 is connected to the piston chamber 72 of the admission chamber 71 in addition to the return flow line 75. This line 91 is controlled by a three-port, two-position solenoid valve 23‴. In a first switching position the line 91 is simultaneously connected to both the line 21 from the suction chamber 22 of the injection pump 10 and the outflow line 27. In this way the admission chamber 71 can be relieved of pressure and fuel flowing from the suction chamber 22 can flow directly to the tank 29. In a second switching position of the valve 23‴ the line 91 only is connected to the line 21 so that the adjusting piston 67 can function in the manner previously described for the third embodiment of Fig. 5. Because the feed pump 46 is provided with a pressure-limiting valve 82, communication between the control line 91 and the feed line 21 could also be shut off upon the control line 91 being connected to the outflow line 27. If the control line 91 were directly connected to the feed line 21, the solenoid valve 23‴, like the solenoid valve 77, could be in the form of a two-port, two-position valve although, nevertheless, it still functions like the three-port, two-position valve illustrated in Fig. 6.

The mode of operation of the embodiments described previously will be described hereinafter:

In the first embodiment illustrated in Fig. 1, initially the two solenoids 25 and 42 are non-energized, the injection pump 10 is stationary, the suction chamber 22 is non-pressurized, and fuel in the admission chamber 18 has leaked to the outflow line 27 via a leakage location (not shown) which exists by virtue of the clearance between the valve spool 24 and the bore which receives it. The compression spring 31 has moved the adjusting piston 16 to the left into its illustrated position in which the end face 34 of the adjusting member 17 forms an abutment for the maximum possible position of the regulating rod 13. In this position, either the full load delivery quantity or, alternatively, an excess quantity required for starting the engine, can be delivered by the fuel injection pump 10. When the solenoid 25, alternatively designated "starting solenoid", of the solenoid valve 23 is energized, the valve spool 24 is projected downwardly against the force of the return spring 26 and connects the admission chamber 18 to the outflow line 27 by way of the annular groove 28, so that the fuel flowing in from the suction chamber 22 when the pump is running can immediately flow back into the tank 29, and any fuel still present in the admission chamber 18 also flows off.

The solenoid 25 of the solenoid valve 23 remains energised during travelling operation and the adjusting member 17 remains in its illustrated position, although the governor 9 withdraws the regulating rod 13 from its illustrated position into a full load position (not illustrated) wherein its end face is spaced from face 34 which is determined by means of a stop (not illustrated) within the governor 9.

If the engine is to be stopped, the supply of current to the solenoid 25 is interrupted and the valve spool 24 of the solenoid valve 23 returns to its position illustrated in Fig. 1, whereby the outflow line 27 is shut off and the admission chamber 18 is pressurized. The adjusting member 17 provided with the adjusting piston 16 thereby moves to the right, as viewed in the drawing, against the force of the spring 31 and urges the regulating rod 13 of the injection pump 10 into its zero fuel delivery position in which the injection pump 10 no longer delivers fuel and the engine thus stops.

This shut-off movement is also initiated when the supply of current to the solenoid 25 is unintentionally interrupted by a fault in the electrical system.

If, in the case of the motor being operated to drive the vehicle with the solenoid 25 switched on, it is desired to limit the full load fuel quantity to a lower valve by providing an intermediate stop for the regulating rod this is achieved by displacing the adjusting member 17 to its reduced quantity stop position by energising the solenoid 42 and de-energising the solenoid 25. The solenoid 42 displaces the stop 41 into the recess 44 in the adjusting piston 16. Then the adjusting member 17, acting as an abutment for the regulating rod 13, moves to the right (as viewed) until its shoulder 44*a* abuts against the stop 41. In this manner, an arbitrarily controllable reduced quantity position of the abutment for the governor-controlled regulating rod 13 can be established. If the solenoid 42 should fail owing to a fault in the electrical system, the shut-off movement of the adjusting piston 16, already described, is effected, member 17 moves to the extreme right (as viewed) against spring 31 and the engine stops.

This control device 11 also constitutes an anti-theft device since, when the electrical system is not switched on, the control device 11 moves the regulating rod 13 in the "stop" direction should the vehicle be rolled forward in an attempt to push-start the engine.

The control device 11′ of the second embodiment illustrated in Figs. 2 to 4 operates in the same manner as the control device 11 illustrated in Fig. 1. However, the control valve spool 24′ is additionally provided with a safety and overflow valve 52 which is intended to prevent overloading of the adjusting piston 16′. A valve of this type is primarily necessary when the feed pump of the injection pump 10 does not have an individual pressure-limiting valve. Since the adjusting piston 16 or 16′, (designated a "shut-off piston") of the two embodiments of Figs. 1 and 2 to 4, acts as a reduced quantity or intermediate stop by virtue of the fact that it co-operates with the stop 41 of the second solenoid 42, the control device is constructed in a very compact and space-saving manner. Referring to Fig. 3, the stop 41 is illustrated in a position which it assumes to define the reduced quantity or intermediate position when the solenoid 42 is energised.

In contrast to the embodiments described hitherto, in the third embodiment of Fig. 5, the position of the adjusting member 69 is hydraulically controlled. This position is illustrated in Fig. 5 in which the solenoid valve 23″ is de-energized and in a position in which it shuts off the flow of fuel from the admission chamber 71 to the outflow line 27, and the second solenoid valve 77 is illustrated in the position in which, when the solenoid 76 is energized, the valve member 78 keeps the flow-through cross section of the return-flow line 75 open. The fuel flowing off by way of the control point, formed by the annular groove 81 and the control shoulder 79*a* maintains the adjusting piston 67, and thus the adjusting member 69, in their positions determining the reduced quantity position of the abutment for the regulating rod 13 of the injection pump 10. When the solenoid 76 of the solenoid valve 77 is de-energized, the return-flow line 75 is shut off and the adjusting member 69 moves further in the fuel cut-off direction and thus displaces the regulating rod 13 into its zero fuel delivery position.

In order to start the engine, and also when the engine is running, the solenoid valve 77 remains de-energized and the solenoid valve 23″ is energized whereupon it assumes a position in which the outflow line 27 is connected to the admission chamber 71.

The fourth embodiment illustrated in Fig. 6 is shown in the same operating position, determining the reduced quantity position of the abutment for the regulating rod 13, as is shown in Fig. 5. The second solenoid valve 77 keeps the return-flow line 75 open, and the first solenoid valve 23‴ shuts off communication between the admission chamber 71 and the outflow line 27. The differing arrangement of the corresponding lines and the construction of the first solenoid valve 23‴, has already been described in detail above.

In all the four embodiments illustrated, the fuel returning to the tank 29 from the suction chamber 22 of the fuel injection pump 10 acts as hydraulic medium for the control device in accordance with the invention. It will be appreciated that, alternatively, all the embodiments may be operated by the lubricating oil pump of the engine or by oil pressurized by a separate source of pressure. The adjusting diaphragm 68 used in the embodiments of Figs. 5 and 6 may also be used in combination with the adjusting piston 16 and 16′ of the first two embodiments of Figs. 1 and 2 to 4, if this should be advantageous owing to the forces required or if it is desired to improve sealing towards the pump.

WHAT WE CLAIM IS:–

1. A control device for a diesel fuel injection internal combustion engine, which device comprises a hydraulically-operated adjusting member constituting a fuel quantity limiting abutment for a governor controlled fuel quantity regulating rod of a fuel injection pump, a first solenoid-operated valve controlling a supply of hydraulic medium to an admission chamber associated with the adjusting member, and allowing the medium to exhaust when the solenoid is energised so that the abutment adopts a retracted position allowing the rod to be moved to a full maximum fuel delivery position but retaining the medium in the chamber when de-energised, whereby the adjusting member is displaced from its retracted position towards an abutment position in which the rod is moved into a zero fuel delivery position, and a second solenoid device adapted on actuation to limit the movement of the adjusting member from its retracted position, whereby the adjusting member provides an abutment for an intermediate or reduced maximum fuel delivery position for the rod.

2. A control device as claimed in claim 1 adapted to receive fuel as the hydraulic medium.

3. A control device as claimed in claim 1 or 2, in which the adjusting member comprises an adjusting piston and in which the second solenoid device has a stop, which is arranged substantially perpendicularly to the longitudinal axis of the adjusting piston and which is selectively actuable to engage a shoulder of a groove which is incorporated in an outer surface of the adjusting piston.

4. A control device as claimed in claim 3, in which the stop when retracted is engageable with a flat portion of the groove thereby preventing rotation of the adjusting piston but permitting longitudinal movement thereof to its retracted position.

5. A control device as claimed in claim 3 or 4, in which a stop pin is positioned in a bore of the adjusting piston and its end face, which is remote from the admission chamber, acts as the abutment for the fuel quantity regulating rod of the injection pump, the stop pin being sealed relative to the adjusting piston.

6. A control device as claimed in claim 5, in which the stop pin is provided with a spring abutment plate which acts as an abutment for a compression spring which supplies a restoring force urging the adjusting member into its retracted position.

7. A control device as claimed in claim 5 or 6, in which the stop pin is adjustably screwed into the adjusting piston by means of a screw-threaded portion and is secured by means of a lock nut.

8. A control device as claimed in claim 7, in which the range of adjustment of the stop pin relative to the adjusting piston is determined on the one hand by the distance between the adjusting piston and the spring abutment plate, and, on the other hand, by limiting member secured to the end of the screw-threaded portion which is remote from the spring abutment plate.

9. A control device as claimed in any preceding claim, in which the valve member, of the first solenoid valve, is in the form of a valve spool which comprises, in a longitudinal bore connected to an outflow line, which leads to the exhaust, a safety and overflow valve which, when the valve spool is in any position, has its pressure side connected to an inlet line adapted to receive hydraulic medium under pressure and which leads to the admission chamber.

10. A control device as claimed in claim 1 or 2, in which the adjusting member comprises an adjusting piston and in which the second solenoid device comprises a second solenoid valve having a second valve member which controls the flow-through cross section of a return-flow line which is openable by a control shoulder on the adjusting piston and which opens into the wall of the admission chamber and constitutes the connection between the latter and exhaust, said second valve member being displaceable by a solenoid of the second solenoid device.

11. A control device as claimed in claim 10, in which the relative position between the control shoulder on the adjusting piston and a region at which the return-flow line opens into the admission chamber is adjustable for the purpose of determining the intermediate abutment position of the adjusting member.

12. A control device as claimed in claim 11, in which the admission chamber is formed by a cylindrical bore, which accommodates the adjusting piston, and which is formed in a cylindrical sleeve which is longitudinally displaceable within a housing of the control device.

13. A control device as claimed in claim 12, in which the cylindrical sleeve has a part which is accessible from the outside of the housing and which is provided for engagement by an adjusting tool and which is lockable in an adjusted position by securing means.

14. A control device as claimed in any of claims 10 to 13, in which a control line, which serves for both the inflow and outflow of the hydraulic medium to and from the admission chamber, is connected to the latter, in addition to the return-flow line which is controlled by the second solenoid valve, and, by means of the first solenoid valve, which is a three-port, two position-valve, is connectible to an outflow line leading to exhaust when the first solenoid valve is in one switching position and, when the first solenoid valve is in its other switching position, is connectible to an inlet line for receiving hydraulic medium under pressure.

15. A control device as claimed in any of claims 3 to 14, in which the adjusting member has an adjusting diaphragm which is connected to the adjusting piston and which has a larger diameter than the latter and which is also operable by the pressure in the admission chamber.

16. A control device substantially as hereinbefore described with reference to and as illustrated in Fig. 1 of the accompanying drawings.

17. A control device substantially as hereinbefore described with reference to and as illustrated in Figs. 2 to 4 of the accompanying drawings.

18. A control device substantially as hereinbefore described with reference to and as illustrated in Fig. 5 of the accompanying drawings.

19. A control device substantially as hereinbefore described with reference to and as illustrated in Fig. 6 of the accompanying drawings.

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Fig.1

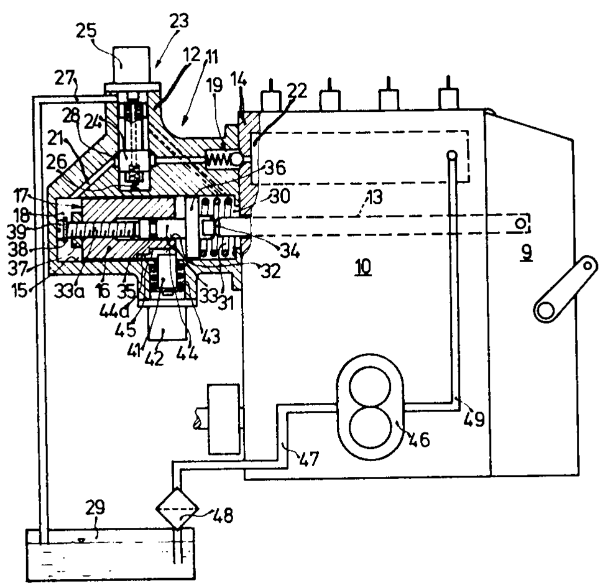
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Fig.2

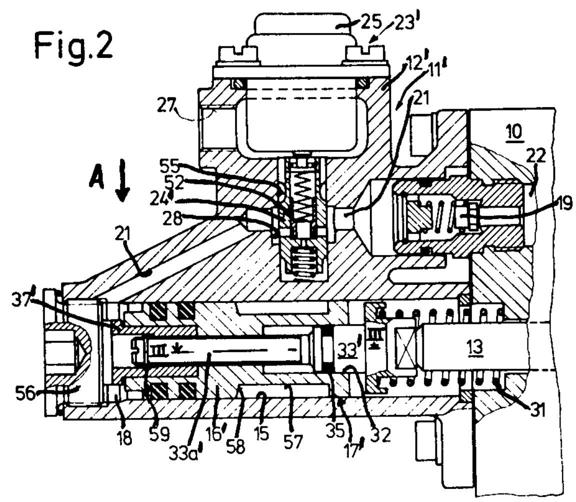
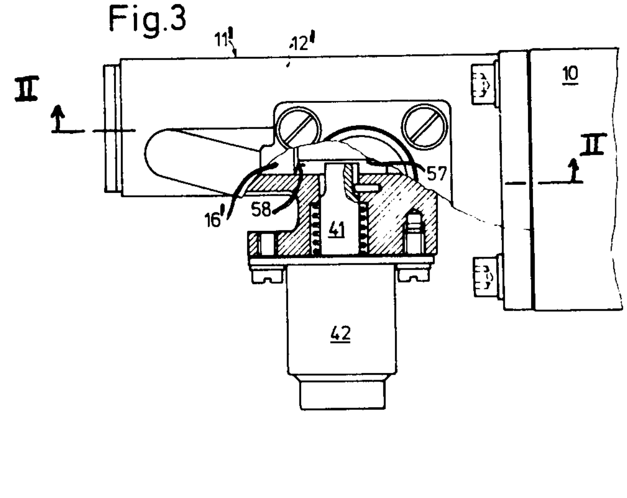


Fig.3



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Sheet 3

Fig. 4

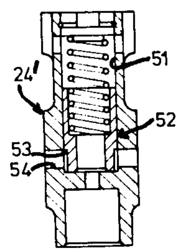
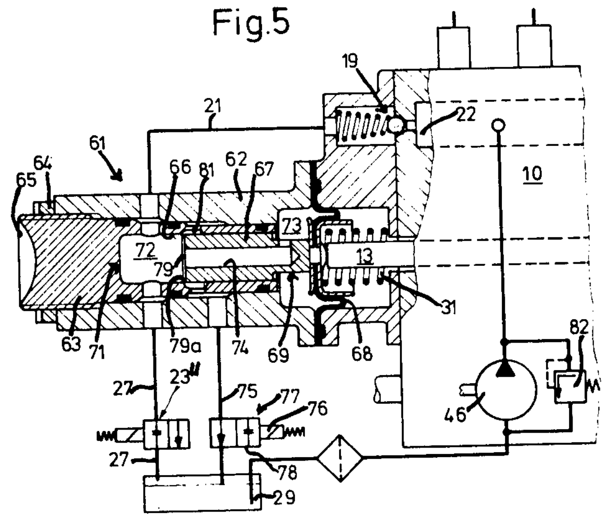


Fig. 5



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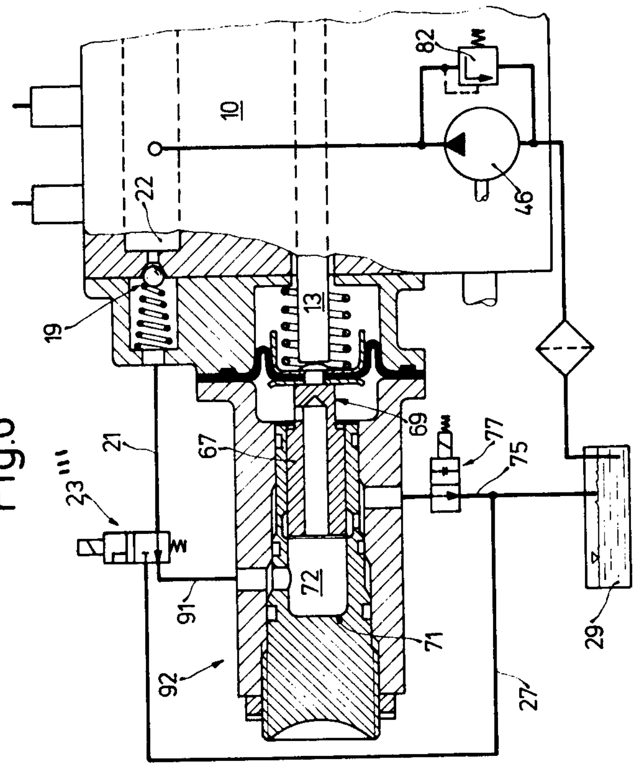

Fig.6