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54 **Pumping apparatus.**

57 A pumping apparatus for supplying fuel to a compression ignition engine includes a body which is formed in three portions, the first portion 55 defining a projection 54 which extends into an opening 53 formed in the second portion 51. The projection houses a bore 12 in which is located a pumping plunger 11 the actuating mechanism of which is housed in the third body portion. Also actuated by the mechanism is a rotary distributor 16 housed in the second body portion 51 and located in the first body portion is an electromagnetically operable spill valve 38.

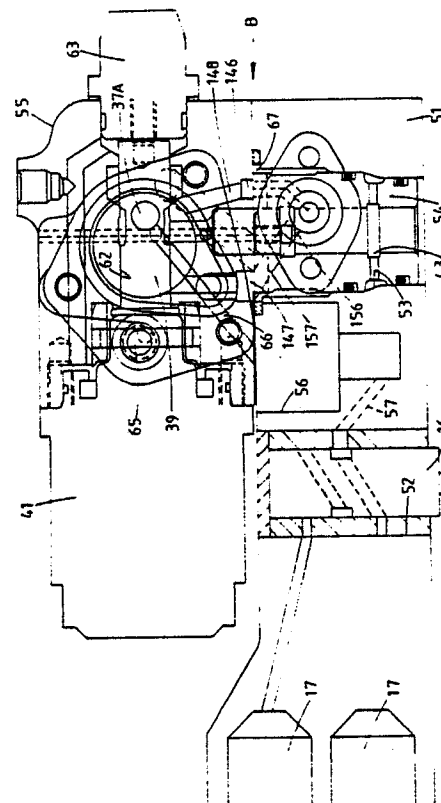


FIG 3

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"PUMPING APPARATUS"

This invention relates to a fuel injection pumping apparatus of the kind comprising a body, a fixed stroke reciprocable pump plunger housed within a bore in the body with the bore and the plunger defining a pump chamber, a distributor member which distributes fuel expelled from the pump chamber during successive pumping strokes of the plunger to a plurality of outlet ports in turn, an electromagnetically operable spill valve operable to divert fuel expelled from the pumping chamber to a drain so as to enable the amount of fuel delivered through said outlets to be controlled, a low pressure pump for supplying fuel to the pumping chamber and valve means operable in the event of failure of the control system which controls the valve, to permit the apparatus to continue to supply fuel to an associated engine.

An apparatus of the aforesaid kind is described in British Published Specification 2153017A. The apparatus is intended to supply fuel to the combustion chambers of a compression ignition engine. Modern compression ignition engines operate at increasingly higher speeds and require precise fuel quantity and timing control to enable them to comply with strict exhaust emission regulations. The precise fuel quantity and timing control is provided by the use of the electromagnetically operable spill valve and the associated electronic control system. The higher engine speeds and the need for improved atomisation of the fuel to ensure better combustion of the fuel require high injection pressures. The high injection pressures can lead to increased leakage within the apparatus particularly where a passage conveying the high pressure fuel traverses an interface between two parts of the apparatus. The use of increased clamping forces between the aforesaid parts can cause distortion of the parts with the result that excessive wear of moving parts of the apparatus can occur with the possibility of increasing leakage in other parts of the apparatus.

The present invention is concerned with an apparatus of the kind specified and has for its object to provide such an apparatus in a simple and convenient form.

According to the invention an apparatus of the kind specified is characterized in that the body is formed in three portions which are secured together in assembled relationship, the first portion of the body having a projection which locates within an opening formed in the second portion of the body, said projection being formed with the bore which accommodates the plunger, the distributor member being mounted in a further opening in the second body portion, drive means for the plunger

and distributor member being housed within the third body portion, said spill valve including a valve member slidable within a bore formed in the first body portion and said valve means being positioned within the second body portion.

In the accompanying drawings:-

Figure 1 is a diagrammatic representation of the fuel circuit of the pumping apparatus.

Figure 2 is a plan view of part of the apparatus.

Figure 3 is a side view in the direction of the arrow A of Figure 2.

Figure 4 is a side view in the direction of the arrow B of Figure 3.

Figure 5 is a view in the direction of the arrow C of Figure 2.

Figure 6 is a view of part of the apparatus seen in Figures 2, 4 and 5.

Figures 7 and 8 show a linkage connecting parts of the apparatus, and

Figures 9, 10 and 11 show settings of a valve forming part of the apparatus.

Referring firstly to Figure 1 of the drawings the apparatus comprises a high pressure fuel injection pump generally indicated at 10 and including a plunger 11 reciprocable in a bore 12 which has an outlet passage 13 connected by way of a spring loaded delivery valve 14 to a fuel distributor generally indicated at 15 and which includes a rotary distributor member 16. The distributor member distributes fuel delivered during successive inward movements of the pumping plunger, to a number of outlets 17 in turn the outlets being connected to the fuel injection nozzles respectively of an associated engine.

The plunger 11 is connected to a tappet mechanism indicated at 18 and is driven upwardly by means of a cam 19 mounted on a drive shaft 20. It is driven downwardly by a lever and further tappet mechanism (not shown) which is also actuated by the cam. The plunger therefore is of the fixed stroke type. The drive shaft also carries a bevel gear 21 which meshes with a further bevel gear 22 coupled to the distributor member 16 and the drive shaft is driven in timed relationship with the associated engine. The shaft of which the distributor member forms part, carries the rotor 23 of a low pressure fuel supply pump having an inlet 24 and an outlet 25. The inlet in use is connected to a source of fuel and the outlet communicates with a fuel reservoir generally indicated at 26 and which comprises a piston 27 which is slidably mounted within a cylinder 28 and the piston is biased towards one end of the cylinder by means of a spring 29. In the wall of the cylinder is a port 30

which is uncovered by the piston when the latter has moved a predetermined distance against the action of the spring. The port 30 communicates with the inlet 24 of the low pressure pump and the piston acts to control the output pressure of the pump. The end of the cylinder 28 containing the spring 29 also communicates with the inlet 24.

Formed in the wall of the bore 12 is a plurality of ports 33A which communicate with an annular space 33 and these can constitute a fuel inlet for the high pressure pump. The space 33 communicates by way of passage means 34 with the reservoir 26 and a valve 35 which is to be described, controls the flow of fuel through the passage means 34. The reservoir 26 communicates by way of a passage 37, with a spill valve which is generally indicated at 38 and which includes a spring loaded valve member 39 having a head 40 which can engage with a seating when a solenoid device 41 associated with the valve is energised. The spring urges the head 40 away from the seating and in this position fuel can flow from the passage 13 to the passage 37. As will be seen the outlet 25 of the low pressure pump is connected to the spill valve through a passage 25A. The passage 37 therefore also serves to convey fuel from the low pressure pump to the reservoir.

The plunger 11 when at its maximum outward position as determined by the cam 19, uncovers the ports 33A to the pumping chamber defined by the bore and the plunger. Assuming for the moment that the valve 35 is open and that the plunger is at the outermost limit of its stroke and with the pumping chamber full of fuel, as the drive shaft 20 rotates inward movement will be imparted to the plunger 11 and the ports 33A will be covered by the end of the plunger. The fuel in the pumping chamber is now displaced along the passage 13 and if the spill valve 38 is in the closed position, the fuel will be displaced past the delivery valve 14 to the distributor member 15 and then to an outlet 17. If during this displacement of fuel or before displacement commences, the spill valve 38 is opened, the displaced fuel will be diverted through the spill valve and it will be returned by way of the passage 37 to the reservoir 26. As a result no fuel will flow to the outlet 17. The spill valve can be operated at any time to determine the timing of fuel delivery and the quantity of fuel delivered. The plunger 11 is provided with a central passage 11A which forms a spill path opening to a groove formed on the periphery of the plunger at a position to be uncovered to a groove 42, before the end of the inward movement of the plunger. In normal use however the passage 11A is placed in communication with the groove 42 after the opening of the spill valve to terminate delivery of fuel, so that in normal use the flow of fuel along the

passage 11A from the pumping chamber will be insignificant. A leakage groove 43 is provided in the bore 12 and is connected to the fuel inlet 24. The spillage of fuel through the passage 11A takes place to the reservoir 26 by way of the valve 35.

The outward movement of the plunger is effected by the aforesaid further tappet mechanism and if the spill valve 38 remains in the open position, fuel can flow into the bore 12 by way of the spill valve through the passage 13, from the passages 37 and 25A. Some fuel will flow into the bore when the ports 33A are uncovered by the plunger and if the spill valve is closed during the outward movement of the plunger all the fuel will flow into the bore by way of the ports 33A, such flow taking place only when the ports are uncovered. The reservoir or accumulator 26 assists the low pressure pump in the filling of the bore 12 which in normal operation is completely filled with fuel prior to inward movement of the plunger taking place. The reservoir is recharged by the low pressure pump during the inward stroke of the plunger.

In the event of failure of the control system which powers the solenoid device 41 and/or the device itself, the spill valve 38 because of its spring loading will move to the open position and thereby no fuel can be supplied to the associated engine. The engine therefore is protected against overspeeding which could possibly cause damage thereto.

In order to enable a limited quantity of fuel to be supplied to the engine in an emergency situation, the aforementioned valve 35 is provided.

The valve 35 includes an angularly movable valve member 135 which is coupled directly to the throttle pedal of the vehicle which is driven by the engine so that irrespective of whether the control system or the spill valve are functioning correctly or not the valve member position depends upon the setting of the throttle pedal. As seen in Figure 1 the passage 34 extends through ports in the valve member 135 and the surrounding sleeve or body so that varying the angular setting of the valve member will vary the degree of registration of the ports and therefore the effective restriction of fuel flow. When the control system and the spill valve are operating correctly very little fuel flow occurs through the ports 33A into the bore 12 and so the setting of the valve member 135 will have little or no effect on the amount of fuel which is contained in the bore 12 at the end of the filling stroke. However, in the situation where the control system has failed, the spill valve 38 is moved by manual means to be explained, to the closed position so that all the fuel which flows into the bore 12 must flow through the valve 35 and in this case the setting of the valve 35 does determine the amount of fuel which flows into the bore 12 and hence the

amount of fuel which is supplied to the associated engine.

The valve 35 is also utilized to control fuel flow from the groove 42 to the reservoir, this flow of fuel taking place when the passage 11A in the plunger 11 is brought into communication with the groove 42 towards the end of the inward movement of the plunger. In addition, the valve 35 provides a variable flow path from the reservoir 26 to the inlet 24 of the low pressure pump this flow path including a fixed restrictor 136.

The actuation of the valve member 135 will now be described with reference to Figures 7 and 8 and with reference to Figure 7 the valve member 135 has a shaft 137 extending to the periphery of the apparatus to which is connected a lever 138. This lever is connected by a link 139 to one end of a further lever 140 which is pivotally mounted intermediate its ends on the exterior of the apparatus and has its other end connected to the throttle pedal 141 through a cable connection. A sensor (not shown) is provided which provides an electrical signal indicative of the position of the throttle pedal to the control system.

Mounted about the shaft 137 is a further lever 142 which is coupled by cable to a driver operable control 143. The further lever carries an adjustable stop 144 which can engage the lever 138 when the control 143 is moved to an operative position as shown in Figure 8. When the control is moved to the operative position the lever 142 moves the spill valve member to the closed position. Figures 7 and 8 show the throttle pedal in the foot off position and in Figure 7 the idling speed of the engine will be controlled by the control system. The effect of moving the control 143 to the operative position is to cause the stop 144 to engage the lever 138 and move the lever to an emergency engine idle position in which just sufficient fuel flow occurs through the valve 35 to the ports 33A to allow the engine to idle. The amount of fuel flowing is determined by the setting of the stop 144. As the throttle pedal is depressed the valve 35 will move to allow an increase in the fuel flow to the associated engine. The limit of movement of the lever 140 and hence the remaining levers connected thereto is determined by a stop 145. If with the parts set as shown in Figure 8, the control 143 is returned to the inoperative position the various levers will return to the position shown in Figure 7. This will allow the spill valve 38 to move to the open position so that no fuel will be supplied to the engine. However, in the event that the spill valve is closed due to some failure of the control system or failure within the valve or its actuating device, the valve 35 will operate to prevent flow of fuel to the bore 12 and hence to the engine. In normal operation with the levers set as shown in Figure 7 the idling of the

engine is controlled by the control system and stopping of the engine is achieved by switching off the power to the actuating device so that the spill valve remains in the open position.

In the emergency run condition with the spill valve 38 closed, the passage 11A forms a spill path from the pumping chamber when it is brought into communication with the groove 42. The practical effect of this is that for a given quantity of fuel to be delivered to the engine, delivery of fuel will take place earlier than would be the case if the same quantity of fuel were delivered but without spillage of fuel through the passage 11A. The earlier delivery of fuel means that the production of smoke by the engine will be minimised. However, more fuel must be supplied to the bore than is delivered through an outlet because of the spillage of fuel through the passage 11A which terminates fuel delivery.

The amount of fuel which is spilled through the passage 11A during normal operation is insignificant but in the emergency run situation it is arranged that the spillage of fuel is throttled by the action of the valve member 135. The degree of throttling is arranged to decrease as the valve member 135 is moved to increase the flow of fuel to the engine. The spillage of fuel is prevented when in normal operation, the throttle pedal is in the position shown in Figure 7 and it is required to start the associated engine. In this case the spill valve 38 is closed before the plunger 11 starts its upward movement and without any spillage of fuel the whole of the fuel displaced by the plunger is displaced through an outlet 17 so that an excess of fuel is delivered to the associated engine for starting purposes.

The valve 35 is also used to vary to a limited extent, the output pressure of the low pressure pump. For this purpose the valve controls the flow through the restrictor 136, from the reservoir 26 to the inlet 24 of the low pressure pump. The valve is such that the aforesaid flow starts to occur as the throttle pedal is depressed from the position shown in Figure 8. Although the valve continues to offer a reducing restriction to flow as the throttle pedal is depressed, the influence of the valve becomes progressively less because of the restrictor 136.

The combined effect of varying the spillage of fuel and the output pressure of the low pressure pump is to improve the control which can be effected by the driver when the vehicle is driven in the emergency run condition. It will be understood that when the engine is operated in the emergency run condition, its performance is limited. Nevertheless, it will be able to develop sufficient power to enable the vehicle to be moved.

It is important with the form of apparatus described to try to keep the volume of the passages

of the apparatus which carry fuel at high pressure as low as possible. This is to reduce the so-called "dead volume" of fuel. It is also important to try to minimise so far as is possible the number of seals which are subjected to the high pressure which is developed when the spill valve is closed and fuel is being delivered to the associated engine. Furthermore, since the apparatus is intended to deliver fuel at very high pressure it is important to ensure that carefully machined bores, etc. do not become distorted when the apparatus is assembled and the clamping bolts are tightened.

Figures 2-6 show a practical arrangement of two body portions of the apparatus which accommodate the passages and bores shown above the line 50 of Figure 1. With reference to Figures 2-6, the first body portion 51 defines spaced through openings 52, 53, the opening 52 serving to accommodate the distributor member 16 which is mounted in a sleeve, and the opening 53 serving to accommodate a cylindrical projection 54 which is integral with and extends from one side of the body portion 55.

The body portion 51 also defines in its upper surface a recess 56 which accommodates the delivery valve 14 and it also defines the outlets 17. As seen in Figure 2, the body portion is generally rectangular in plan and has bosses 57 which are apertured to receive clamping bolts whereby the body portion can be secured to a further body portion (not shown) of the apparatus and which houses the drive shaft 20, the cam mechanism and the drive for the distributor member, the further body portion being that which lies below the dotted line 50 in Figure 1. In addition the body portion 51 defines a cylindrical cavity 58 which is fitted with a sleeve 59 in which is located the valve member 135. The valve member extends to the exterior of the body portion and is retained in position by an apertured cap 60 which also carries an annular seal member.

The projection 54 of the body portion 55 locates in the opening 53 and grooves are formed in the projection to accommodate "O" ring seals. The bore 12 which accommodates the pumping plunger 11 is formed in the projection and the body portion is provided with apertures 61 which receive bolts whereby the body portion 55 can be secured to the upper surface of the portion 51. It will be noted that the apertures 61 are well spaced from the bore 12 in order to minimise the risk of distortion of the bore when the bolts are tightened.

The body portion 55 is provided with a cross bore 62 the axis of which is intersected by the axis of the bore 12 at right angles, the end of the bore 12 being connected by a drilling 13A forming the passage 13, with a point intermediate the ends of the cross bore 62. The cross bore 62 accom-

modates the spill valve member 39 and is machined to provide the seating for the head of the valve member 39. A position sensor 63 is mounted on the body portion 55, the sensor having a movable component which is secured to the valve member. Moreover, the actuator 41 is also carried on the body portion 55 and has its armature connected to the valve member.

Also formed in the body portion 55 is the cylinder 28 of the fuel reservoir or accumulator 26. The axis of the cylinder 28 is disposed at right angles to the axes of the bores 12 and 62 and the inner end of the cylinder is connected by a short drilling 37A which opens into the cross bore 62, the drilling constituting the aforesaid passage 37. The opposite end of the cylinder is closed by a cap 64 which is shaped to provide a bearing for an angularly movable shaft 65, located to one side of the cylinder 28 and extending inwardly as shown in Figure 2, to the actuator 41. The shaft 65 is coupled to the valve member 39 by mechanism not shown.

The fuel at high pressure which flows through the outlets is conveyed from the cross-bore 62 to the delivery valve chamber 56 by way of a passage 66 in the body portion 55 which opens onto the underface of the body portion 55 opposite the end of the chamber 56. At this point a seal ring (not shown) is provided to provide a high pressure seal. From the chamber 56 the fuel is conveyed by a passage 57 to a port in the sleeve which surrounds the distributor member. The sleeve is also provided with ports connected to the outlets 17 respectively.

The bore 12 is provided with the ports 33A as previously described and these as shown in Figures 4 and 5 open onto the periphery of the projection 54 and into the annular space 33 defined between the projection 54 and the opening 53. The groove 42 in the wall of the bore 12 is connected by way of a cranked passage 42A to the valve 35.

Formed in the undersurface of the body portion 55 are a pair of spaced elongated troughs 146, 147 which are disposed generally parallel to the axis of the valve member 135. The trough 146 is slightly longer but of smaller depth than the trough 147 and is connected to the reservoir cylinder 28 by a passage 148.

Extending within the body part 51 and downwardly from the trough 146 is a passage 149 which communicates with a port 150 formed in the sleeve 59 in which the valve member 135 is supported. Moreover, formed in the valve member 135 is a port 151 which is connected to the annular space 33 by an axial drilling in the valve member, the port and drilling forming part of the passage 34 seen in Figure 1.

Also extending within the body part 51 and downwardly from the trough 146 and communicat-

ing with a port 152 in the sleeve is a further passage 153 and at a corresponding axial position on the sleeve 59 there is located a further port 152A (Figures 1, 9, 10, 11) which is connected to the passage 42A. Finally a third passage 154 extends within the body part 51 and downwardly from the trough 146 and communicates with a port 155 in the sleeve. At a corresponding axial position on the sleeve is a port 156 which includes the restrictor 136 and which communicates with a passage 157 which communicates with the trough 147. The trough 147 communicates with the inlet 24 of the low pressure supply pump.

At axial positions corresponding to the further port 152A and the port 152 and the ports 155 and 156 the valve member 135 is provided with grooves 158, 159 which are shown in diagrammatic form in Figures 9, 10 and 11. The setting of the valve as shown in Figure 9 corresponds to Figure 7 with the throttle pedal released and the engine idling speed being controlled by the control system. Figure 10 shows the setting of the valve corresponding to Figure 8 with the ports 150, 151 offering a restricted flow of fuel for idling purposes in the emergency run situation and Figure 11 shows the position of the valve when the throttle pedal is depressed the maximum amount. It will be noted that the ports 150, 151 are in full register but the fuel flow which occurs therethrough will be insufficient to cause no load overspeeding of the associated engine but at the same time the engine will be able to develop sufficient power to allow the vehicle to be moved.

Claims

1. A fuel injection pumping apparatus of the kind comprising a body, a fixed stroke reciprocable pump plunger 11 housed within a bore 12, the bore and pump plunger defining a pump chamber, a distributor member 16 which distributes fuel expelled from the pump chamber during successive pumping strokes of the plunger 11 to a plurality of outlet ports 17 in turn, an electromagnetically operable spill valve 38 operable to divert fuel expelled from the pumping chamber to a drain so as to enable the amount of fuel delivered through said outlets to be controlled, a low pressure pump 23 for supplying fuel to the pumping chamber and valve means 35 operable in the event of failure of the control system which controls the valve 38, to permit the apparatus to continue to supply fuel to an associated engine characterized in that the body is formed in three portions which are secured together in assembled relationship, the first portion 55 of the body having a projection 54 which locates within an opening 53 formed in the second portion

51 of the body, said projection being formed with the bore 12 which accommodates the plunger 11, the distributor member 16 being mounted in a further opening 52 in the second body portion, said spill valve including a valve member 39 slidable within a bore 62 formed in the first body portion 55 and said valve means 35 being positioned within the second body portion 51.

2. A pumping apparatus according to Claim 1 characterized by ports 33A extending from said bore 12 and a space 33 defined between the surface of said projection 54 and said opening 53, said ports communicating with said space and said space communicating with an accumulator 26 through said valve means 35.

3. A pumping apparatus according to Claim 2 characterized in that said accumulator 26 includes a cylinder 28 formed in said first portion 55 of the body and includes a piston slidable in said cylinder.

4. A pumping apparatus according to Claim 3 characterized in that said cylinder 28 extends inwardly from one face of said first portion of the body the apparatus further including a cap 64 which closes the open end of the cylinder.

5. A pumping apparatus according to Claim 1 characterized in that said bores 12 and 62 are disposed at right angles to each other, the apparatus including a short passage 13A interconnecting the inner end of the bore 12 with a point intermediate the ends of the bore 62.

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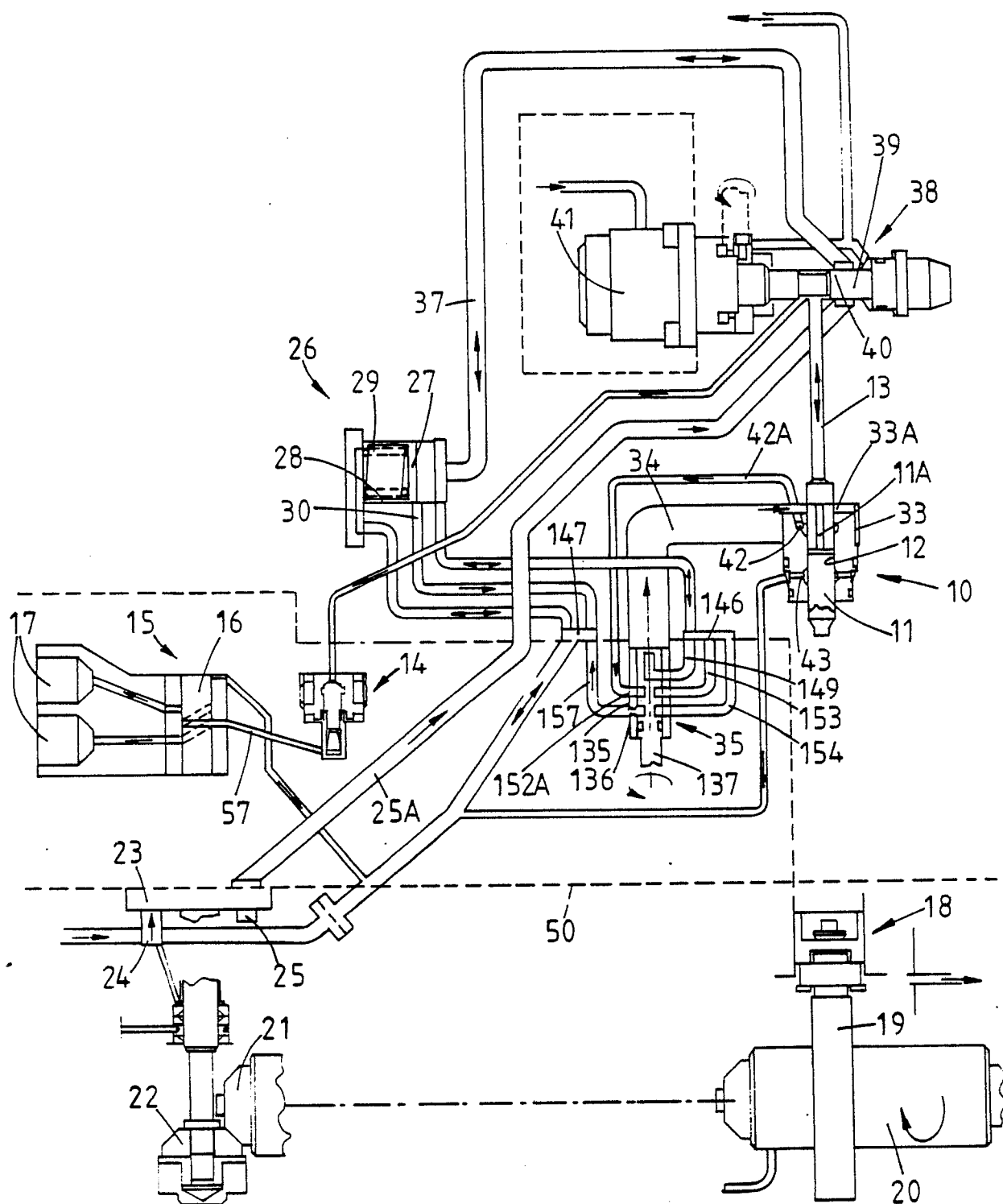


FIG. 1.

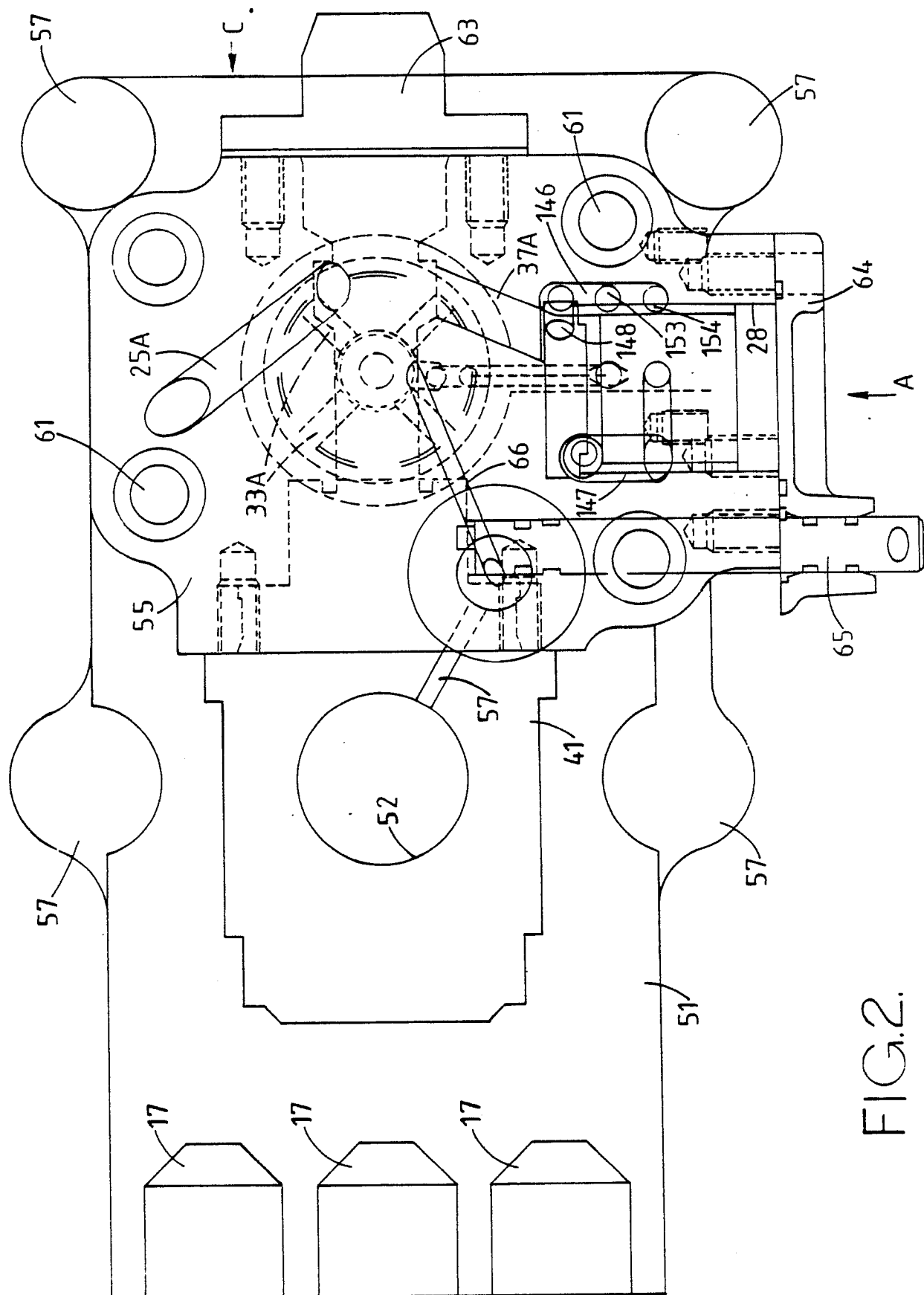


FIG. 2.

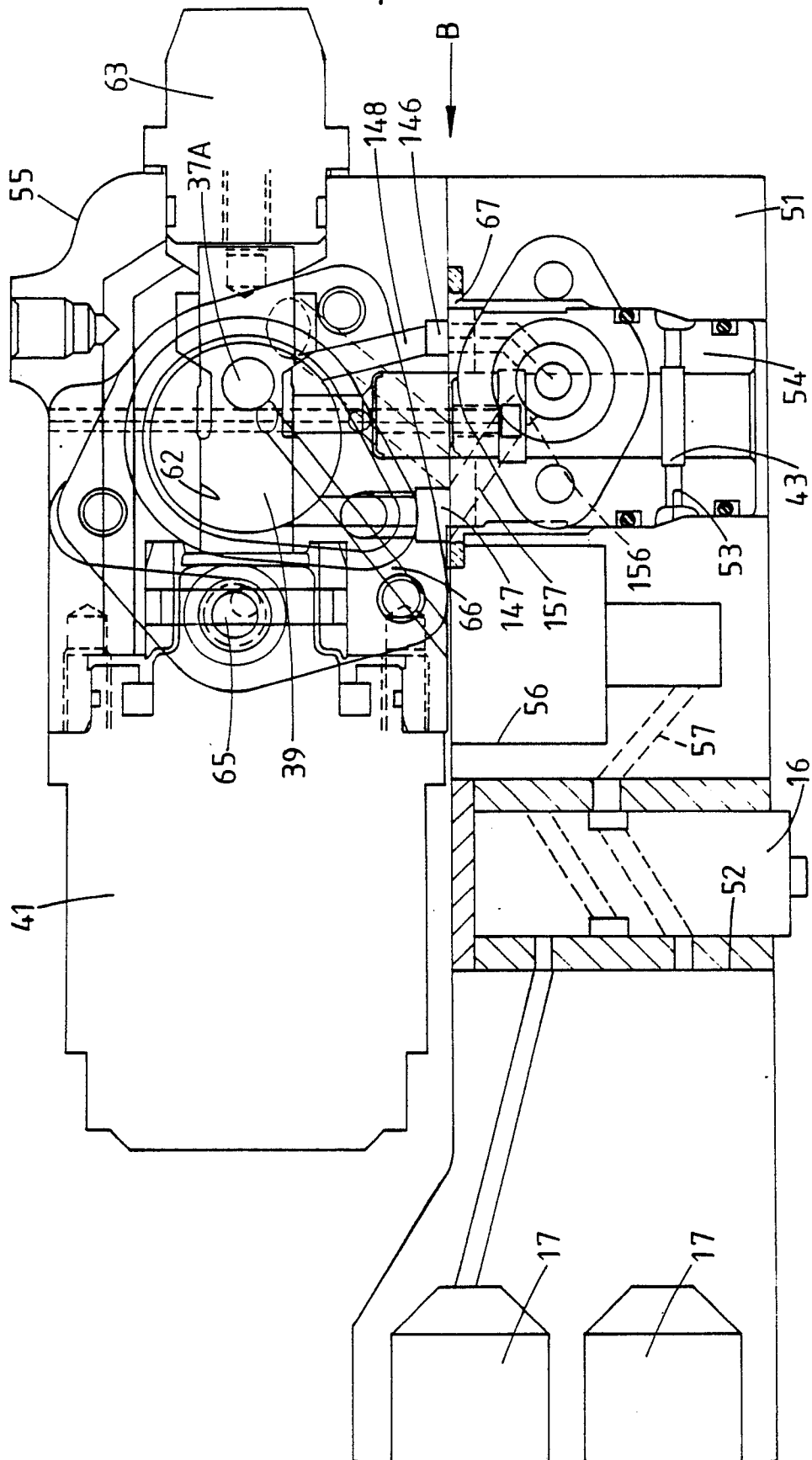


FIG. 3.

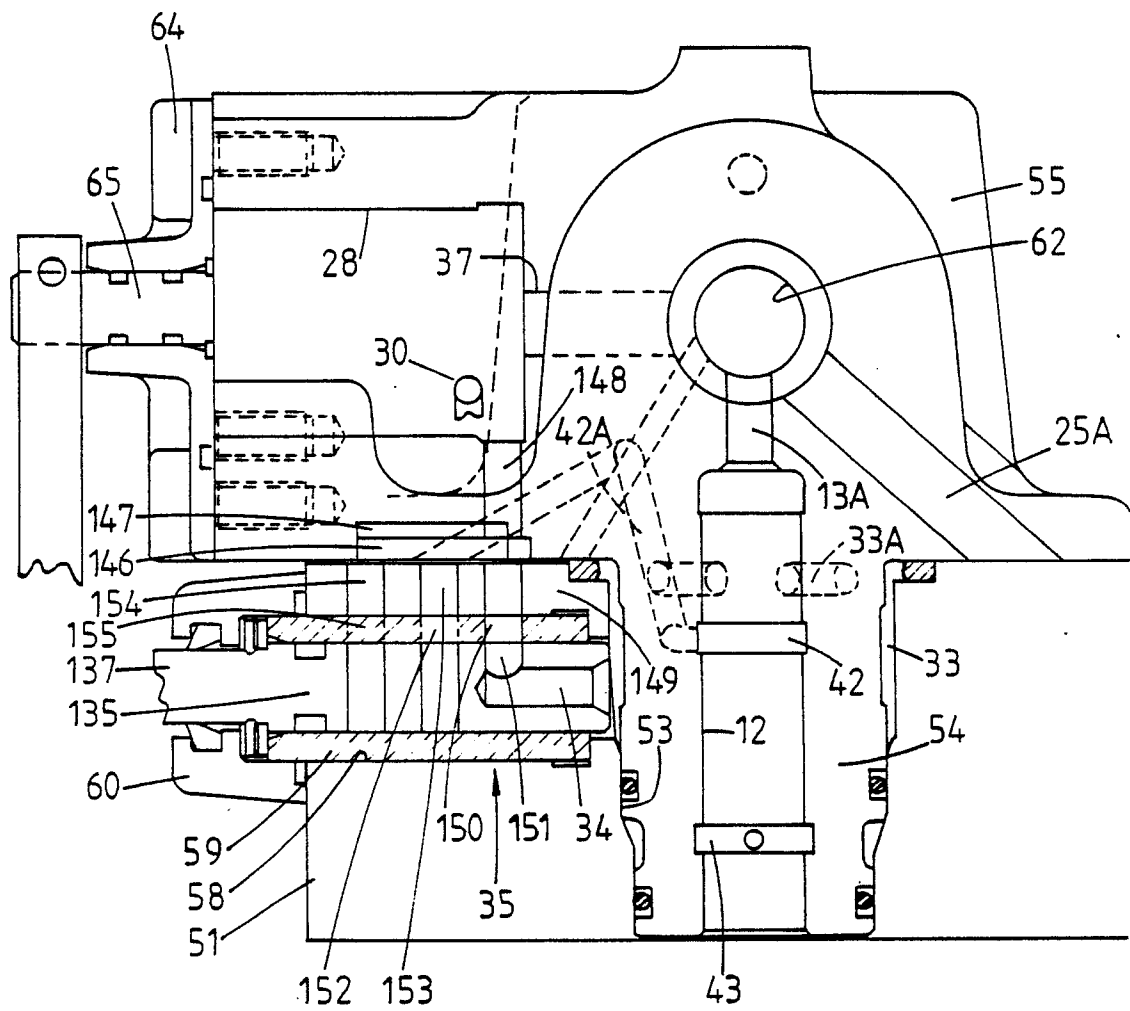


FIG. 4.

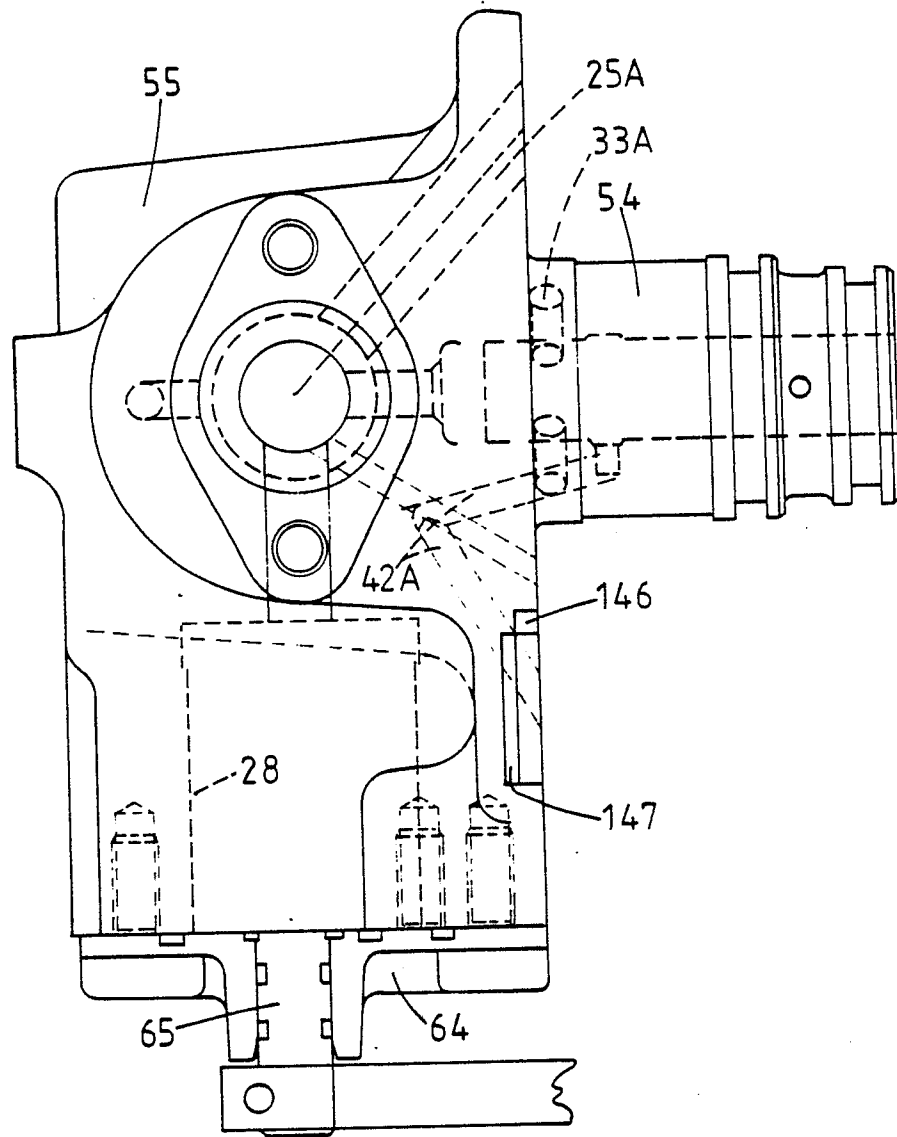


FIG. 5.

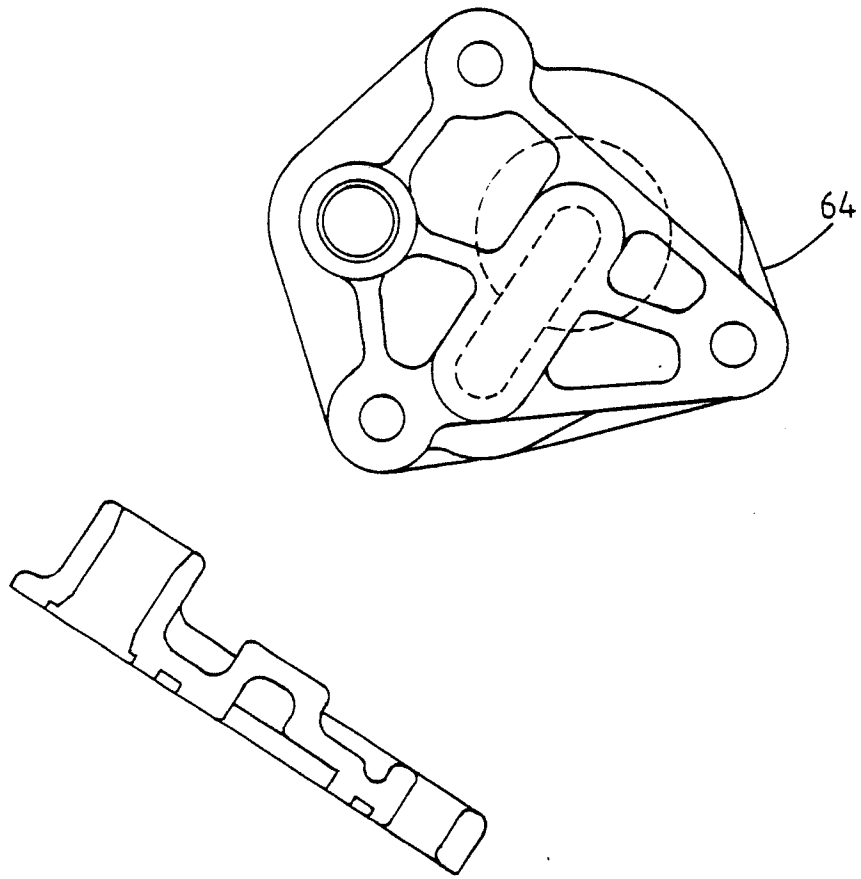


FIG.6.

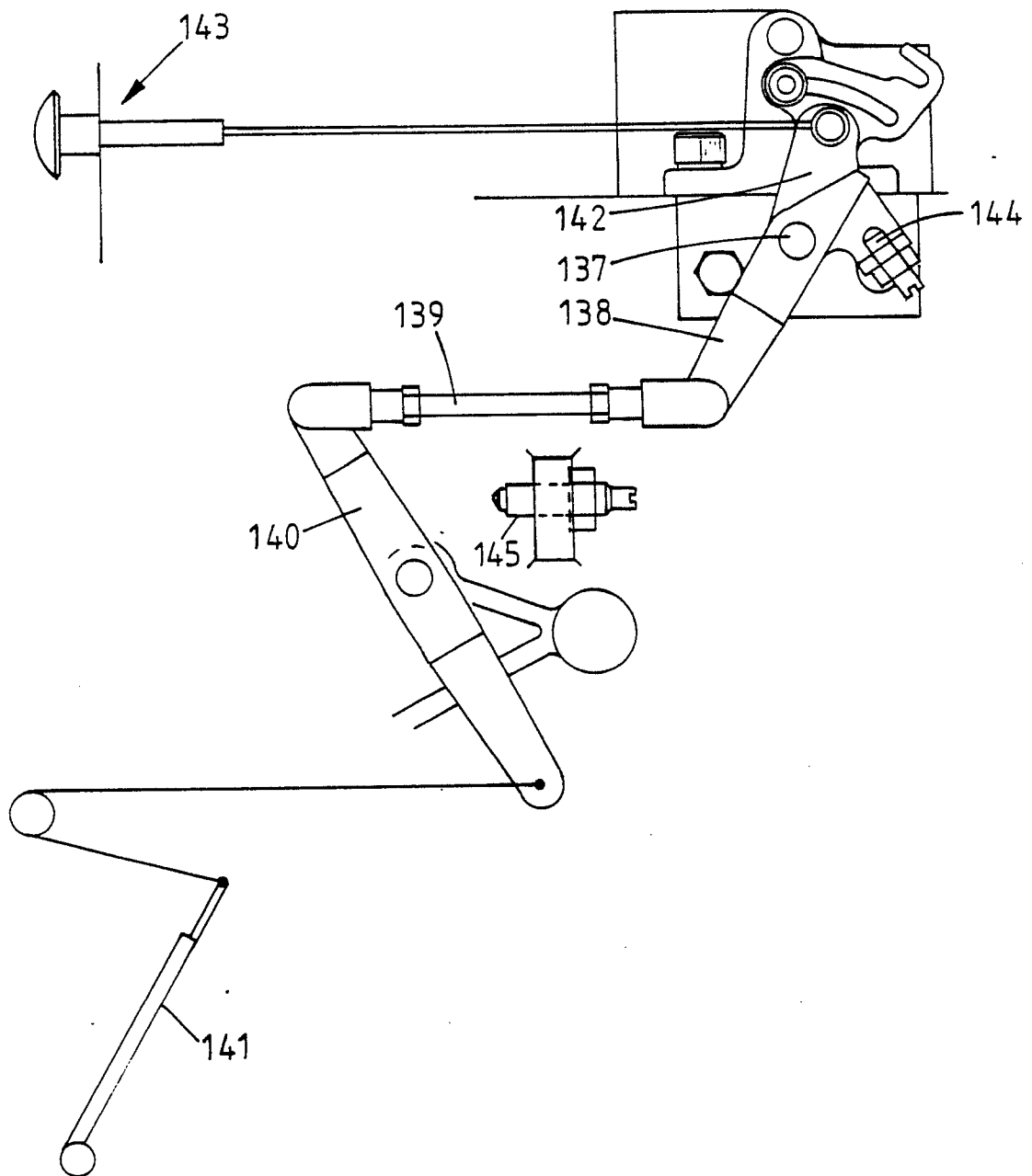


FIG. 7.

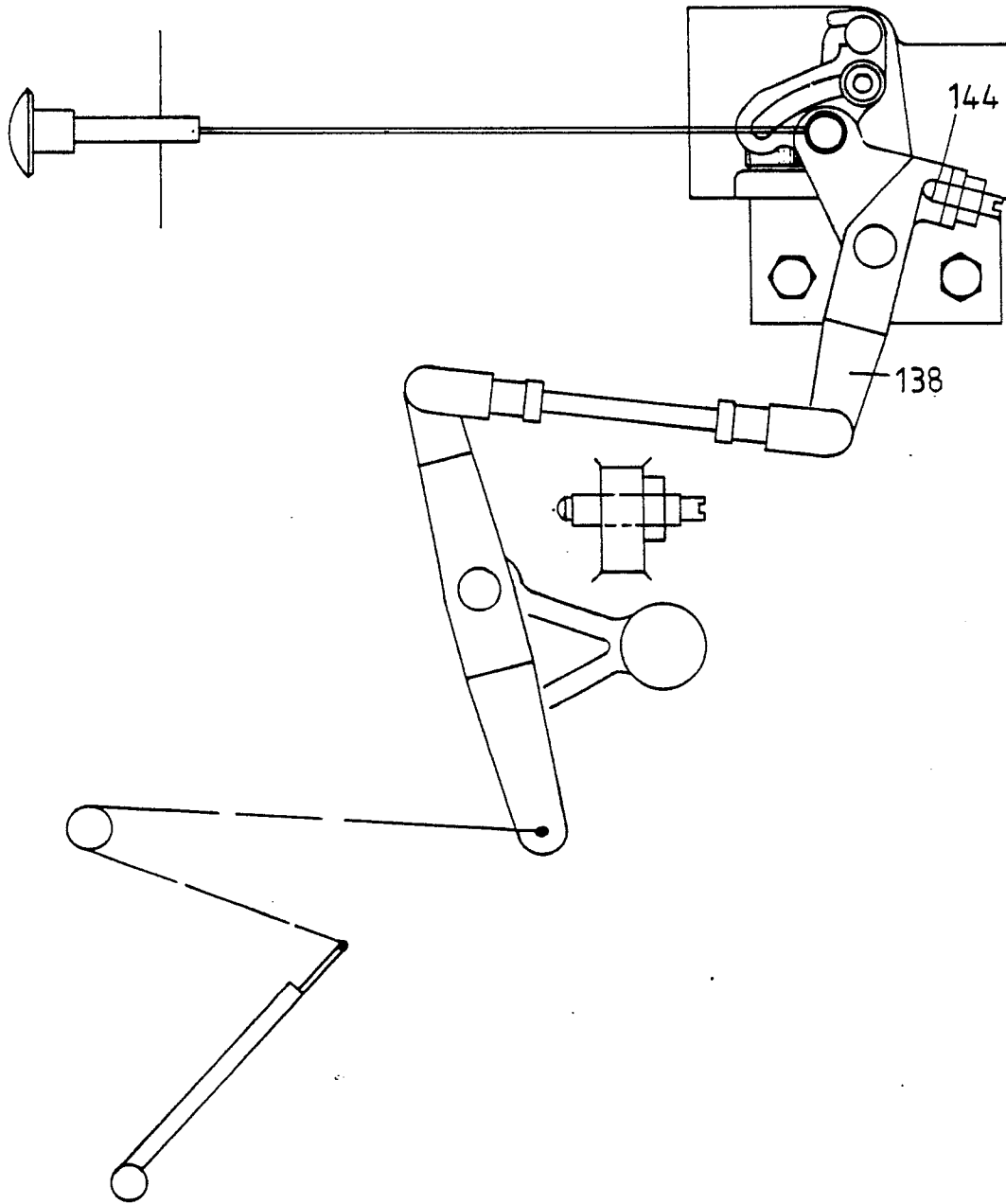


FIG. 8.

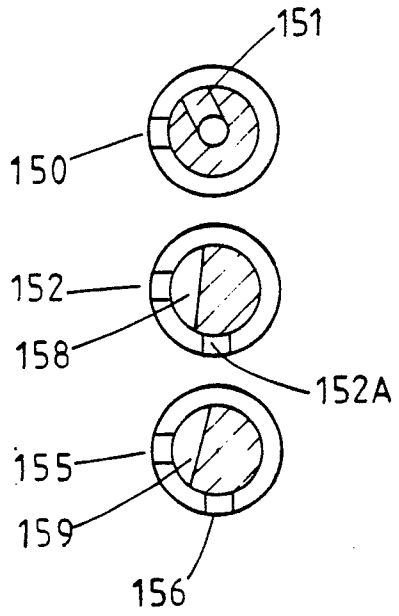


FIG. 9.

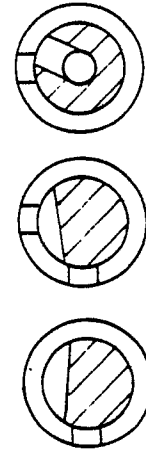


FIG. 10.

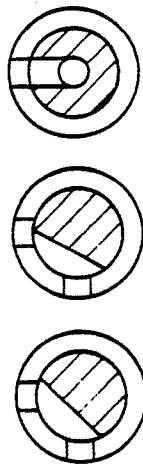


FIG. 11.

EP 87 31 0260

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
A	US-A-4 347 818 (WYSONG) * Column 1, line 62 - column 5, line 24; figure 1 * ---	1	F 02 M 41/06 F 02 M 59/44 F 02 M 59/36
D,A	GB-A-2 153 017 (LUCAS) * Page 1, line 126 - page 3, line 85; figures 1-4 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			F 02 M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14-03-1988	Examiner HAKHVERDI M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	