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## (54) MOULD CLOSING DEVICE FOR AN INJECTION MOULDING MACHINE

(71) I, KATASHI AOKI, a citizen of Japan, of 6037, Ohazaminamijo, Sakakimachi, Hanishinagun, Nagano-ken, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, 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 mould closing device for an injection moulding machine. More particularly, the invention relates to a mould closing device of the kind in which ports or passages formed through a mould closing piston working in a mould closing cylinder can be opened to reduce the hydraulic resistance to rapid movement of the mould closing piston so as to allow the latter to be moved rapidly between extreme positions by supplementary means, to speed up mould opening and closing operations.

There are several well known mould closing devices in which oil passages are formed in a mould closing piston working in a mould closing cylinder, and which oil passages can be opened by means of valves, thereby reducing the hydraulic resistance to rapid movement of the mould closing piston.

In these known devices, however, either only the opening or only the closing of such valves has been effected by hydraulic pressure, and no structurally simple and economical way has up till now been devised of effecting both the opening and closing of such valves by hydraulic pressure.

It is, therefore, an object of the present invention to provide an improved mould closing device for an injection moulding machine in which both the opening and closing operations of such a valve for such hydraulic oil passages of oil ports in such a mould closing piston can be carried out by hydraulic pressure.

According to the invention there is provided a mould closing device for an injection moulding machine, the mould closing device

comprising a mould closing cylinder, a mould closing piston working in said mould closing cylinder and dividing the mould closing cylinder into first and second chambers on opposite sides of the mould closing piston, the mould closing piston having a first piston rod extending from one side thereof through said first chamber and extending sealingly through the respective end of the mould closing cylinder for connection with a mould member, the mould closing piston having a second piston rod extending from the other side of the piston through the other end of said mould closing cylinder whereby rapid movement can be imparted to the mould closing piston by said second piston rod, the mould closing piston having ports provided therethrough and a disk valve being mounted for axial sliding movement on said second piston rod between an open position, in which said ports are open to allow passage of fluid via said ports, between said first chamber and said second chamber, and a closed position in which said ports are closed by the disk valve to prevent such passage of fluid, via said ports, between said first and second chambers, said second piston rod defining, with said disk valve, two valve controlling chambers, sealed with respect to each other and with respect to said second chamber in the mould closing cylinder and so arranged that the disk valve can be moved from its open to its closed position by supplying fluid under pressure to one of said valve controlling chambers whilst permitting exhaust of fluid from the other of said valve controlling chambers and can be moved from its closed to its open position by supplying fluid under pressure to said other of said valve controlling chambers whilst permitting exhaust of fluid from the other of said valve controlling chambers, each of said valve controlling chambers being connected with a respective passage for fluid extending within said second piston rod, whereby fluid under

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pressure can be supplied to and fluid allowed to exhaust from said valve controlling chambers.

5 An embodiment of the invention is described below, by way of example, with reference to the accompanying drawings in which:-

10 Figure 1 is a horizontal view in axial section of one form of a mould closing device embodying the invention, in the position in which a mould closing piston has been moved forward to a mould closing position with a disk valve being closed;

15 Figure 2 is a sectional view similar to Figure 1 but showing the device in a position in which the mould closing piston is retracted to a mould opening position and the disk valve is opened;

20 Figure 3 is a horizontal view in axial section showing part of the apparatus of Figure 1 to a larger scale;

25 Figure 4 is a horizontal view in axial section of part of Figure 3 to a yet larger scale, showing a part of the disk valve showing valve controlling oil chambers;

Figure 5 is a vertical cross-sectional view of part of the device shown in Figure 3 and is taken along the line V-V in Figure 3; and

30 Figure 6 is a vertical cross-sectional view of the same part as shown in Figure 5 but taken along the line VI-VI in Figure 3.

35 The drawings show a hydraulic mould closing device for an injection moulding machine (not shown). The device includes a mould closing cylinder 1 which is provided with a quick-return cylinder 2 at its rear end. Working within the mould closing cylinder 1 is a mould closing piston 5, from one side of which extends a first piston rod 3 which extends sealingly through the front end of the cylinder 2 and which, when the device is in use is attached to a movable platen (not shown) carrying one half of a split injection mould (not shown), the other half of which is secured to a member with respect to which the cylinder 1 is fixed by tie bars, shown fragmentarily, extending from the front end of the cylinder. The piston rod 3 is hereafter referred to as the mould closing ram. To the rear side of the piston 5 is connected a second piston rod 4, hereafter referred to as the quick shifting ram 4, which extends through the rear end of cylinder 1. Thus the mould closing cylinder 1 is divided into first and second oil chambers A and B by the mould closing piston 5.

60 The quick shifting ram 4 is reciprocable between the mould closing cylinder 1 and the quick return cylinder 2, extending from the rear end of cylinder 1, the ram 4 being provided at its rear end within cylinder 2 with a return piston 8. In the rear part of the quick shifting ram 4 is formed a forward cylinder 6 into which extends a booster ram 7 supported by the rear end of the quick return

cylinder 2, and extending axially through cylinder 2, the booster ram 7 extending sealingly through a central bore in piston 8. An axial passage is provided through the booster ram 7, through which hydraulic fluid may be supplied to an exhausted from the cylinder 6.

70 A plurality of oil ports or passages 9 are formed through the mould closing piston 5 via which ports 9 the above-mentioned oil chambers A and B can communicate with each other. All the oil ports 9 may be opened or closed by a disk valve 10 which is fitted on the rear side of the piston 5 and is thus disposed in the oil chamber B.

80 The disk valve 10 comprises a central collar portion 10a and a radially outer portion 10b which is integrally formed around the central collar portion 10a.

85 As best shown in Figures 3 and 4 the ram 4, which is cylindrical in cross-section is stepped adjacent the piston 5, providing a root portion 4a nearer piston 5 which is of greater diameter than the remainder of ram 4 and providing an annular shoulder between the portions of different diameter, which shoulder faces rearwardly. A stepped cylindrical bore is formed through the central collar portion 10a. A cylindrical part of this bore, of lesser diameter, being a sliding fit on the lesser diameter part of the ram 4 and a cylindrical part, of greater diameter, of this bore being a sliding fit on the greater diameter part of the ram 4. Between said cylindrical parts of said bore is formed a shoulder 10c (Figure 4) having the same height radially as that of the shoulder formed around the root portion 4a of the quick shifting ram 4 and facing forwardly towards the last-mentioned shoulder.

105 Adjacent the forward end of the stepped bore through the collar portion 10b of the disk valve is formed an entry portion which flares outwardly towards the forward end of the collar portion 10b.

110 That part of said bore through the collar portion 10b which lies between this flared entry portion and the shoulder 10c, is of uniform cylindrical form corresponding to the exterior of root portion 4a of ram 4, apart from a shallow circumferential groove 10d which is spaced from shoulder 10c and the tapering entry portion and the bottom of which groove has the form of a cylinder coaxial with the remainder of the bore, and spaced radially outwardly from the periphery of root portion 4a.

120 The disk valve 10 having the above-described construction is slidably fitted to the root portion 4a of the quick shifting ram 4 before the return piston 8 is attached to the other end of the quick shifting ram 4. The oil space formed between the inside wall of the disk valve 10 and the root portion 4a of the quick shifting ram 4 is divided into two valve controlling chambers by a piston ring 11 130

which is previously fitted in a circumferential groove in root portion 4a and which slidably engages the bottom of groove 10d. One such valve controlling chamber is a valve opening oil chamber 12 and the other is a valve closing oil chamber 13.

5 Within the quick shifting ram 4 are formed a hydraulic oil passage 14 which connects that chamber of the quick return cylinder 2 which lies on the side of piston 8 nearer piston 5 to the valve opening oil chamber 12, and a hydraulic oil passage 15 which connects the quick forward cylinder 6 to the valve closing oil chamber 13. The disk valve 10 is moved back and forth by the hydraulic oil supplied from the above-mentioned cylinders 2 and 6.

10 The piston ring 11 which separates the above-mentioned oil chambers 12 and 13 and one piston ring 16 which seal off the oil chamber 13 from the chamber B, are disposed in the respective grooves around the root portion 4a of the quick shifting ram 4. A further piston ring 16 which seals off chamber 12 from chamber B is disposed in a circumferential groove in the lesser diameter portion of ram 4 adjacent root portion 4a. As the fitting diameter of the root portion 4a can be slightly varied, the disk valve 10 can be movably fitted to the root portion 4a. The portion 10a of the disk valve 10 is slidable axially to a limited extent on the ram 4 and acts as the movable cylinder of a double-acting piston and cylinder assembly, of which the root portion 4a forms the piston.

15 Furthermore, the above-mentioned oil chamber 12 for opening the disk valve has a larger displacement volume, for a given axial displacement of valve 10 relative to ram 4 than the oil chamber 13 for closing the disk valve.

20 The outer portion 10b of the disk valve, which is integrally formed with the central portion 10a, is provided with a flat face which comes into contact with an annular valve seat 5a which is disposed radially outwardly of, and encircles the oil ports 9 of the mould closing piston 5. The mould closing piston 5 and the disk valve 10 are movably connected by a plurality of pins 17 in the form of bolts having enlarged heads which engage the disk valve 10 and having nuts which engage the piston 5, to limit movement of disk valve 10 away from piston 5. The bolts 17 extending in the axial direction with clearance through respective bores in the piston 5.

25 The operation of the device described above is as follows:-

30 When the mould closing piston 5 is to be moved quickly into the mould closing position shown in Figure 1, from the position shown in Figure 2, in order to close the injection mould (not shown) hydraulic oil is supplied to the quick forward cylinder 6 through the booster ram 7. In this operation, the

quick return cylinder 2 and the oil chamber A of the mould closing cylinder 1 are connected to a reservoir at low pressure so as to allow the hydraulic oil to flow out with the movement of the mould closing piston 5. The quick shifting ram 4 as well as the mould closing piston 5 and the mould closing ram 3 are moved forward all together by the oil pressure in the quick forward cylinder 6. At the same time, the oil pressure is applied to the valve closing oil chamber 13 and a force in the valve closing direction is exerted on the disk valve 10. However, the force on valve 10 due to the difference in oil pressure in the oil chambers A and B, caused by the forward movement of the mould closing piston 5 and acting upon portion 10b through ports 9 is very large compared with the opposing force due to the pressure within chamber 13 particularly since the pressure in chamber 6 remains relatively low while the forward motion of piston 5 is substantially unopposed so that the disk valve 10 is nevertheless moved to its open position so that hydraulic oil can flow from the oil chamber A into the oil chamber B via the ports 9. As the result, the resistance presented by oil in the oil chamber A can be reduced and the rapid forward movement of the mould closing piston 5 is facilitated.

35 When the associated injection mould is almost closed, the forward movement of piston 5 is slowed down by means (not shown). Thus, the rate of supply of hydraulic oil to the forward cylinder 6 from the booster ram 7 is slowed down allowing the pressure in cylinder 6 to rise. With the slowdown of the piston 5, the pressure in the oil chamber A becomes small and the force pressure exerted on the disk valve 10 by the fluid in chamber A is also reduced. When the force on the valve disk due to the hydraulic oil in the valve closing oil chamber 13 exceeds the force due to the fluid in Chamber A, the disk valve 10 is moved to its closed position in which the disk portion 10b engages the valve seat 5a and the oil ports 9 are closed.

40 As a result, the two oil chambers A and B are completely separated and the oil which is fed under pressure to the oil chamber B in order to clamp the mould by exerting a large force on the mould closing piston 5 cannot leak into the oil chamber A, and thereby diminish the mould clamping force.

45 When the mould is opened by retracting the mould closing piston 5 by reversing the above forward operation, the quick forward cylinder 6 and the oil chamber B are connected to the reservoir at low pressure and the quick return cylinder 2 is supplied with hydraulic oil under pressure. A part of this hydraulic oil that is supplied into the cylinder 2 acts on the valve opening oil chamber 12 through the hydraulic oil passage 14 and the disk valve 10 is moved back to the open

position. Thus the oil ports 9 are opened and the two oil chambers A and B communicate with each other. This retraction of the disk valve 10 is effected in a short moment just before the retraction of the quick shifting ram 4 together with the mould closing piston 5 and the mould closing ram 3. Therefore, when the mould closing piston 5 is moved backward, the oil ports 9 have already been opened, so that the mould closing piston 5 can be quickly retracted with the minimum of resistance being presented by the hydraulic oil in the oil chamber B.

In the embodiment described above, the disk valve 10 is a double acting valve which responds to the oil pressure used for rapid movement of the mould closing piston 5. Therefore, as compared with the case in which either only the valve closing or only the valve opening is effected by hydraulic pressure, the opening of the oil ports during mould closing and mould opening and the closure of the oil ports during mould clamping is more reliable. Furthermore, since the valve closing is attained by surface contact of the valve 10 with the valve seat 5a, the contacting portions of the valve and valve seat are not damaged even when large mould closing forces are exerted on the disk valve and the valve can therefore be used for a long time without oil leakage caused by wear under repeated uses. Furthermore, since a piston ring is used as the partition, the piston head which has been regarded as indispensable in the prior art, becomes unnecessary, and the oil chambers provided to move the disk valve can be formed in a very small space.

The mould closing device described with reference to the drawings is simple and reliable in operation, is simple in structure and durable for repeated long term use and can be manufactured without difficulty at low cost.

Both opening and closing of the oil controlling valve carried by the mould closing piston is effected by hydraulic pressure, which has been regarded as practically impossible in the conventional art. In the small space between the valve member and a quick shifting ram slidably carrying the valve member, two valve controlling oil chambers are formed which can be subjected to hydraulic pressure alternately for alternate opening and closing movement of the valve. The above two oil chambers are supplied with a part of the hydraulic oil which drives a mould closing piston, so as to open and close the valve accurately. Thus, when the mould closing piston is moved, the oil ports in the mould closing piston are quickly opened by the action of the valve 10 and the oil pressure in the driving oil chamber on the lower pressure side is reduced to promote the mould opening or closing operation.

WHAT I CLAIM IS:

1. A mould closing device for an injection moulding machine, the mould closing device comprising a mould closing cylinder, a mould closing piston working in said mould closing cylinder and dividing the mould closing cylinder into first and second chambers on opposite sides of the mould closing piston, the mould closing piston having a first piston rod extending from one side thereof through said first chamber and extending sealingly through the respective end of the mould closing cylinder for connection with a mould member, the mould closing piston having a second piston rod extending from the other side of the piston through the other end of said mould closing cylinder whereby rapid movement can be imparted to the mould closing piston by said second piston rod, the mould closing piston having ports provided therethrough and a disk valve being mounted for axial sliding movement on said second piston rod between an open position, in which said ports are open to allow passage of fluid, via said ports, between said first chamber and said second chamber, and a closed position in which said ports are closed by the disk valve to prevent such passage of fluid, via said ports, between said first and second chambers, said second piston rod defining, with said disk valve, two valve controlling chambers, sealed with respect to each other and with respect to said second chamber in the mould closing cylinder and so arranged that the disk valve can be moved from its open to its closed position by supplying fluid under pressure to one of said valve controlling chambers whilst permitting exhaust of fluid from the other of said valve controlling chambers and can be moved from its closed to its open position by supplying fluid under pressure to said other of said valve controlling chambers whilst permitting exhaust of fluid from the other of said valve controlling chambers, each of said valve controlling chambers being connected with a respective passage for fluid extending within said second piston rod, whereby fluid under pressure can be supplied to and fluid allowed to exhaust from said valve controlling chambers.

2. A mould closing device as claimed in claim 1 wherein said mould closing piston is movable rapidly axially in either direction by hydraulic actuating means including a first actuating chamber to which fluid can be supplied under pressure to cause the mould closing piston to move so as to reduce the volume of said first chamber in the mould closing cylinder and a second actuating chamber to which fluid can be supplied under pressure to cause the mould closing piston to move so as to increase the volume of said first chamber in the mould closing cylinder, and wherein said passage within said second piston rod

which is connected with the valve controlling chamber to which fluid is supplied to move the disk valve to its closed position is connected with said first actuating chamber and the other said passage within the piston rod is connected with said second actuating chamber whereby the disk valve can be moved to its open and closed positions in synchronism with the movement of the mould closing piston by said actuating means.

3. A mould closing device as claimed in any preceding claim wherein said two valve controlling oil chambers are sealingly separated from each other by a piston ring.

4. A mould closing device as claimed in claim 3 wherein said disk valve includes a collar portion through which said second piston rod extends and a portion integral with said collar portion and extending outwardly from said collar portion and serving to close said ports in the closed position of the disk valve, said collar portion having a stepped bore therethrough which receives a stepped portion of said second piston rod, said stepped bore and said stepped portion of the second piston rod providing respective annular shoulders which face towards each other and between which one of said valve controlling chambers is defined, a cylindrical portion of said stepped bore in which a correspondingly cylindrical portion of said second piston rod is slidingly received, having a circumferential groove providing a cylindrical surface spaced radially outwardly from said correspondingly cylindrical portion of said second piston rod and said piston ring being carried by the last mentioned portion of said second piston rod and slidingly engaging said cylindrical surface provided by said groove, the other of said valve controlling chambers being defined between said cylindrical portion of said second piston rod and said cylindrical surface provided by said circumferential groove, on the side of said piston ring remote from the first-mentioned valve controlling chamber.

5. A mould closing device as claimed in claim 4 wherein the valve controlling chamber to which fluid is supplied to open the disk valve is that defined between said opposing annular shoulders.

6. A mould closing device as claimed in any preceding claim wherein the displacement volume, for a given axial displacement of the disk valve on the second piston rod, is greater, for the valve controlling chamber to which fluid is supplied to move the disk valve to its open position than for the valve controlling chamber to which fluid is supplied to move the valve disk to its closed position.

7. A mould closing device as claimed in any preceding claim, in which said disk valve has a flat face which, in the closed position of the valve, is in sealing engagement with an

annular valve seat, provided by the mould closing piston, which is disposed radially outwardly of, and encircles, said ports in the mould closing piston.

8. A mould closing device as claimed in any preceding claim wherein axial movement of said disk valve relative to the mould closing piston is restricted by a plurality of setting pins extending between the disk valve and the mould closing piston.

9. A mould closing device substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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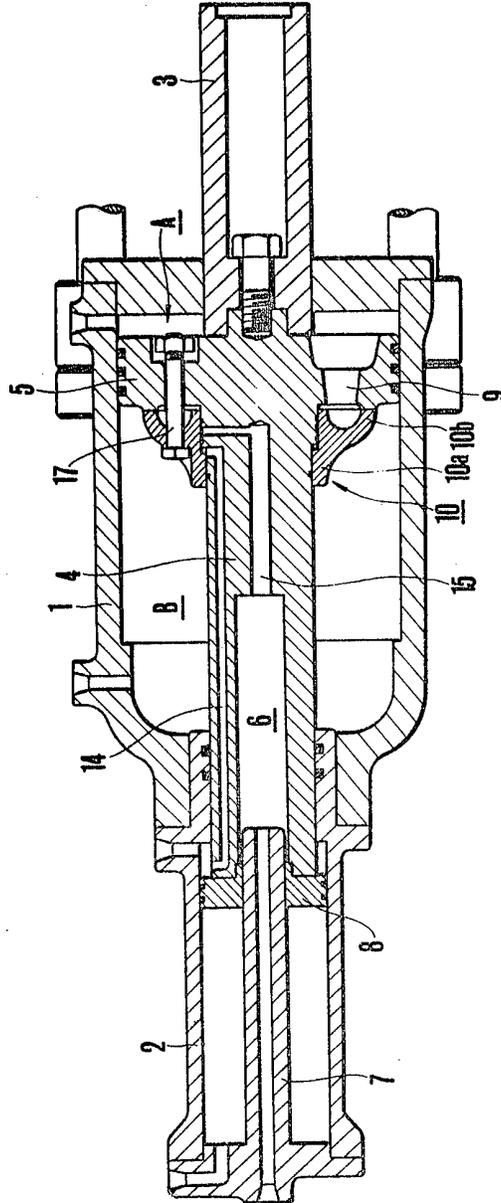
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Sheet 1

FIG. 1



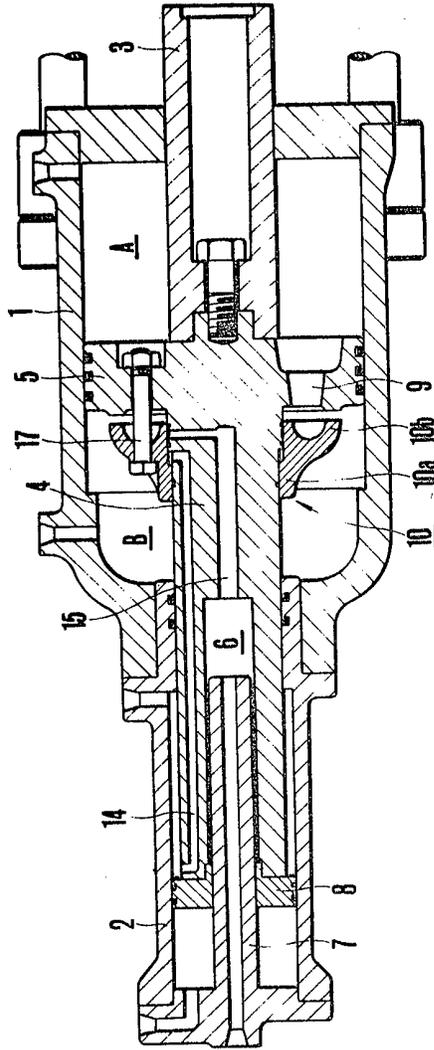
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FIG.2



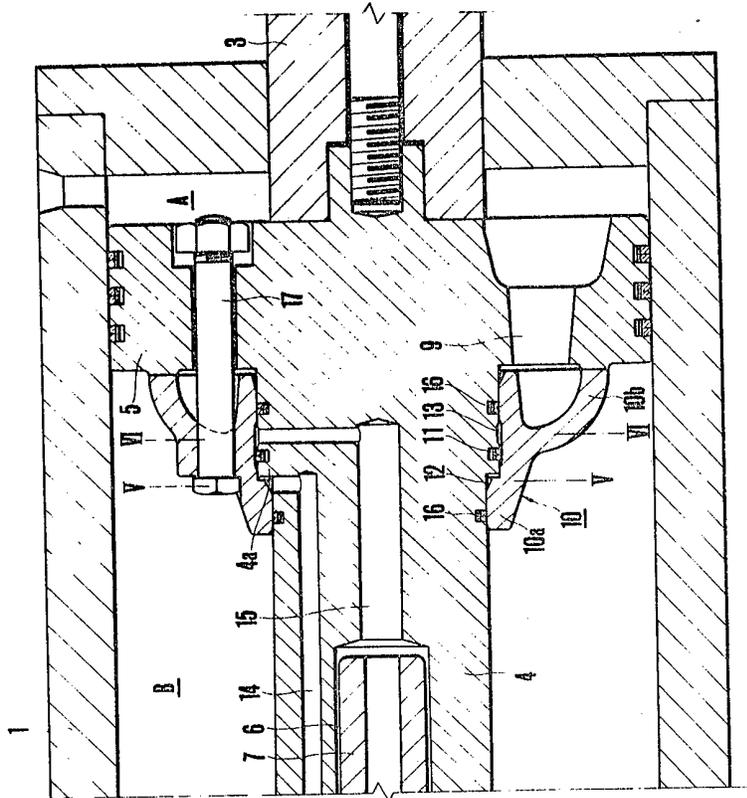


FIG. 3

FIG.4

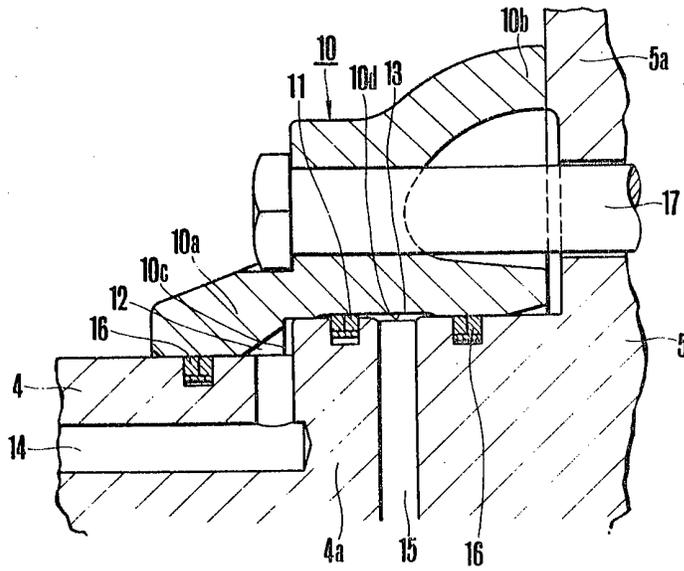


FIG.5

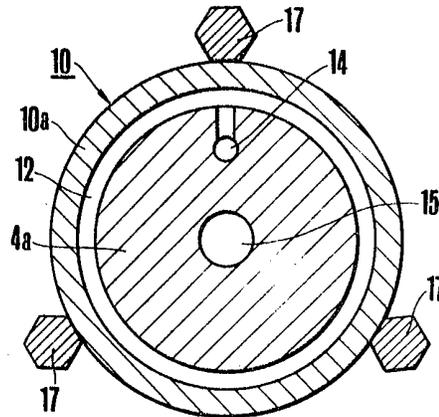


FIG.6

