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(71) Applicant:
RIVA CALZONI OLEODINAMICA S.p.A.
Anzola dell'Emilia (Bologna) (IT)

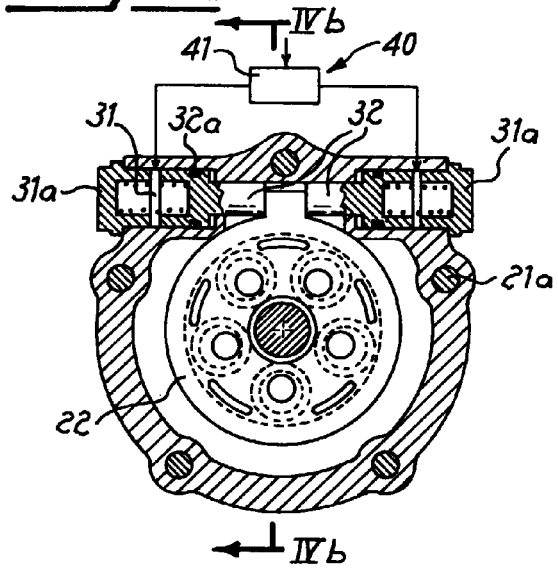
(72) Inventor:
Breviglieri, Alessandro
Casalecchio di Reno (Bologna) (IT)

(74) Representative:
Raimondi, Alfredo, Dott. Ing. Prof.
Dott. Ing. Prof. RAIMONDI ALFREDO S.r.l.
Piazzale Cadorna 15
20123 Milano (IT)

(54) Feedback control circuit for a variable speed hydromotor

(57) Device for adjusting the advance of hydraulic motors/pumps provided with propulsors (13) actuating an eccentric drive shaft (14) and with a rotating group (20) for distribution of the fluid actuating the propulsors (13), said rotating distribution group (20) comprising at least one plate (22) mounted idle on the drive shaft (14) and means (31;131;231) designed to co-operate with said plate (22) so as to produce its rotational actuation relative to the drive shaft, said rotation being able to be actuated in both directions and between predetermined angular end-of-travel positions.

Fig.4a



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Description

[0001] The present invention relates to a device for adjusting the advance of the phase-timing of hydraulic engines.

[0002] In the art hydraulic engines with radial/axial propulsors which, acting on the eccentric drive shaft, cause rotation thereof are known; in order for the said propulsors to operate, a rotating distributor must cause the correct succession of the phases for supplying/discharging each of them.

[0003] It is also known that the supply fluid requires a certain amount of time to pass through the ducts which lead from the rotating distributor to each propulsor (supply stage) and vice versa (discharge stage), resulting in the need to determine beforehand the correct phase-timing of the engine, or the instant at which opening/closing of the duct supplying/discharging the fluid to some of the propulsors occurs, so that it is synchronized with the corresponding discharging/supplying of the other propulsors.

[0004] In order to keep the operation of all the propulsors synchronized and compensate for the delay with which the fluid actually reaches the associated propulsor after opening of the duct by the rotating distributor, it is attempted to adjust the so-called "advance" of the engine, namely the advance with which the rotating distributor opens/closes the said duct with respect to the instant at which the fluid is expected to actually reach the corresponding propulsor.

[0005] This adjustment of the advance is, however, necessarily associated with the speed of rotation of the engine since, with an increase in the speed of the engine and hence the speed with which each propulsor changes phase (supplying/discharge), the delay in supplying/discharging of the fluid causes malfunctioning of the engine.

[0006] The technical problem which is posed, therefore, is that of providing a device which allows control and adjustment of opening/closing of the ducts supplying/discharging each propulsor of an hydraulic/oleodynamic propulsor upon variation in the number of revolutions of the engine itself.

[0007] Within the scope of this problem a further requirement is that said device should be simple and low-cost to manufacture and should be able to be operated both manually and automatically by associated control means.

[0008] These technical problems are solved according to the present invention by a device for adjusting the advance of hydraulic engines provided with propulsors actuating an eccentric drive shaft and a rotating group for distribution of the fluid actuating the propulsors, said rotating distribution group comprising at least one plate mounted idle on the drive shaft and means designed to co-operate with said plate so as to cause rotational operation thereof relative to the drive shaft, said rotation being able to be actuated in both directions and between predetermined angular end-of-travel positions.

[0009] Further details may be obtained from the following description of a non-limiting example of embodiment of the invention provided with reference to the accompanying drawings in which:

- Figure 1 shows a cross-sectional view, along a plane indicated by I-I in Fig. 2, of an oleodynamic motor according to the present invention;
- Figure 2 shows a cross-section along a plane indicated by II-II in Fig. 1;
- Figure 3 shows an enlarged cross-sectional view of the detail relating to the rotating distributor of the fluid actuating the cylinders;
- Figure 4a shows a cross-section along the plane indicated by IVa-IVa in Fig. 3 illustrating the devices for actuating the plate with automatic operating means;
- Figure 4b shows a cross-section along the plane indicated by IVb-IVb in Fig. 4a;
- Figure 5a shows a cross-section similar to that of Fig. 4a with the plate rotated in the clockwise direction;
- Figure 5b shows a cross-section similar to that of Fig. 4a with the plate rotated in an anti-clockwise direction;
- Figs. 6a, 6b show variations of examples of embodiment of the means for actuating rotation of the plate;
- Figure 7a shows the device for performing positioning of the plate using means for automatic operation and control of the angular position of the plate itself;
- Figure 7b shows a cross-section along the plane indicated by VIIb-VIIb in Fig. 7a;
- Figure 8 shows the device for performing positioning of the plate using manual-type operating means;
- Figs. 9a,9b show the device for performing positioning of the plate in a radial configuration;
- Fig. 10a shows the device for performing positioning of the plate in an axial configuration; and
- Fig. 10b shows a cross-section along the plane indicated by Xb-Xb in Fig. 10a.

[0010] As illustrated in Figs. 1 and 2 an engine 10 of the oleodynamic type is composed essentially of a casing 11 which is closed by covers 12 and houses, internally, radial cylinders 13, each of which is placed in communication with a rotating distributor 20 (Fig. 2) which designed to open/close the ducts for supplying/discharging the cylinders so that the latter are cyclically compressed/discharged and are able to exert their thrusting action on an eccentric shaft 14 which is supported on the casing 11 of the engine by means of associated bearings 11b.

[0011] Said rotating distribution group (Fig. 3) consists of an external container 21 which is fixed to the casing

11 by means of bolts 21a and which has inside it, arranged coaxially, a plate 22 mounted idle on an extension 14a of the shaft 14 on which it may rotate in both directions.

[0012] The plate 22 is provided with openings 22a for connection to the ducts 13a supplying/discharging the cylinders 13.

[0013] A rotating distribution disk 23 bears against the plate 22, coaxially therewith, and is in turn provided with through-ducts 23a and pushed against the plate 22 by a reaction ring 24 provided with a prestressed spring (not shown) arranged between the ring 24 and the cover 21 of the distributor.

[0014] The plate 22 has a radial extension 22b which is designed to engage with the device 30 for adjusting the advance in accordance with the invention which causes rotational actuation thereof.

[0015] In a first embodiment, said actuating device 30 (Fig. 4) consists of a pair of cylinders 31 formed in the casing 11 of the engine in an opposite position with respect to that of the radial extension 22b of the plate 22.

[0016] Said cylinders 31 are closed towards the outside by an end-piece 31a and have, arranged inside them, corresponding coaxial pistons 32 provided with associated seals 32 which act on the opposite radial surfaces of the extension 22b of the plate 22.

[0017] As illustrated in Figs. 5a and 5b, respectively, the appropriate supplying/discharging of the two cylinders 31 causes the corresponding advance/retraction of the two pistons 32 towards/away from the radial extension of 22b the plate 22 with the consequent thrust on either side thereof and rotation in the clockwise/anticlockwise direction of the plate itself.

[0018] Said rotation of the plate 22 causes the desired effect of an advance in the opening/closing of the supply/discharge ducts of the cylinders 13 since it causes the angular displacement of the circumferential position of the holes 22a where the openings of the plate are aligned with the openings 23a of the rotating disk 23, allowing flowing of the fluid.

[0019] Figs. 6a and 6b illustrate respective variations in examples of embodiment of the device according to the invention and comprising: two cylinders 131 with a single piston 132 provided with a seat 132a designed to engage with the extension 22b of the plate 22 (Fig. 6a); or a single double-delivery cylinder 231 with piston 132 having a seat 132a for engagement with the extension 22b (Fig. 6b).

[0020] In order to be able to operate externally the actuating device according to the invention, control means 40 which are designed to supply correspondingly the fluid to the cylinders 31 are envisaged.

[0021] In a first version said automatic control means 40 comprise a sensor 41 which is designed to detect the speed of rotation of a disk 41a associated with the drive shaft 14 and send a corresponding signal to a control board 42 which emits pulses operating a distributor 43 which, in turn, drives a metering valve 44, the outputs of which control supplying/discharging of the two cylinders 31 and the consequent advance/retraction of the pistons 31.

[0022] In this case the operating group 40 causes total supplying/discharging of the two cylinders and the consequent displacement of the pistons 32 as far as the respective end-of-travel stop, on either side; this means that the plate 32 rotates between two fixed angular positions and stops only in said positions, causing a predefined advance suitable for a predetermined and precise value of the speed of rotation of the drive shaft.

[0023] As illustrated in Figs. 7a and 7b, it is also possible to envisage means 140 for automatically operating and controlling the angular position of the plate 22.

[0024] Said means comprise all the operating means 40 already described above and a blocking valve 145 arranged between the metering valve 44 and the cylinders 31; the blocking valve is designed to ensure balanced supplying of the two cylinders 31, blocking the pistons 32 in any intermediate position between the two end-of-travel positions.

[0025] In this case it is therefore possible to adjust continuously the advance of the engine depending on the variation in its speed of rotation.

[0026] As illustrated in Fig. 8, means 150 for manual operation of the device for rotational actuation of the plate are also provided.

[0027] In this case the radial extension 22b of the plate 22 engages in a seat 152a of a rod 152, one end of which is connected to a screw 151, the other end of which projects outside the casing 11 of the engine and is integral with a manual operating knob 151a.

[0028] As illustrated, the opposite end of the rod 152 has a fork 152b inside which a safety end-of-travel pin 153 preventing rotation of the rod 152 about its longitudinal axis is inserted.

[0029] Although not illustrated, the manual operating system could also be realized by means of the metering valve 44 supplied by means of a circuit, the opening/closing of which is controlled manually by the operator.

[0030] In the figures described above, the adjusting device is of the tangential type, although actuating systems of the radial and axial type are also envisaged, as described below with reference to the respective figures.

[0031] In particular (Figs. 9a, 9b), the device of the radial type envisages that the two cylinders 331 are arranged in substantially radial directions; in this case the respective pistons 332 have a surface 332a which is inclined towards the end and towards the inside of the piston and is designed to co-operate with a corresponding inclined surface 122c of the radial extension 122b of the plate 22.

[0032] As illustrated, the alternate thrusting operation of the two pistons 331 causes the thrusting of the associated inclined surface 332a onto the corresponding

inclined surface 122c of the radial extension 122b with consequent rotation, in one direction (Fig. 9a) or in the other direction (Fig. 9b), of the disk 22.

[0033] In a preferred embodiment the inclination of the inclined surfaces is such as to make the movement of the plate irreversible.

[0034] In this configuration it is envisaged that the adjustment of the advance can be controlled by means of a sensor 141, for example of the inductive type, which is designed to detect passing of a mass consisting, for example, of the head of a screw 141a screwed onto the disk 22 in a suitable position or of a block 141b located in the same position.

[0035] It must be emphasized that the radial device is of the irreversible type since, when there is no pressure in the cylinders, the shape of the inclined surfaces does not allow free rotation of the plate 22.

[0036] In the radial configuration also, manual operating means may be envisaged, said means consisting of a pair of threaded rods similar to that illustrated in Fig. 8, but arranged in a substantially radial direction in place of the pistons 432: in this case the end opposite to that of the knob 151a will have an inclined surface for cooperating with the corresponding surface 122c of the radial projection 122 of the plate 22.

[0037] Figs. 10a, 10b finally show the axial embodiment of the device for performing adjustment of the advance according to the invention.

[0038] In this configuration, rotation of the disk 22 is performed by rotation of a cam 423 actuated by the shaft 431a of a conventionally controlled actuator 431.

[0039] In this case the cam of the adjusting device is housed inside a radial seat 222c of the disk 22.

[0040] In this case the presence of the controlled actuator provides the device for performing adjustment of the advance with an intrinsic reversibility.

[0041] It is envisaged, moreover, that said means for performing rotation of the plate 22 may be directly connected to the engine supply so as to provide automatic adjustment in both directions of rotation of the phase advance of the distribution.

[0042] It is therefore obvious how the device according to the invention allows simple and effective manual or automatic adjustment of the advance with which the rotating group for distribution of the fluid open/closes the supply/discharge ducts of the cylinders of the engine, allowing perfect phase-timing thereof even when there is a variation in the speed of rotation of the engine.

[0043] It is also within the grasp of a person skilled in the art to envisage the application of the device according to the invention to apparatus acting as pumps rather than engines.

Claims

1. Device for adjusting the advance of hydraulic engines provided with propulsors (13) actuating a drive shaft (14a) mounted on an eccentric cam (14) and with a rotating group (20) for distribution of the fluid actuating the propulsors (13), which comprises at least one plate (22) located between the distribution group (20) itself and the supply ducts (13a) of the propulsors (13), which plate is axially fixed and idle with respect to the drive shaft (14a), characterized in that it comprises operating means (31;131;231;331;431;151) which are designed to cooperate with said plate (22) for rotational operation thereof relative to the cam (14), said rotation being able to be actuated in both directions so as to produce a corresponding angular phase-timing between the eccentric cam (14) and the plate (22).

2. Device according to Claim 1, characterized in that said operating means (31;131;231;151) are arranged tangentially with respect to the plate (22).

3. Device according to Claim 1, characterized in that said operating means (331) are arranged radially with respect to the plate (22).

4. Device according to Claim 1, characterized in that said operating means (431) are arranged parallel to the axis of rotation of the plate (22).

5. Device according to Claim 1, characterized in that said plate (22) is coaxially mounted on an extension (14a) of the drive shaft.

6. Device according to Claim 2 or 3, characterized in that said plate (22;122b) has at least one radial extension (22b) which is designed to co-operate with said actuating means (31;131;231;331).

7. Device according to Claim 2, characterized in that said means for the rotational actuation of the plate (22) comprise at least one double-delivery cylinder (231), the piston (232) of which has a seat (232a) for engagement with said radial extension (22b) of the plate.

8. Device according to Claim 2, characterized in that said means for rotational actuation of the plate (22) comprise a pair of opposing cylinders (131) with a common piston (132) which has a seat (132a) for engagement with said radial extension (22b) of the plate.

9. Device according to Claim 2, characterized in that said means for rotational actuation of the plate (22) comprise a pair of opposing cylinders (31), the associated pistons (32) of which are arranged on opposite sides of the said radial extension (22b) of the plate (22) on which the they alternately exert a thrusting action.

10. Device according to Claim 3, characterized in that it comprises a pair of cylinders (331) arranged on opposite sides of the radial extension (112b) of the plate (22).

11. Device according to Claim 10, characterized in that the piston (332) of said cylinders (331) has an inclined surface (332a) for engagement on a corresponding inclined surface (122c) of the radial extension (122b) of the plate (22).

12. Device according to Claim 11, characterized in that the inclination of said inclined surfaces (332a,112c) is such as to make the movement of the plate irreversible.

13. Device according to Claim 3, characterized in that it comprises a sensor (141) for detection of the angular position of the plate (22).

14. Device according to Claim 7 or 8 or 9, characterized in that said cylinders (31;131;231;331) are supplied so as to be compressed/discharged by means of corresponding operating means (40;140;150).

15. Device according to Claim 14, characterized in that said means for performing supplying of the cylinders (31) for rotational actuation of the plate (22) are of the automatic type.

16. Device according to Claim 15, characterized in that said automatic operating means comprise at least one sensor (41,41a) which is designed to detect the speed of rotation of the drive shaft (14) and emit a corresponding electric signal, at least one device (42) for transforming said electric signal into a signal for operating a valve (44) for distribution of the fluid operating the cylinders (31;131;231) and at least one metering valve (44) arranged downstream of said distribution valve (43).

17. Device according to Claim 14, characterized in that said operating means comprise means for automatic control of the angular position of the plate (22) in relation to the speed of rotation of the drive shaft (14).

18. Device according to Claim 17, characterized in that said automatic control means comprise a valve (145) for blocking the cylinders (31;131;231) for rotational actuation of the plate (22), arranged between said adjusting valves (44) and cylinders (31;131;231).

19. Device according to Claim 4, characterized in that it comprises cam means (432) which are designed to co-operate with a radial seat (222c) of the plate (22) so as to cause rotation thereof.

20. Device according to Claim 19, characterized in that said cam (222c) is rotationally actuated by associated operating means (431,431a).

21. Device according to Claim 1, characterized in that said means for performing rotation of the plate (22) are of the manual type.

22. Device according to Claims 2 and 21, characterized in that said manual operating means consist of a rod (151), one end of which is connected to an end of a screw (152), the other end of which projects outside the casing (11) of the engine and is integral with a manual operating knob (152a), said rod bring provided with a seat (151a) for engagement with the radial extension (22b) of the plate (22).

23. Device according to Claim 22, characterized in that said rod (151) for actuation of the plate (22) has a free end opposite to that connected to the screw in the form of a fork (151a) for engagement with an end-of-travel pin (153).

24. Device according to Claims 4 and 22, characterized in that said seat of the operating rod is an inclined surface designed to co-operate with the corresponding inclined surface (122c) of the radial projection (122b) of the plate (22).

25. Device according to Claim 21, characterized in that manual operating means consist of a valve (41) for distribution of the fluid for actuation of the manually operated cylinders (31;131).

26. Device according to Claim 1, characterized in that said means for performing rotation of the plate (22) are directly connected to the engine supply.

Fig.1

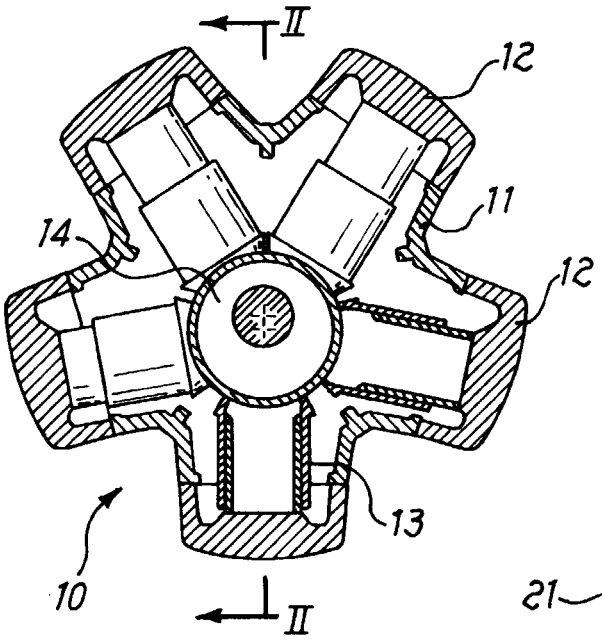
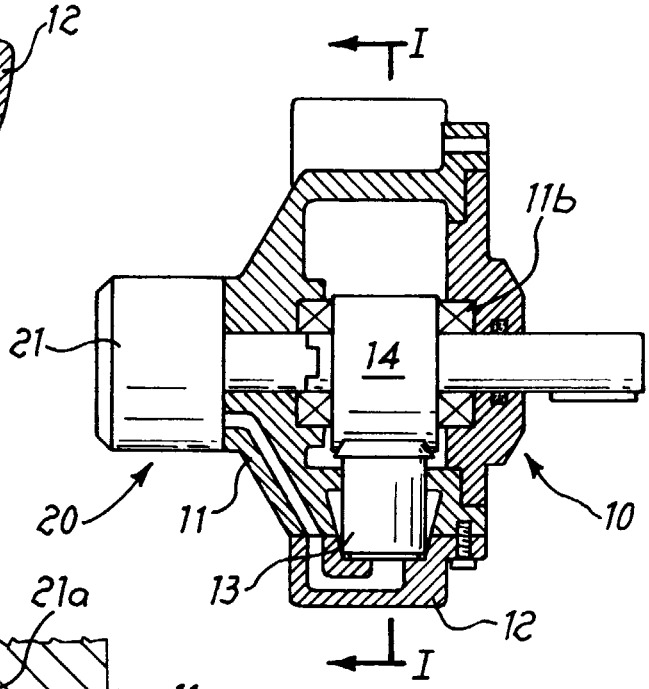


Fig.2



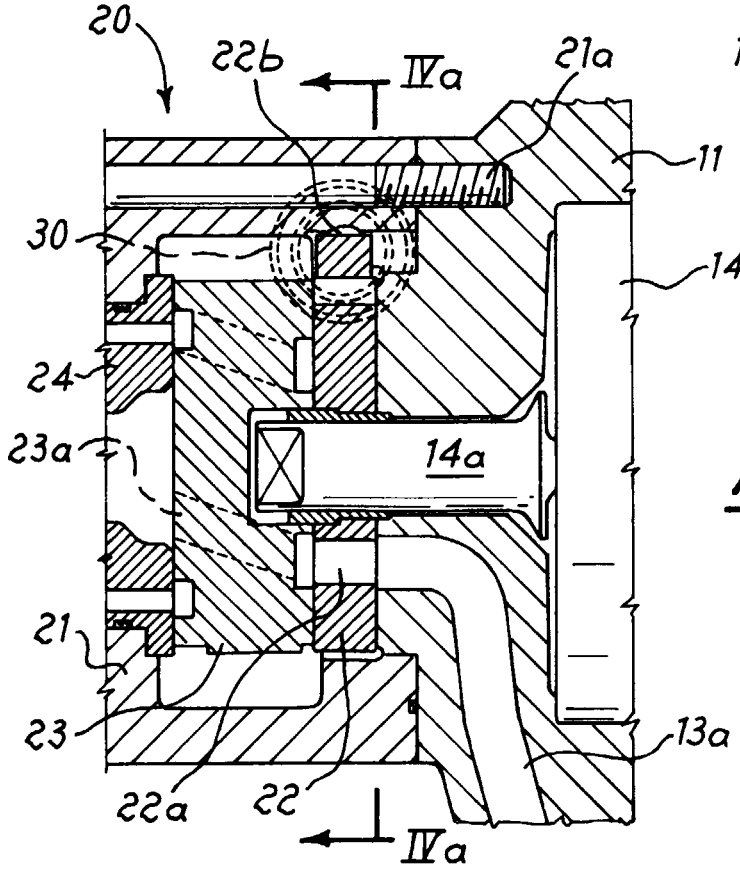


Fig.3

Fig.4a

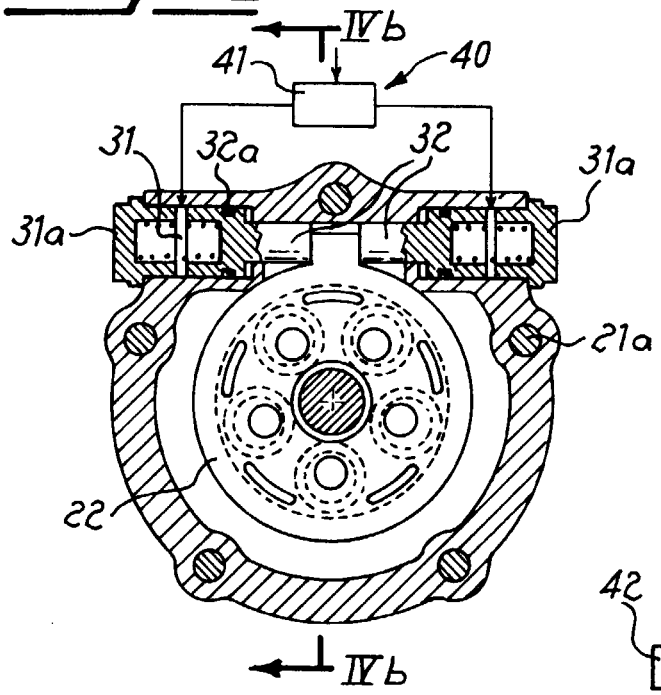


Fig.4b

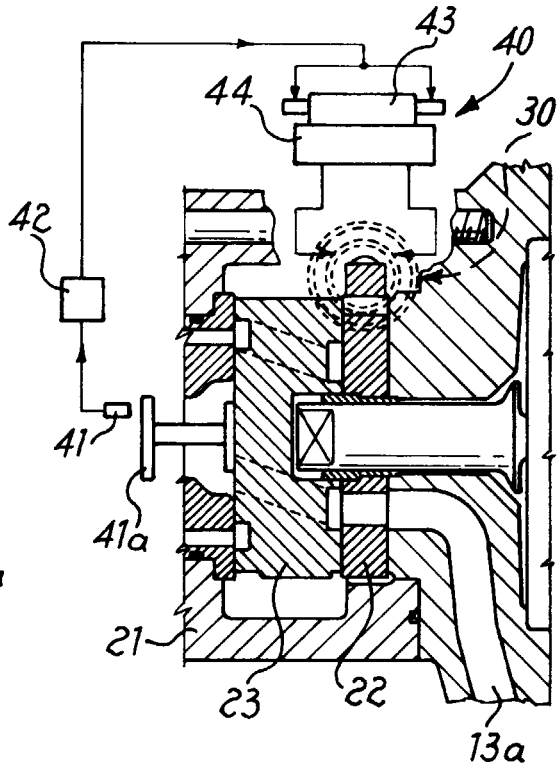


Fig.5a

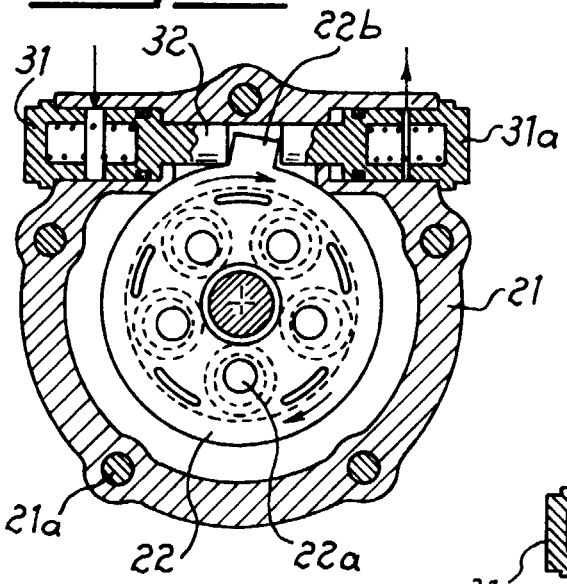


Fig.5b

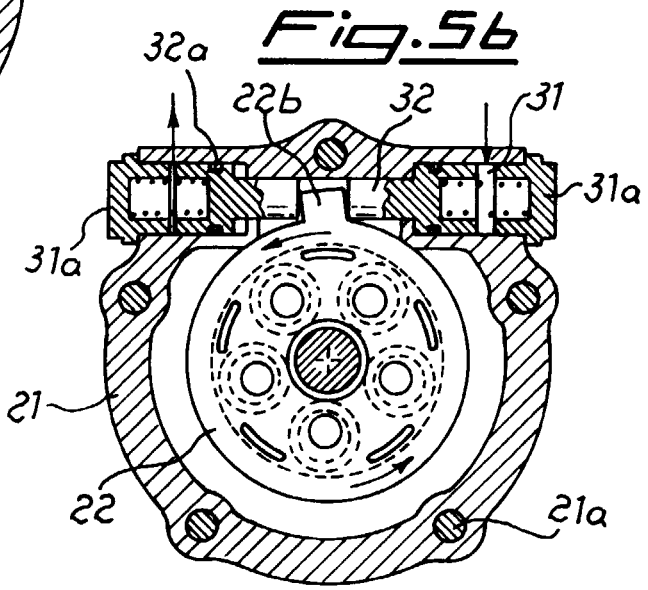


Fig.6a

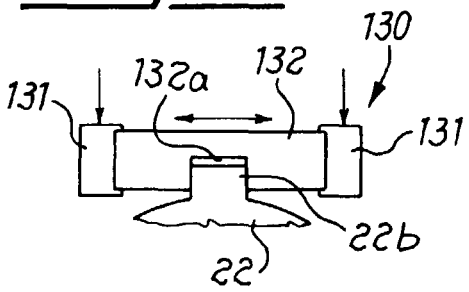


Fig.6b

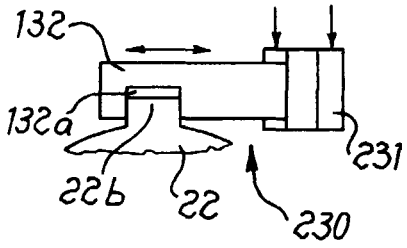


Fig.7a

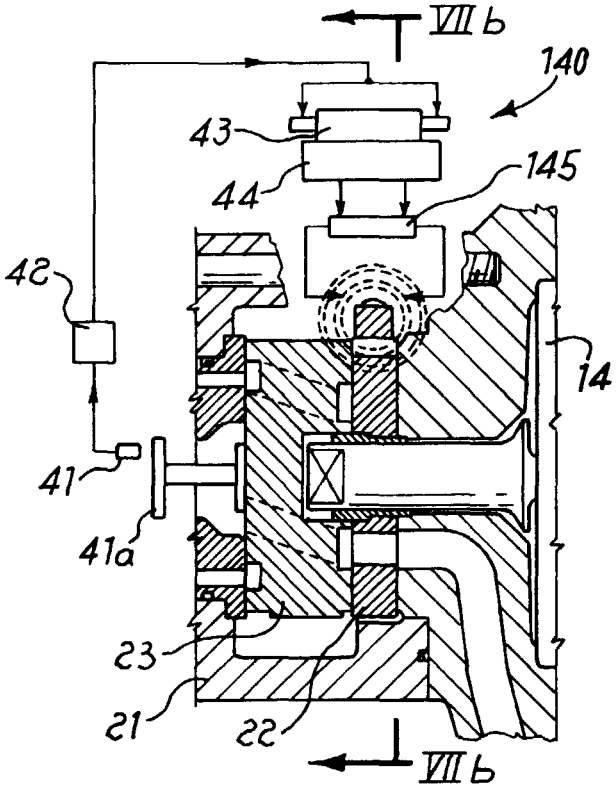


Fig.7b

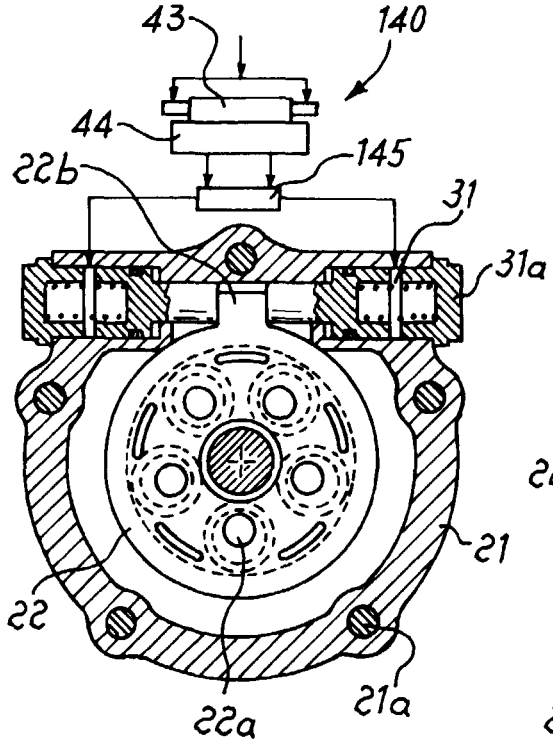


Fig.8

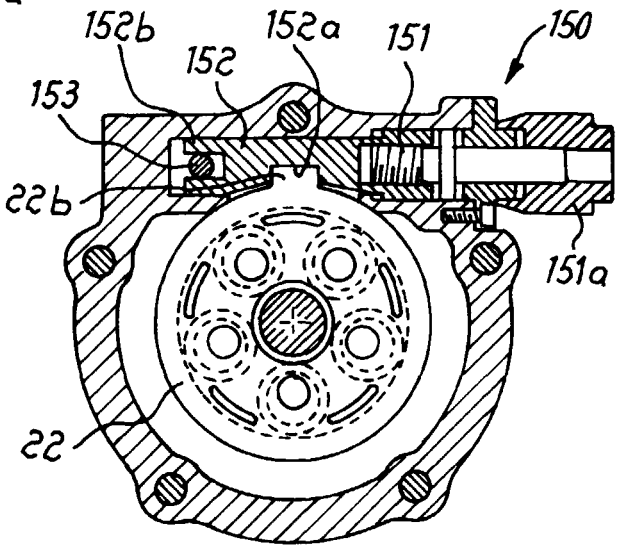


Fig.9a

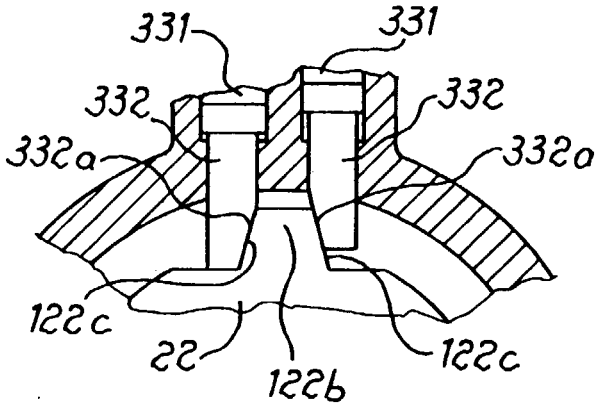


Fig.9b

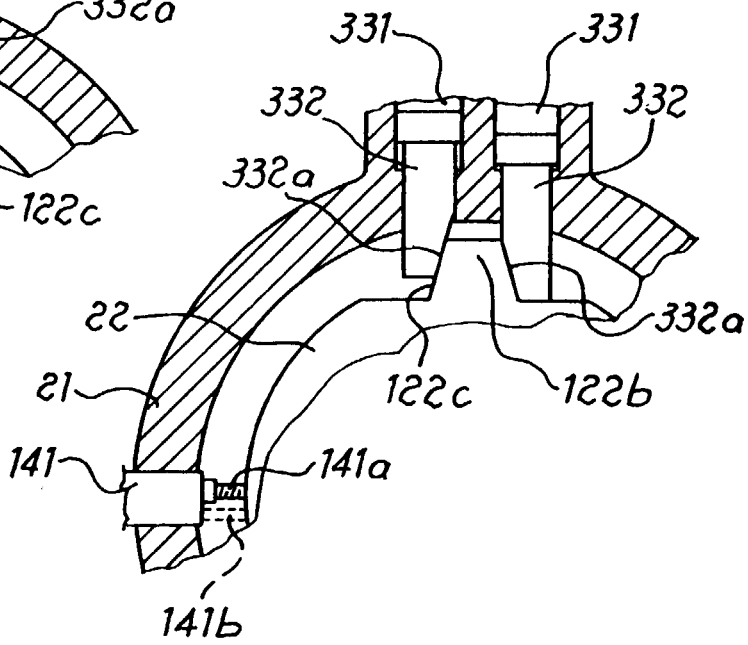


Fig.10a

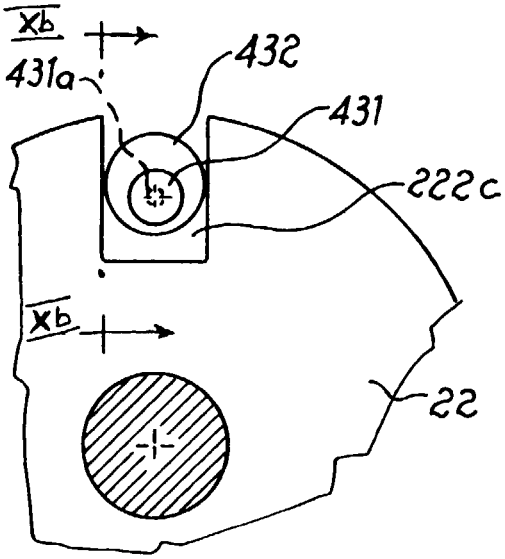


Fig.10b