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[54] **PRESSURE BALANCED RADIAL PISTON MACHINE**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **F01b 13/06**

[58] **Field of Search** 91/6.5, 476, 478, 91/498, 489, 505

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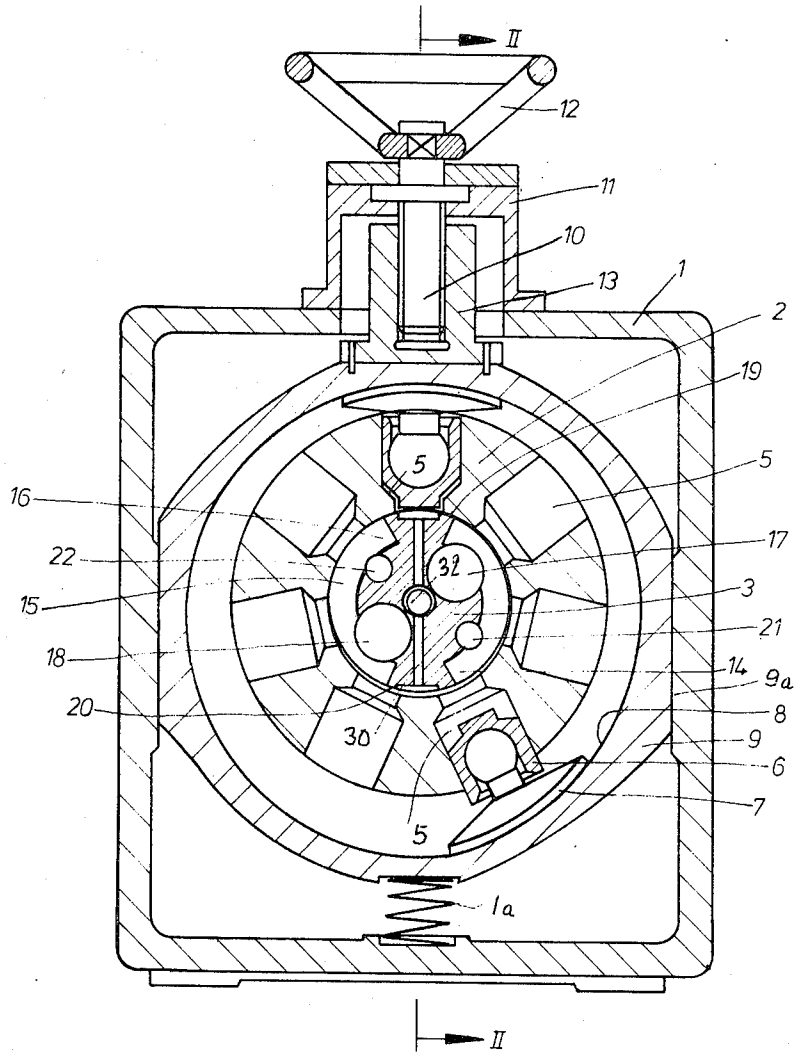
[57] **ABSTRACT**

The inward pressure exerted by the cylinder rotor of a hydraulic radial piston machine on the stationary control member on which the rotor rotates, is compensated by balancing chambers on control portions between the high and low pressure ports of the control member. Fluid under high pressure is supplied from the high pressure port to the respective control portion on which the inward pressure of the cylinder of the piston in the inner radial dead center position acts. The conduit system of the control member includes check valves preventing communication between the high pressure port and the low pressure port.

4 Claims, 3 Drawing Figures



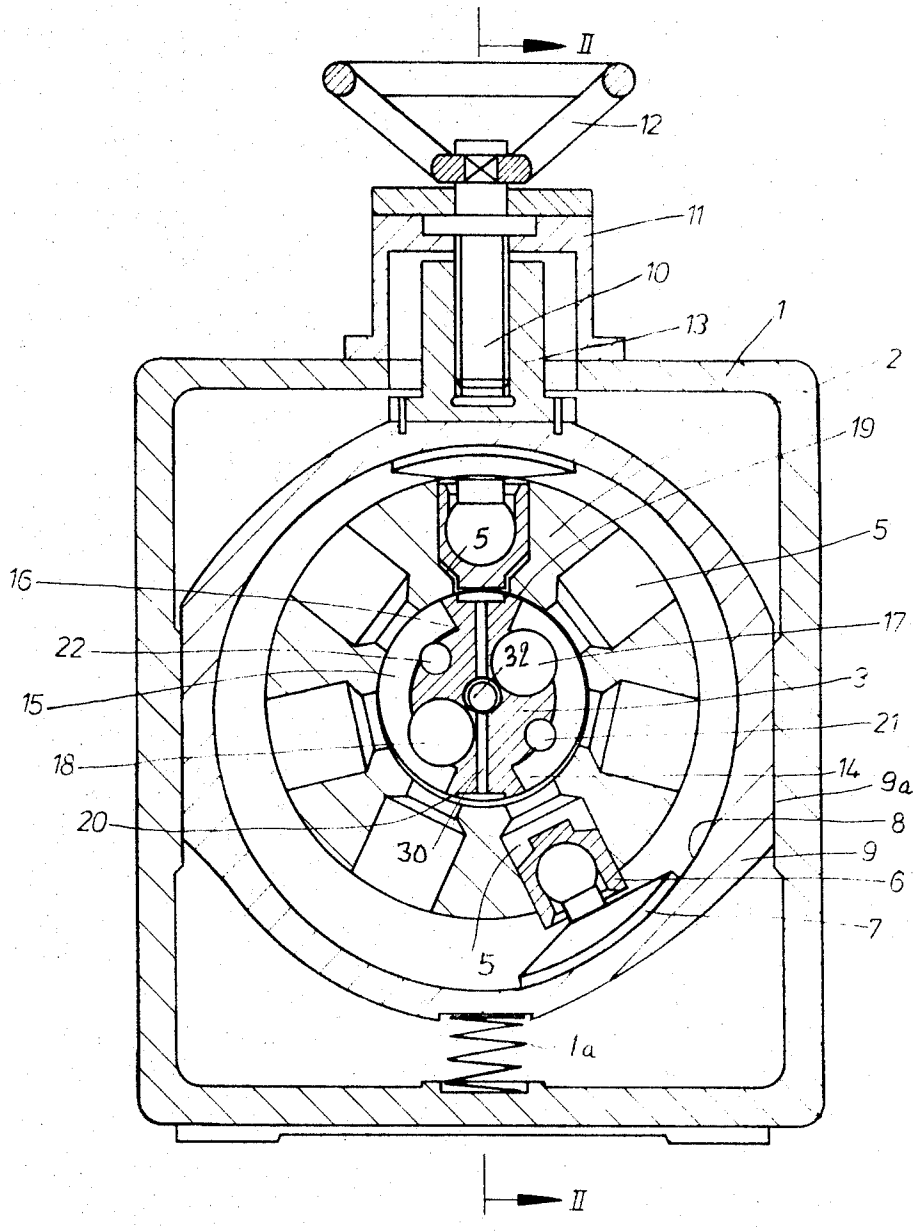


Fig. 1

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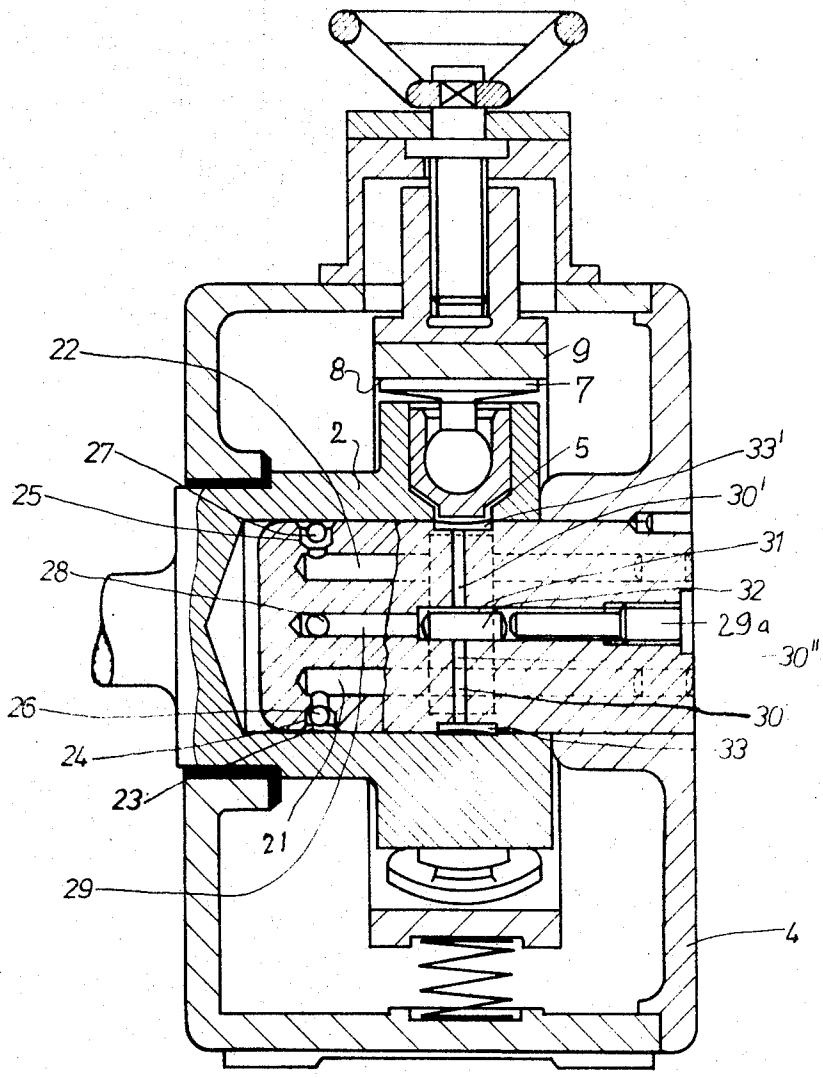

Fig. 2

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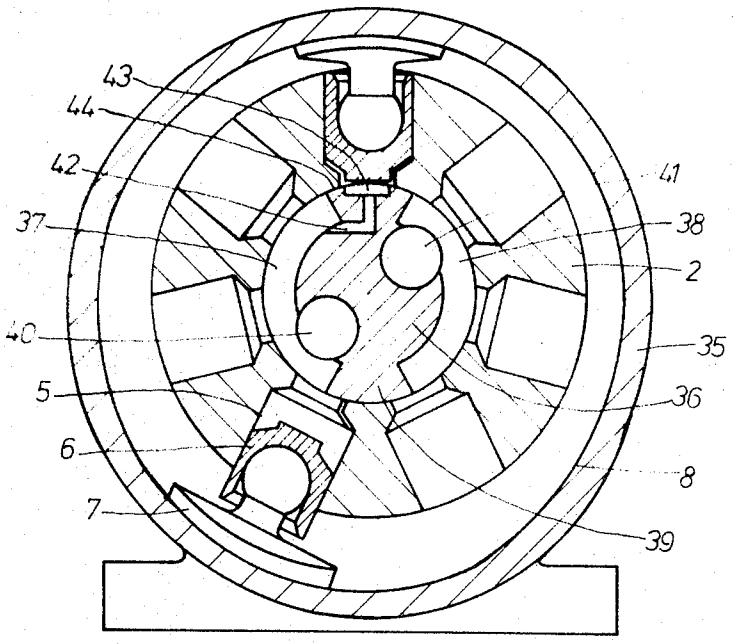

Fig. 3

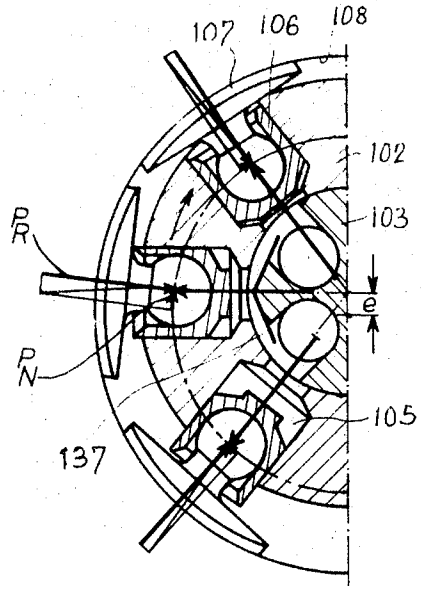

Fig. 4

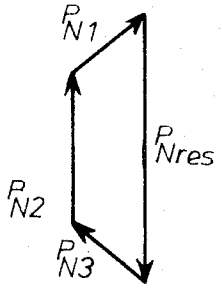

Fig. 4a

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PRESSURE BALANCED RADIAL PISTON MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to a radial piston machine, which may operate as a pump or hydraulic motor, and comprises an endless cam surface for reciprocating the radial pistons in cylinder chambers of the rotor which rotates on a stationary control member which acts as journal, and has pressure ports communicating with the inlet and outlet means of the machine.

In a radial piston machine of this type, pressures act on the pistons on the pressure side of the machine substantially in radial direction. The pressure forces can be divided into components one of which is hydrostatically equalized, while the other components of the piston forces together produce a resultant force which has the effect that the rotor abuts at the inner dead center position of the respective piston on the control journal member, and exerts a transverse force on the same. German Offenlegungs-schrift 1,453,629 discloses the provision of grooves on the control member in the region of the pressure ports. By connecting the grooves on the low pressure side with the high pressure side of the machine, pressure areas are obtained on the low pressure side which, however, are capable of compensating only those forces which act on the control journal member in the region of a low pressure side. The grooves which are connected with the high pressure side, which extend over the entire circumference of the control journal member, produce pressure areas which serve only the centering of the cylinder rotor on the control journal member.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a radial piston machine, for example a pump, whose control journal member is relieved of the force acting thereon in the region of the inner dead center position of the respective piston.

Another object of the invention is to balance the cylinder rotor with the radial pistons so that no inward pressure is exerted on the control journal member.

The objects of the invention are obtained by providing a pressure area on a portion of a control journal member which is located in the region of the inner dead center position of the pistons. The pressure area is connected by conduit means with the high pressure side of the machine.

Due to the balancing of the force acting on the control journal member at the inner dead center position of the pistons, it is prevented that the always existing play between the control journal member and the inner surface of the rotor causes communication between the inlet and outlet of the machine, which would cause high leakage losses.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view illustrating a reversible radial piston machine in accordance with a first embodiment of the invention;

FIG. 2 is an axial sectional view taken on line II—II in FIG. 1;

FIG. 3 is a cross-sectional view illustrating a non-reversable radial piston machine in accordance with a second embodiment of the invention;

FIG. 4 is a fragmentary cross-sectional view of a radial piston machine according to the prior art, and includes a diagrammatic illustration of the distribution of the forces created during operation of the machine, and acting on the control journal member; and

FIG. 4*a* is a schematic force diagram.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A radial piston machine according to the embodiment of the invention illustrated in FIGS. 1 and 2 has a housing 1, closed by a cover 4, and provided with confronting slide faces 9a along which corresponding slide faces of a displacement ring 9 can slide when the manual wheel 12 is rotated together with a spindle 10 engaging a nut secured to displacement ring 9. Spindle 10 is mounted in a bracket 11 secured to housing 1. The displacement ring 9 can be moved by spindle 10 from the illustrated end position to an other end position while compressing the spring 1a which supports the displacement ring 9 in the housing 1. Displacement ring 9 has an inner endless cam surface 8.

A stationary control journal member 3, whose axis is eccentrically spaced from the center of the cam surface 8, has an outer cylindrical surface formed with two ports 14, 15 which are diametrically arranged, and separated by control portions 16. The port 14 communicates with an axially extending bore 17, while the port 15 communicates with the corresponding axial conduit 18. The conduits 17 and 18 constitute inlet means and outlet means for the fluid pumped by the machine, or supplied to the machine when the same is operated as a hydraulic motor.

The control portions 16 which separate the arcuate ports 14 and 15, have outer face portions 19 and 20, respectively, forming portions of the cylindrical outer surface of the control journal member 3. Control portions 16, and the surface portions 19 and 20 are substantially located in an axial plane in which the eccentricity of the endless cam surface 8 in relation to the axis of the control journal member 3 can be adjusted, and in which the inner and outer dead center positions of the pistons are located.

Each of the ports 14 and 15 communicates with a channel 21 or 22, respectively into which open radial stepped bores 24 and 25, respectively which communicate with an annular channel 23 surrouding the control journal member 3 and being located in the outer cylindrical surface of the same. The stepped cylindrical bores 24, 25 form valve seats for the balls of check valves 26, 27. A third radial bore 28 connects the annular channel 23 with an axially extending channel 29 which is closed by a closure means 29a and communicates with a valve chamber 31 in which a valve element 32 is located.

Valve chamber 31 connects two portions 30′ and 30″ of a straight diametrical bore 30, the outer ends of the bore portions 30′, 30″ opening into balancing grooves 33′ and 33 which confront the inner open ends

of the cylinder chambers 5 which pass over the respective balancing groove rotation of rotor 2.

Referring now to FIGS. 4 and 4*a*, a radial piston pump of the type with which the present invention is concerned is shown, without the novel features of the invention. The center of the endless cam surface **108** is shown to be eccentric to the axis of the control journal member **103,** and of the rotor **102,** as indicated at *e*. The port **137** communicates with the three cylinder chambers **105** of a group of cylinder chambers in which radial pistons **106** including slide shoes **107** are mounted in a position in which slide shoes **107** slide on the eccentric cam surface **108,** so that the pistons are reciprocated. The port **137** is assumed to be the pressure port, so that pressure forces act in inward direction. The forces can be divided into a force component P_R acting at the axis of the respective slide shoe **107,** and a force P_N perpendicularly to the respective force P_R. The deviation of the force P_R from the radial direction is due to the eccentricity of the cam surface **108.**

The components P_R are hydrostatically equalized, while the transverse components P_N of the piston forces acting on the pressure side of the machine, can be geometrically added as shown in FIG. 4a so that a resultant force P_{Nres} is obtained. The resultant force P_{Nres} has the effect that the cylinder rotor **102** abuts the control journal member **103** when the respective piston is in the inner dead center position. In the same manner, a force is exerted on the control journal member 3 of the embodiment of FIGS. 1 and 2 which, however is compensated by the pressure of the pressure fluid supplied to the respective balancing groove **33** or **33'** according to the invention. The effective area of the balancing groove is selected so that the outward force, reacting against the pressure in the working chamber, balances the radial inwardly directed force produced in the working chamber by the piston which passes over the balancing groove in the inner dead center position.

When the radial piston machine is operated as a pump, and the cylinder rotor rotates in clockwise direction, the port **14** is connected with the suction inlet, and the port **15** is connected with the pressure outlet when the inner dead center position of the piston movement is located at the surface **19** of the control portion **16,** as shown in FIG. **1.** In this operational condition, pressure fluid from the pressure port **15** flows through the closed bore **22** and through the opened check valve **25** into the annular channel **23** of the control journal member **3.** The ball of check valve **26** is pressed onto its seat and prevents a flowing of the pressure fluid through the bore **21** into the low pressure port **14.**

Pressure fluid flows from the annular channel **23** into the radial bore **28,** and through the axially extending channel formed by the closed bore **29** to the valve chamber **31.** By the action of the flow of the pressure fluid the valve element **32** is always driven to that side and is pressed on the opening of that bore portion **30',** **30''**, where the largest play exists between teh control journal member **3** and the cylinder rotor **2.** Pressure fluid gets now, for example, through the bore portion **30'** into the balancing groove **33'**. There a pressure field is built up. The pressure field of the fluid in the balancing groove **33'**, acts on the surface **19** of the respective control portion **16,** and opposes the above-described resultant force P_{Nres}.

When the adjusting spindle **10** is operated to displace the cam ring **9** to its other end position, so that the inner dead center position of the pistons **6** is located at the surface **20** of the respective other control portion **16,** the port **14** becomes the high pressure port, and the port **15** becomes the low pressure port where action is exerted. The pressure fluid for balancing the forces flows from the high pressure port **14** through the closed bore **21** and the opened check valve **24** to teh annular channel **23.** Check valve **25** prevents a flow of the pressure fluid into the closed bore **22** which communicates with the low pressure port. The pressure fluid flows from the annular channel **23** through the radial bore **28** and the axially extending closed bore **29** into the valve chamber **31.** The valve element **32** closes the bore portion **30'** of the transverse bore **30,** and the pressure fluid flows the bore portion **30''** into the balancing groove **33** so that a pressure area is produced which balances the force acting on the surface portion **20** of the other control portion **16** of the control journal member **3.**

It is apparent that the annular channel **23** is connected in both operational conditions with the high pressure port of the machine. Furthermore, due to the function of the valve element **32,** there is always a balancing pressure area located opposite the surface portion of the control journal member **3** where the resultant force P_{Nres} acts.

The embodiment illustrated in FIG. **3** is simplified as compared with the embodiment of FIGS. **1** and **2,** but the machine is not reversible. Corresponding parts are indicated by the same reference numeral as in FIGS. **1** and **2.**

The machine has a housing **35** with an endless cam surface **8** whose center is eccentric to the axis of the control journal member **36.** Pistons **6** are mounted for radial movement in cylinder bores **5** of the cylinder rotor, and have slide shoes **7** mounted on the piston **6** for angular movement, and sliding under pressure along the cam surface **8.**

Control journal member **36** has two diametrically spaced high pressure and low pressure ports **37, 38** which are separated by control portions **39.** An axially extending bore **40** in the control journal member communicates with the port **37,** and a corresponding axially extending bore **41** communicates with the port **38** forming inlet and outlet conduits for the pressure fluid.

During rotation of the cylinder rotor **2** in clockwise direction, port **37** is the high pressure port and port **38** is the low pressure port. A duct **42** directly connects a balancing groove **43** on the outer surface **44** of one control portion **39** of the control journal member **2** with the high pressure port **37.** The balancing groove **43** is located directly opposite the inner dead center position of the respective piston **6** in the axial plane in which the centers of the endless cam surface **8** and of the control journal member **36** are eccentrically spaced from each other.

Pressure fluid flows from the pressure port **37** through duct **42** directly into the balancing groove **43** so that a pressure area is created which opposes the resultant force P_{Nres} acting on one side of the control journal member **2,** as explained with reference to FIGS. **4** and **4***a*.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of radial piston ma-

chines including pistons moving along an endless cam surface differing from the types described above.

While the invention has been illustrated and described as embodied in a pressure balanced radial piston machine, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

I claim:

1. Pressure balanced radial piston machine comprising supporting means including a housing and an endless cam surface; rotor means mounted in said housing and having a rotor axis eccentric to said cam surface in an axial plane, said rotor means having angularly spaced cylinder chambers, and piston means mounted in said cylinder chambers for radial movement and having outer ends sliding on said cam surface so that said piston means are reciprocated; a stationary control member supporting said rotor means for rotation about said rotor axis, and having diametrically spaced high pressure and low pressure ports communicating with fluid inlet and outlet means, and also communicating, respectively, with groups of said cylinder chambers located on opposite sides of said axial plane, said control member having two diametrically spaced control portions located between said high pressure and low pressure ports whereby inward pressure is exerted by said rotor means on one control portion in said axial plane when the piston means passing over said one control portion is in the inner dead center position, each of said control portions having a balancing groove, respectively, confronting the inner ends of said piston means, said control member having conduit means connecting said balancing grooves with the high pressure port whereby the fluid pressure in said balancing groove balances said inward pressure, said conduit means including a valve chamber, first duct means connecting said valve chamber with the port which is the high pressure port in the respective operational condition, second duct means connecting said valve chamber with said balancing grooves, and a valve element in said valve chamber for connecting said first duct means with said second duct means so that pressure fluid is supplied to the balancing groove of the control portion against which inward pressure is exerted in said axial plane by said rotor means, said second duct means including a bore extending transversely through said control member and having two ends opening into said balancing chambers, respectively; said valve member and valve element dividing said straight bore into two radial bore portions, each radial bore portion connecting one of said balancing chambers with said valve chamber and said first duct means.

2. Radial piston machine as claimed in claim 1 wherein said first duct means include two first channels connected with said ports, respectively, an annular channel surrounding said control member, check valves connecting said first channels with said annular channel, and an axially extending channel communicating with said annular channel and with said valve chamber.

3. Radial piston machine as claimed in claim 2, wherein said supporting means include a displacement ring mounted in said housing for movement in said one axial plane and having said endless cam surface movable with said displacement ring between two end positions; means for moving said displacement ring between said two end positions in which said inward pressure acts on said two control portions, respectively; and comprising means for rotating said rotor means in opposite directions.

4. Radial piston machine as claimed in claim 1 wherein said rotor means has an inner cylindrical surface on which said inner ends of said cylinder chambers open; wherein said control member has an outer cylindrical surface slidingly engaged by said inner cylindrical surface and formed with said ports and said balancing chamber.

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