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Bosch

[11] **3,802,321**

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[54] **ROTOR BALANCING ARRANGEMENT FOR AXIAL PISTON MACHINES**

[75] Inventor: **Paul Bosch,** Sudwigsburg, Germany

[73] Assignee: **Robert Bosch GmbH,** Stuttgart, Germany

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[30] **Foreign Application Priority Data**

July 6, 1971 Germany 2134026

[52] **U.S. Cl.** **91/485**
[51] **Int. Cl.** **F01b 13/04**
[58] **Field of Search** 91/485, 486, 487, 489

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Primary Examiner—William L. Freeh
Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

The cylinder block of an axial piston machine includes a rotary control face pressed against a stationary control face having inlet and outlet ports. A peripheral annular shoulder of the cylinder block cooperates with an annular shoulder on a pressure ring surrounding the cylinder block so that a pressure chamber is formed, communicating through a channel including a check valve, with an annular groove in the stationary control face connected by a throttle duct with a low pressure area. When the pressure between the control faces increases, the pressure in the pressure chamber also increases and urges the cylinder block with its control face against the stationary control face. A supporting ring for the pressure ring is mounted for universal tilting movement in the housing, to permit the cylinder block to assume the correct position.

10 Claims, 9 Drawing Figures

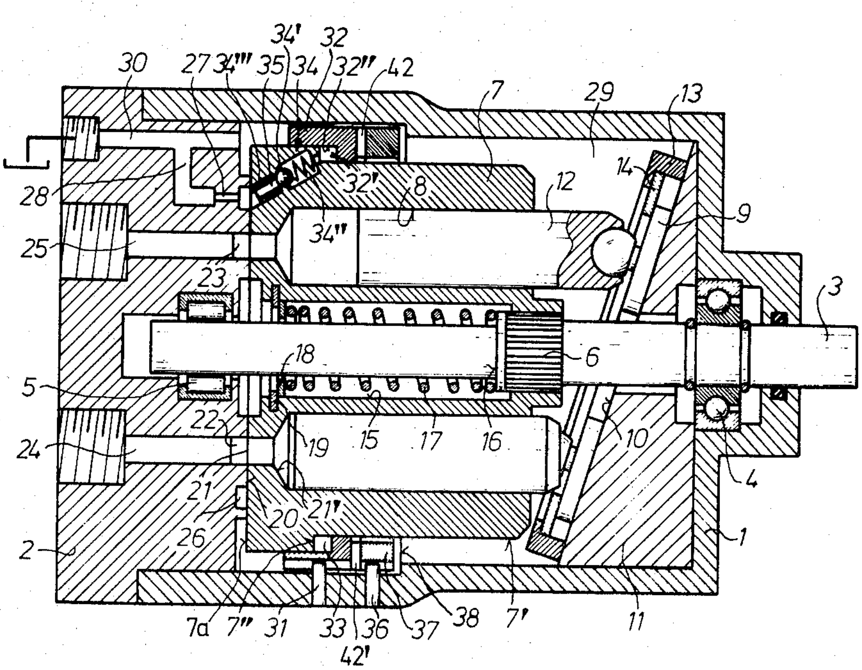

Fig. 1

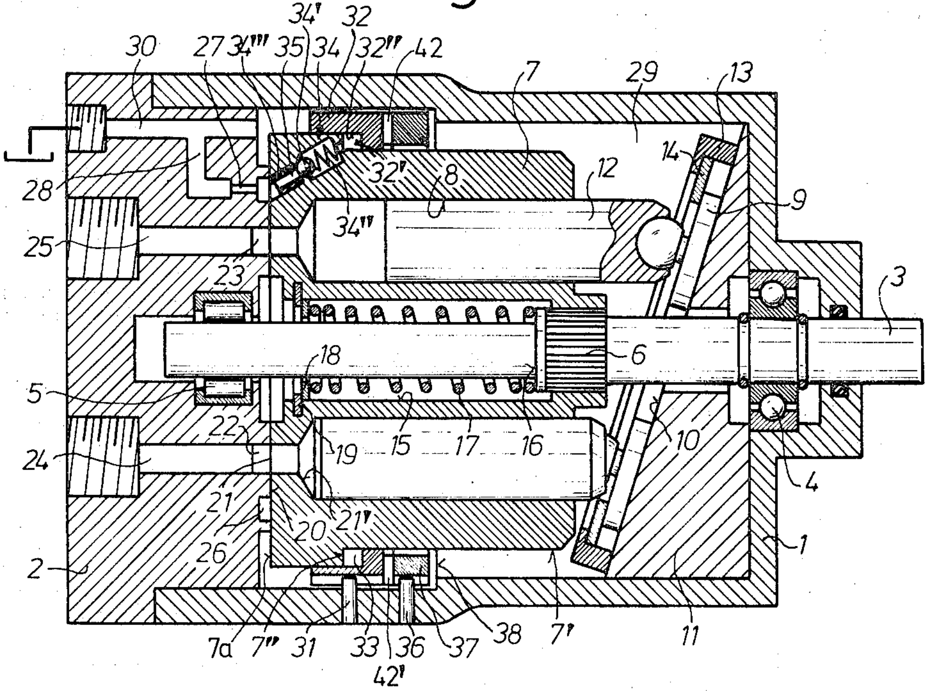

Fig. 2a

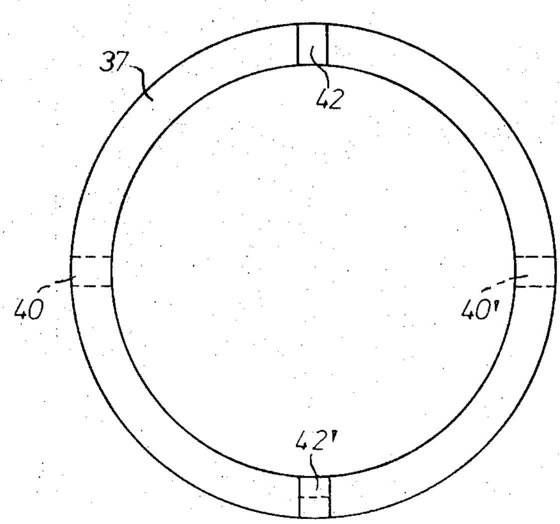

Fig. 2b

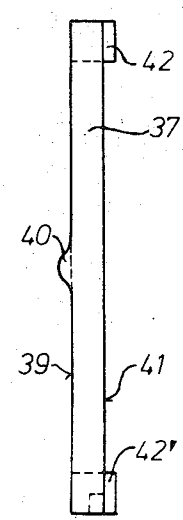

Fig. 3

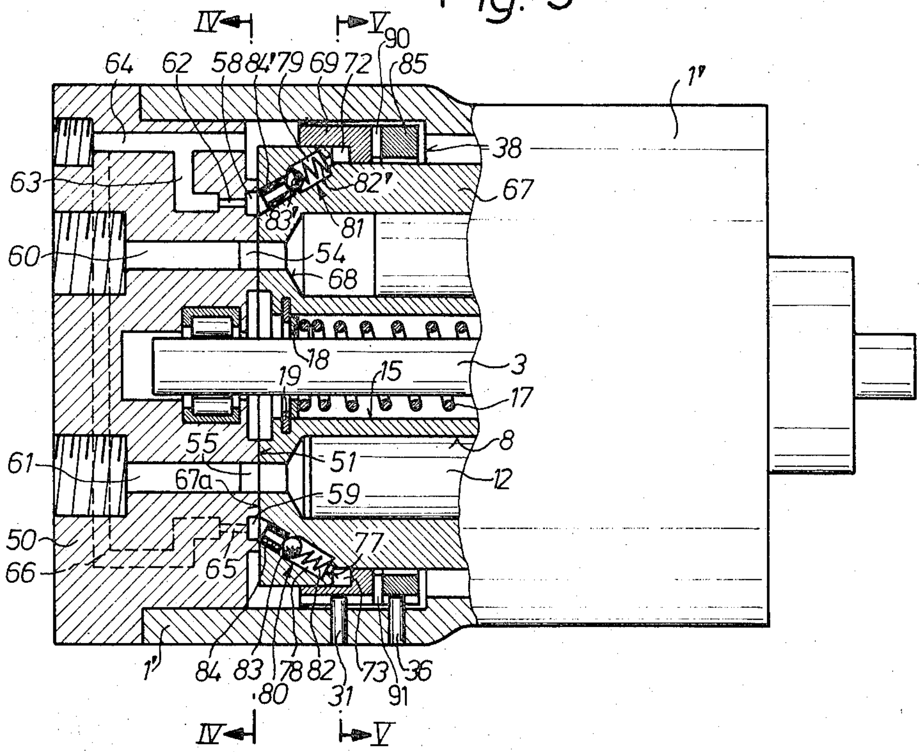
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Fig. 4

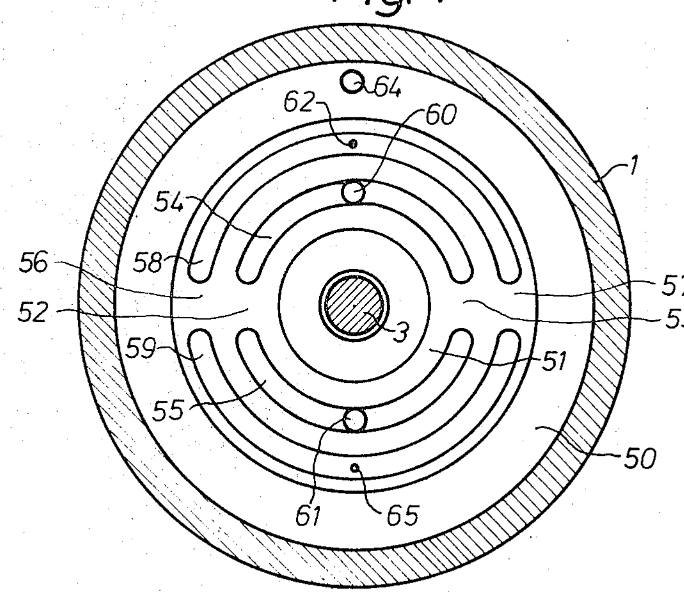
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Fig.5

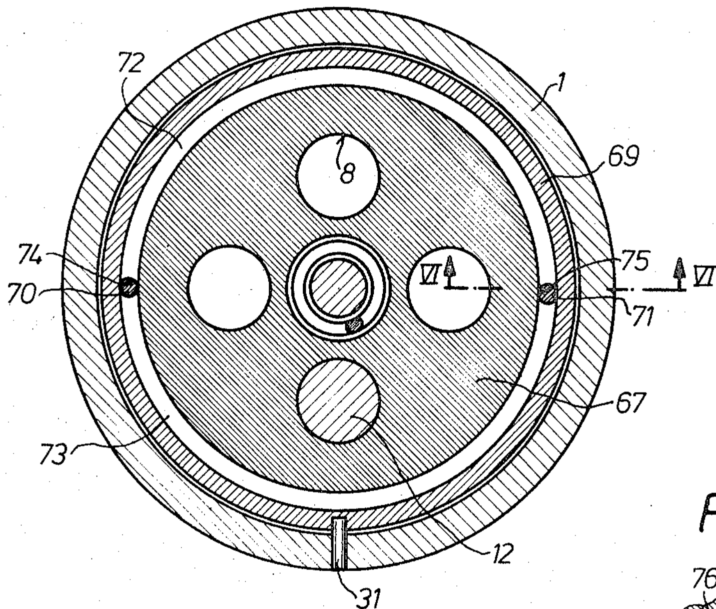


Fig.6

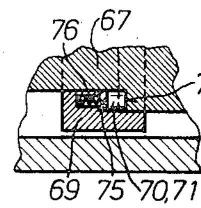


Fig. 7a

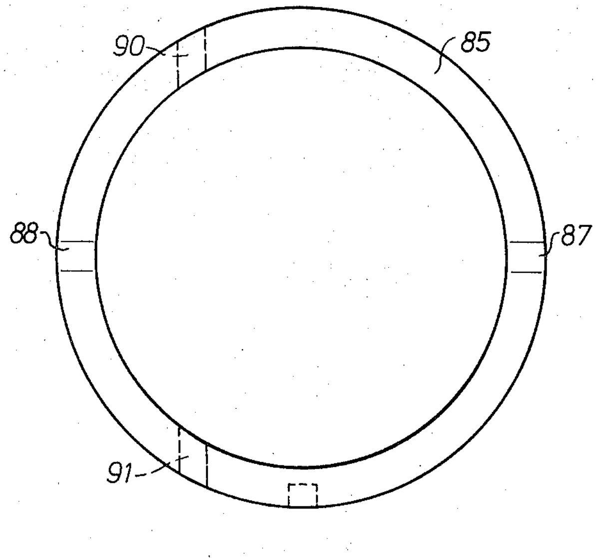
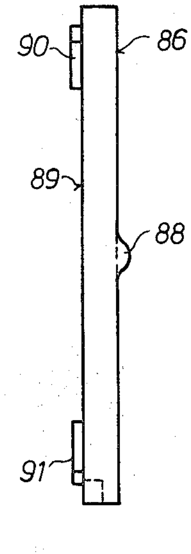


Fig.7b



ROTOR BALANCING ARRANGEMENT FOR AXIAL PISTON MACHINES

BACKGROUND OF THE INVENTION

The present invention relates to axial piston machines, pumps or motors, which are provided with pressure chambers for pressing the cylinder block against a stationary control face having inlet and outlet ports.

An axial piston machine of this type is disclosed in the German Patent 1,003,039. The apparatus of the prior art has the disadvantage that the cylinder block has to be guided for its entire length, which causes, in addition to high cost, also increased friction losses and developing of heat which reduces the efficiency. Furthermore, leakage losses at the abutting control faces, and edging of the cylinder block may occur.

SUMMARY OF THE INVENTION

It is one object of the invention to overcome the disadvantages of axial piston machines according to the prior art, and to provide an axial piston machine with a rotor balancing arrangement, which accomplishes reduction of the pressure on the control faces, and reduces leakage losses, while axial movement or angular tilting of the cylinder block away from the stationary control face is reliably prevented.

With these objects in view, an annular shoulder is provided on the peripheral surface of the cylinder block, and an annular pressure ring, which surrounds the cylinder block is provided with a corresponding shoulder, forming a pressure chamber. By means of a supporting ring, the pressure ring is mounted in the housing for universal tilting movement which has the advantage that the pressure ring can align itself in axial direction with the cylinder block, and transmits no tilting forces to the cylinder block. Consequently, the entire rotary end face of the cylinder block fully abuts the entire surface of the stationary control face of the housing so that leakage losses from a gap between the slidingly engaged control faces are avoided.

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 drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an axial sectional view illustrating an axial piston machine provided with the apparatus of the invention;

FIG. *2a* is a front view, and FIG. *2b* is a side view illustrating a universally tiltable supporting ring for the embodiment of FIG. **1**;

FIG. **3** is a side view, partially in axial section, illustrating a modification of the embodiment of FIG. **1**;

FIG. **4** is an axial sectional view taken on line IV—IV in FIG. **3**, and particularly illustrating the construction of a stationary control face on the housing;

FIG. **5** is a cross-sectional view taken on line V—V in FIG. **3**;

FIG. **6** is a fragmentary sectional view taken on line VI—VI in FIG. **5**; and

FIG. *7a* is a front view, and FIG. *7b* is a side view illustrating a universally tiltable supporting ring for the embodiment of FIGS. **3** to **6**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. **1**, *2a* and *2b*, an axial piston machine has a housing **1** closed by a cover **2**. A rotor shaft **3** is mounted in housing **1** in a ball bearing **4**, and in the cover **2** in a roller bearing **5**, and connected by a splined shaft portion **6** with a cylinder block **7** for rotation. Cylinder bores **8** are provided in cylinder block **7** concentric and parallel to the axis of shaft **3**, and contain pistons **12** provided with slide shoes **9** slidingly abutting a sliding surface **10** of a wobble plate **11**. A holding ring **14** secured in a cover ring **13** abuts on the slide shoes **90** and prevents a separation of the slide shoes from the slide surface **10**.

The rotor shaft **3** passes through the cylinder block **7** permitting by the splines **6** a limited axial movement of cylinder block **7**. A spring **17** abutting a shoulder **16** on shaft **3**, abuts a ring **19** which is inserted into an annular groove of the cylinder block bore **15**, so that the rotary end face *7a* of cylinder block **7** is mechanically pressed against the stationary control face **20** formed on cover **2** confronting the surface **10** of the wobble plate **11**.

The cylinder bores **8** have frustoconical end portions **21'** forming cylinder ports **21** of reduced cross-section which cooperate with part circular inlet and outlet ports **22, 23** in the stationary control face **20** which are supplied with pressure fluid by the inlet and outlet means **24, 25.** The arrangement is well known, and corresponds substantially to elements **60, 61, 54, 55** shown in FIG. **4** for another embodiment of the invention. The stationary control face **20** is further provided with an annular groove **26** surrounding the control ports **22, 23,** and connected by a conduit **28** including a throttle duct **27** wiht a discharge channel **30** which opens into a low pressure area, such as a reservoir for leakage oil.

A pressure ring **32** surrounds the outer peripheral surface of cylinder block **7**, and has an axially extending recess into which a pin **31** mounted on the housing **1** projects so that the pressure ring **32** is movable in axial direction, but prevented from rotation. An annular shoulder is formed about the periphery of cylinder block **7** and includes the cylindrical peripheral surface **7'** of the cylinder block, and an annular pressure surface **7''** facing toward the wobble plate **11.** The annular shoulders **7''** and **32'**, the cylindrical face **32''**, and the peripheral surface **7'**, together form a pressure chamber **33** which is so disposed that pressure fluid in the annular pressure chamber **33** urges the cylinder block **7** to move to the left as viewed in FIG. **1.** Axial movement of the pressure ring **32** is blocked by a supporting ring **37**, which is prevented from rotation by a pin **36** on housing **1** projecting into an axial recess of supporting ring **37.** Supporting ring **37** abuts an annular shoulder **38** formed in the inner surface of the housing **1.** The annular pressure chamber **33** formed in this manner, is connected by a channel **35** in cylinder block **7** with the annular groove **26** in control face **20** and a check valve body **34'** of check valve **34** is urged by a spring **34''** against an annular seat formed by a threaded bushing **34'''** which permits adjustment of the spring force to a predetermined pressure at which the check valve opens. FIGS. 2a and 2b show the construction of the supporting ring 37 in detail. On one annular lateral face 35, two diametrical projections 40, 40', and on the other lateral annular surface 41, two diametrically disposed projections 42, 42' are made. The projections have a part circular outline and are cylindrical in axial direction. The line of symmetry between projections 42, 42', and the line of symmetry between the projections 40 and 40' intersect at right angles in the axis of cylinder block 7 and shaft 3.

The function of an axial piston machine as illustrated in FIG. 1 is assumed to be known, and it will be understood that on the reduced portions 21' of the cylinder bores 8, a pressure acts together with the resilient force of spring 17 to cause abutment of the rotary control face 7a on the stationary control face 20 of the housing. Due to leakage losses from the gap between the rotary and stationary control faces, particularly in the region of the high pressure conduit 25 or 24, pressure fluid enters the annular groove 26 in the stationary control face 20. The amount of leaking pressure fluid depends on the operational pressure in the machine. Pressure fluid in the annular groove 26 can flow through the throttling duct 27 and conduit 28 to a low pressure area. Before throttling duct 27 and annular groove 26, pressure develops which depends on the amount of pressure fluid flowing away, and thereby on the working pressure. If, the pressure in the annular groove 26, acting to push the rotor to the right as viewed in FIG. 1, increases, and exceeds the closing force of the check valve 34, check valve 34 opens so that pressure fluid can flow through channel 35 into the annular pressure chamber 33. Pressure acting now on the annular shoulder 7'' on the cylinder block 7 in a direction to the left as viewed in FIG. 1, produces a force acting on the cylinder block 7 uniformly about its periphery and pressing the end face 7a of the cylinder block 7 against the stationary control face 20 with a force whose magnitude depends on the pressure before the throttling duct 27, which depends on the operational pressure, while the pressure in the gap between the rotary and stationary control faces 7a and 20, and the pressure acting in the annular groove 26, urges the rotor control faces 7a and thereby the rotor 7 away from the stationary control face 20.

If the pressure in the high pressure conduit 25 or 24 drops, the pressure also drops in the cylinder bores 8 which communicate with the inlet and outlet ports, and the forces acting on the reduced portions 21' of the cylinder bores 8, and pressing the cylinder block 7 against the control face 20, are also reduced, while the forces acting in the gap between stationary control face 20 and rotary control face 7a to displace rotor 7, to increase the width of the gap, are reduced due to the throttle effect at a smaller rate. The annular pressure surface 7'' of cylinder block 7, on which the pressure in pressure chamber 33 acts is so dimensioned that the pressure forces are sufficient to compensate the forces tending to lift the cylinder block off the stationary control face.

In the event that the cylinder block starts a tilting movement, the check valve 34 closes immediately, and the pressure in the annular pressure chamber 33 rises due to the compression of the pressure fluid caused by the tilting movement, so that a further tilting is reliably prevented.

The annular pressure chamber 33 has the effect that the forces transmitted from the pressure ring 32 to the supporting ring 37 are uniformly distributed about the circumference of the supporting ring, while the point at which the forces act coincides with the axis of rotation of the cylinder block 7. Due to the arrangement of the abutments 40, 40' and 42, 42', permitting tilting in two perpendicular directions, supporting ring 37 provides a Cardan-like support for the pressure ring 32 which is free to align itself in axial direction with the cylinder block 7 so that no tilting force is exerted on the cylinder block 7 due to the force pressing the cylinder block against stationary control face 20, since in this type of support by supporting ring 37, the pressure force of the annular face 32', and the reaction force of the supporting ring 37, which acts on the pressure ring 32, have coinciding resultant force lines. Consequently, the rotary control face 7a is parallel to the stationary control face 20 and fully abuts the same in sliding engagement, so that leakage losses are very small, and edging is prevented. The embodiment of the invention described with reference to FIG. 1, 2a and 2b is suitable for operating the axial piston machine in both directions of rotation, and each of the conduits 24 and 25 may be used as inlet or outlet.

FIG. 3 illustrates an embodiment of the invention which is suitable as a pump in which fluid always flows in the same direction. Corresponding parts are indicated by the same reference numerals in FIG. 3 as in FIG. 1.

The pump shown in FIG. 3 has a housing 1' closed by a cover 50 having a stationary control face 51 confronting a rotary control face 67a on the cylinder block 67. The stationary control face 51 is best shown in FIG. 4, from which it is apparent that part-circular inlet and outlet ports 54 and 55 are provided with fluid through conduits 60 and 61, conduit 60 being assumed to be the high pressure conduit. Concentric to the inlet and outlet control ports 54, 55, which are separated by face portions 52, 53, two part circular grooves 58, 59 separated by face portions 56 and 57 are provided. A line of symmetry between face portions 52, 53 coincides with the line of symmetry for groove portions 58 and 59. The groove portion 58 communicate with a conduit 63 which includes a throttling duct 62, shown in FIGS. 3 and 4. Conduit 64 is connected with a low pressure area. Another throttle duct 65 connects the center of groove part 59 with a conduit 66 connected with conduit 64 and a low pressure area.

The cylinder block 67 which has an inner stepped bore 15 through which the rotor shaft 3 passes, is biassed by spring 17 abutting a disc 18 secured by a ring 19 inserted into an annular recess in bore 15 so that the rotary control face 67a is pressed against the stationary control face 51. The cylinder bores with pistons 12 are arranged along a circle concentric with the axis of cylinder block 67 and have reduced portions 68 ending in rotor ports which communicate with the inlet and outlet ports 54, 55.

The cylinder block 67 is surrounded by a pressure ring 69 which forms with a shoulder 77 on cylinder block 67, two semi-circular pressure chambers 72, 73, separated by sealing pistons 70, 71 as best seen in FIGS. 5 and 6. The pistons 70, 71 are slidingly mounted in stepped bores 74, 75 provided in the pressure ring 69, and have peripheral surfaces in sealing engagement with the cylindrical surfaces of the cylinder block 67 and pressure ring 85. The sealing pistons 70, 71 are biassed by springs 76 into sealing abutment with the shoulder 77 of the cylinder block 67. A line connecting the axes of the sealing pistons 70, 71 coincides with the line of symmetry through face portions 52, 53, 56, 57 of the stationary control face 51, so that the pressure chambers 72, 73 are axially aligned behind the inlet and outlet ports 54, 55.

Two diametrically opposite channel means 78 and 79 are provided in the cylinder block 67 which connect the rotary control face 7*a* with the pressure chamber portions 72 and 73, opening on the annular shoulder 77 on the outer periphery of cylinder block 67. Channels 78, 79 connect the groove parts 58, 59 with the pressure chamber parts 72, 73. The width of the face portions between the ports 58, 59 in the stationary control face 51 is dimensioned so that the ports of the channels 78, 79, which cooperate with grooved parts 58, 59 are closed over the same angle as the ports in annular shoulder 77 are closed by the sealing pistons 70, 71. In each channel 78, 79, a check valve 80, 81 is provided whose ball 83, 83′ abuts a seat formed by a threaded bushing 84, 84′ due to the action of a spring 82, 82′, respectively. The pressure ring 69 abuts a supporting ring 85 which abuts on its other side on a shoulder 38 of housing 1′. Pressure ring 69 and supporting ring 85 have axial grooves into which stationary pins 31, 36 project to block rotational movement of pressure ring 69 and supporting ring 85. The construction of the supporting ring 85 is best seen in FIGS. 7*a* and 7*b*. Supporting ring 86 has on one annular face 86, which confronts the housing shoulder 38, two projections 87, 88 which are diametrically disposed on an axial plane, and has on the other side 89 two corresponding projections 90, and 91 which are respectively spaced different angular distances from projections 87 and 88, as best seen in FIG. 7*a*. Each projection has a part circular outline and forms a corresponding cylinder. The lines of symmetry passing through projections 90, 91 on the one hand, and projections 87, 80 on the other hand, intersect at right angles, but the point of intersection does not coincide with the rotor axis, but is located spaced from the rotor axis with which supporting ring 85 is concentric, as clearly shown in FIG. 7*a*.

During operation of the machine, the cylinder block 87 is pressed by spring 17 and by the fluid pressure acting on the frustoconical portions 68 of the cylinder bores 8, against the stationary control face 51. Between the rotary control face 67*a* and the stationary control face 51, particularly in the region of the high pressure conduit 60 and port 54, pressure fluid flows out. Pressure develops between the abutting control faces, tending to separate the rotary control face 67*a* from the stationary control face 51. A part of the leaking pressure fluid enters the groove portion 58 which extends about the high pressure port 54 from where the fluid can flow through the throttling duct 62 conduit 63 and conduit 64 to a low pressure area. A comparatively smaller amount of pressure fluid flows into the other groove part 59, and flows through throttling conduit 65, and conduit 66 and conduit 64 to the low pressure area upstream of the throttle duct 62, 65, pressure develops in the groove parts 58, 59 which produce a force acting on the rotary control face 67*a* to move the same way from the stationary control face 51. The pressure in the groove part 58, communicating with the high pressure port 54, is greater than the pressure in groove part 59 in region of the low pressure port 55, and consequently, a greater force acts in the region of groove part 58 than in the region of groove part 59, to urge the cylinder block 67 away from the stationary control face 51 so that the center of the resultant of the forces is displaced relative to the rotor axis. If cylinder block 67 assumes a position in which the channels 78, 79 sweep the groove parts 58, 59, and if the pressure in the groove parts 58, 59 is sufficiently great to overcome the force of the spring of the check valves 80, 81, pressure fluid enters the two pressure chamber parts 72 and 73. After a certain angle of rotation, one of the channels, for example channel 78 which connects the groove parts 58 with the pressure chamber part 72, is substantially at the same time closed by face portion on the stationary control face 57*a*, as a sealing piston 70, 71 closes a pressure chamber part and connects, when the channel ports are open again, the groove part 89 with the pressure chamber part 73. At the same time, with the first channel 78, the second channel 79, which until now had connected groove part 59 and pressure chamber part 73, connects the groove part 58 with the pressure chamber part 72. Due to the provision of two diametrically disposed channels, the communication between a pressure chamber part and a groove part is only interrupted as long as the channel ports are closed either by a control face portion of the stationary control face 51, or by a sealing piston 72, 71. The pressure acting on the annular shoulder 77 of the cylinder block 67, produces additional forces which cause abutment of the rotary control face 67*a* of cylinder block 67 on the stationary control face 51, and a common resultant force acts on a point which coincides with the point at which the resultant of the forces tending to lift the rotor off the stationary control face 51 acts.

In the event of a sudden pressure drop in the high pressure port 54, the forces acting on the reduced cylinder bore portions 68 disappear, whereas the separating forces acting in the gap between the rotary control face 67*a* and the stationary control face 51 are only slowly reduced due to the throttling effect of the gap. The shoulder 77 of the cylinder block 67 is dimensioned so that the pressure produced in the pressure chamber parts 72, 73 compensates and balances the still effective forces tending to separate the cylinder block 67 from the stationary control face. A sudden pressure drop in the pressure chambers 72, 73 is prevented by the check valves 80 and 81. If the cylinder block 67 nevertheless performs a tilting motion, the check valves 80, 81 close at smallest angular displacement, and the pressure rising in the pressure chamber due to the movement and acting on shoulder 77, prevents a further lifting of the rotary control face 67*a* from the stationary control face 51.

Due to the disposition of the projections 87, 88 in relation to the projections 90 and 91 on supporting ring 85, the center of the forces exerted by pressure ring 69 and pressure chamber parts 72, 73 coincides substantially with the reaction forces acting on the same point. As in the embodiment of FIG. 1, the universally movable supporting ring 85 permits an alignment of the pressure ring 69 in axial direction of the cylinder block 67 so that no tilting forces can act on the cylinder block 67 caused by the forces pressing the cylinder block 67 toward the stationary control face 51.

In a simplified modification, one of the channels, for example channel 78, may be omitted, together with the throttling duct **65** in conduit **77.** In such an arrangement the forces which bias the cylinder block **67** against the stationary control face **51,** are reduced.

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 balancing arrangements for axial piston machines, differing from the types described above.

While the invention has been illustrated and described as embodied in a rotor balancing arrangement for an axial piston machine comprising a pressure ring surrounding the cylinder block and forming a pressure chamber and a tiltable supporting ring between the pressure ring and a shoulder of the housing, 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. Rotor balancing arrangement for axial piston machines, comprising housing means having a stationary control face and a wobble surface confronting each other; rotor means mounted in said housing means for rotation, and including a rotary cylinder block having a rotary control face slidingly engaging said stationary control face, pistons mounted in cylinder bores of said cylinder block and having free ends sliding on said wobble surface, the pressure in said cylinder bores urging said rotary control face against said stationary control face, said cylinder block having a peripheral annular should facing toward said wobble surface; a pressure ring surrounding said cylinder block and mounted thereon for axial movement, said pressure ring having an annular shoulder forming with said peripheral annular shoulder at least one pressure chamber; channel means connecting said pressure chamber with the gap between said control faces so that an increase of the pressure in said gap causes an increase of the pressure in said pressure chamber whereby said rotary control surface is urged against said stationary control face; and a tiltable supporting ring between said pressure ring and an annular shoulder of said housing means for axially supporting said pressure ring for universal tilting movement so that said cylinder block is balanced in a position in which said rotary control face is parallel to said stationary control face, said tiltable supporting ring having on one side a pair of projections abutting said pressure ring and said shoulder of said housing means, respectively, arranged so that lines through said pairs of projections intersect at right angles.

2. Rotor balancing arrangement for axial piston machines, comprising housing means having a stationary control face and a wobble surface confronting each other, said stationary control face having inlet and outlet ports for fluid at different pressures, and a circular groove divided into two groove parts and located radially outward of said inlet and outlet ports; rotor means mounted in said housing means for rotation, and including a rotary cylinder block having a rotary control face slidingly engaging said stationary control face, pistons mounted in cylinder bores of said cylinder block and having free ends sliding on said wobble surface, the pressure in said cylinder bores urging said rotary control face against said stationary control face, said cylinder block having a peripheral annular shoulder facing toward said wobble surface; a pressure ring surrounding said cylinder block and mounted thereon for axial movement, said pressure ring having an annular shoulder forming with said peripheral annular shoulder at least one pressure chamber; means for dividing said pressure chamber into two pressure chamber parts; channel means connecting said pressure chamber with a gap between said control faces so that an increase of the pressure in said gap causes an increase of the pressure in said pressure chamber, whereby said rotary control surface is urged against said stationary control face, said channel means including two channels respectively connecting said groove parts with said pressure chamber parts so that different pressures prevail in said pressure chamber parts; and a tiltable supporting ring between said pressure ring and an annular shoulder of said housing means for axially supporting said pressure ring for universal tilting movement so that said cylinder block is balanced in a position in which said rotary control face is parallel to said stationary control face.

3. Rotor balancing arrangement as claimed in claim **2** wherein said housing means has two throttle conduits connecting said groove parts with a low pressure area, respectively.

4. Rotor balancing arrangement as claimed in claim **3** wherein each of said channels includes adjustable check valve means opening at a predetermined pressure at the respective groove part to permit high pressure fluid and low pressure fluid from the gap between said control faces to enter said pressure chamber parts.

5. Rotor balancing arrangement as claimed in claim **3** wherein said tiltable supporting ring has on either side a pair of projections abutting said pressure ring and said shoulder of said housing means, respectively, wherein lines through said pairs of projections, respectively, intersect at right angles at a point spaced from the axis of said rotor means.

6. Rotor balancing arrangement for axial piston machines, comprising housing means having a stationary control face and a wobble surface confronting each other; rotor means mounted in said housing means for rotation, and including a rotary cylinder block having a rotary control face slidingly engaging said stationary control face, pistons mounted in cylinder bores of said cylinder block and having free ends sliding on said wobble surface, the pressure in said cylinder bores urging said rotary control face against said stationary control face, said cylinder block having a peripheral annular shoulder facing toward said wobble surface; a pressure ring surrounding said cylinder block and mounted thereon for axial movement, said pressure ring having an annular shoulder forming with said peripheral annular shoulder at least one pressure chamber; rigid channel means connecting said pressure chamber with the gap between said control faces so that an increase of the pressure in said gap causes an increase of the pressure in said pressure chamber whereby said rotary control surface is urged against said stationary control face; and a tiltable supporting ring between said pressure ring and an annular shoulder of said housing means for axially supporting said pressure ring for universal tilting movement so that said cylinder block is balanced in a position in which said rotary control face is parallel to said stationary control face.

7. Rotor balancing arrangement as claimed in claim **1** wherein said projections of said pairs are spaced 180°, and wherein said lines intersect at right angles at the axis of said rotor means; and wherein said pressure chamber is annular.

8. Rotor balancing arrangement as claimed in claim **6** wherein said stationary control face has inlet and outlet ports, and an annular groove surrounding said inlet and outlet ports and communicating with said channel means located in said cylinder block.

9. Rotor balancing arrangement as claimed in claim **8** comprising a throttle duct connecting said annular groove with a low pressure area.

10. Rotor balancing arrangement as claimed in claim **9** wherein said channel means include an adjustable check valve opening at a predetermined pressure in said annular groove to permit pressure fluid to enter said pressure chamber.

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