April 12, 1960 E. ORSHANSKY, JR 2,932,256

FLUID PRESSURE PUMP OR MOTOR

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Fig. 1.

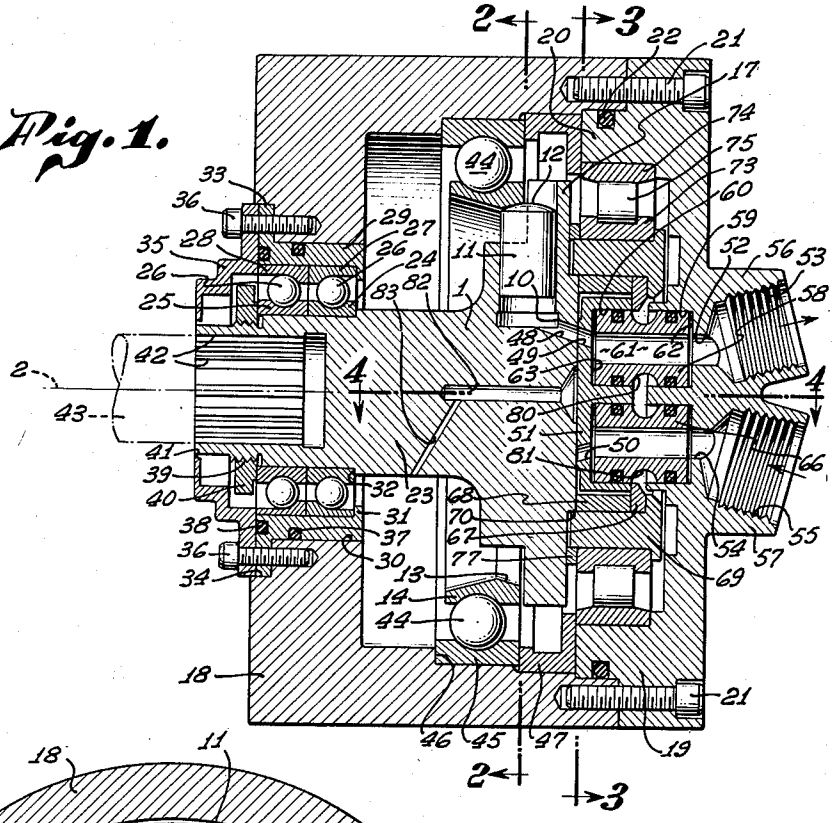
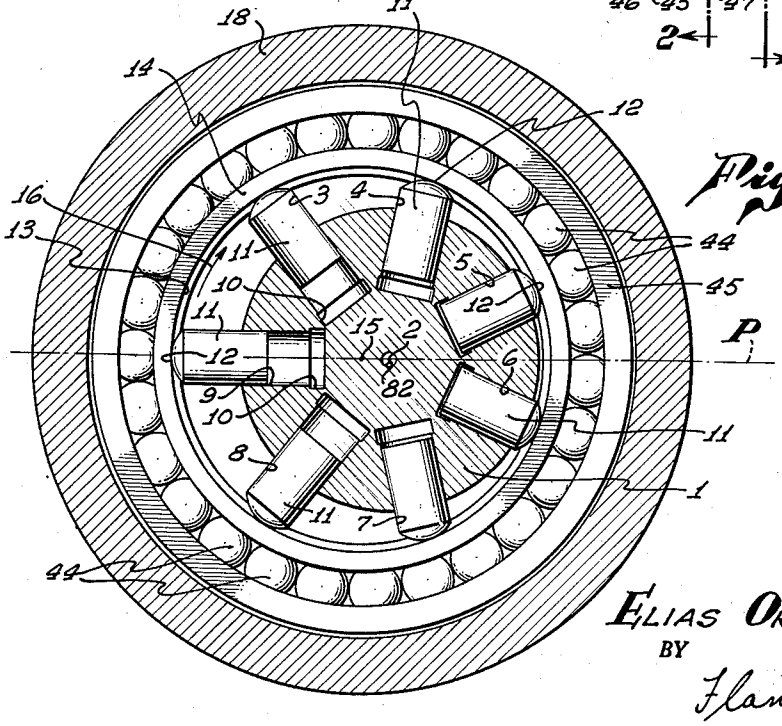


Fig. 2.



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Fig. 3.

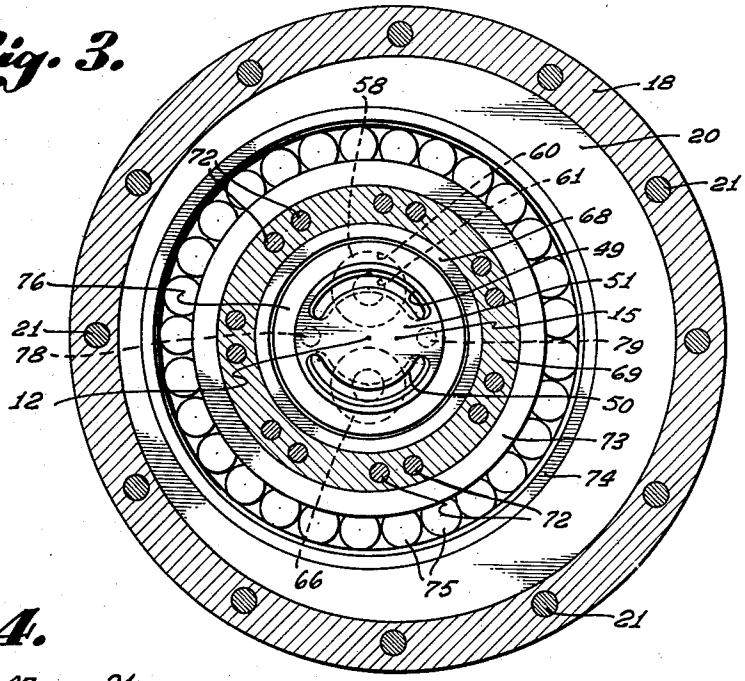


Fig. 4.

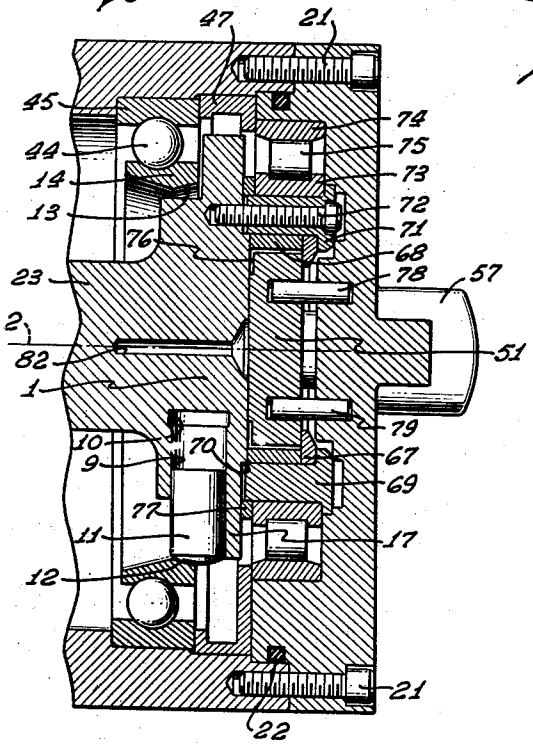
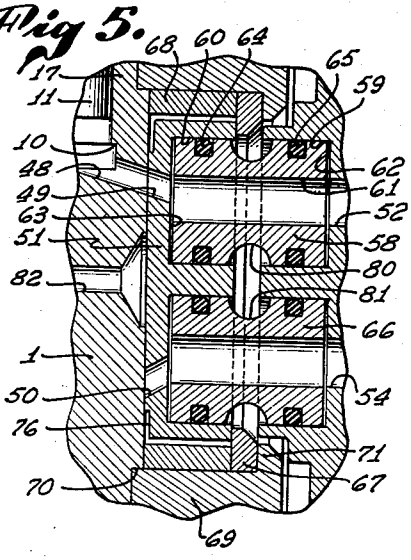


Fig 5.



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United States Patent Office 2,932,256
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FLUID PRESSURE PUMP OR MOTOR

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Application December 21, 1953, Serial No. 399,443

4 Claims. (Cl. 103—161)

This invention relates to apparatus adapted to operate either as a fluid pump or as a fluid motor. More particularly it relates to a structure adapted to operate under high liquid pressures of the order of several thousand pounds per square inch.

This application is a continuation-in-part of an application filed May 11, 1953, under Serial No. 354,018, entitled: Fluid Pressure Mechanism, now Patent No. 2,809,594, issued October 15, 1957.

Pumps capable of producing high pressures are now commonly used on aircraft for providing the hydraulic pressures to operate numerous controls, etc., for the aircraft. Difficulties are encountered in providing a simple, compact, and efficient pump suitable for these purposes.

It is one of the objects of this invention to provide a high pressure pump that effectively complies with all of these requirements; however, embodiments of the invention may of course be utilized for other purposes.

Pumps for producing such high pressures may utilize a rotary cylinder block, having radial cylinder bores, equi-angularly spaced around the axis of rotation of the block. Pistons operate in the bores. The reciprocation of the pistons is effected by the aid of an eccentric reaction ring, having an internal surface against which the outer ends of the pistons bear. Let it be assumed that a plane passes through the axis of the cylinder block and the axis of the eccentric ring. Then all of the pistons on one side of the plane are moving outwardly of the bores (corresponding to intake of fluid), and all those on the other side of the plane are moving inwardly (corresponding to the pressure stroke). Provisions for connecting the bores first to the inlet and then to the outlet of the pump, are effected in the usual manner, as by a non-rotary valve plate.

In said prior application, the valve plate is firmly attached to one of the walls of the casing. In order to provide a pump structure in which leakage of the liquid being pumped is minimized, provisions were made to ensure that the valve plate and the cylinder block would be maintained in proper contacting relationship.

It is one of the objects of this invention to ensure against substantial leakage by providing a limited freedom of movement for the valve plate, elements carried by the cylinder block. Accordingly, the cylinder block may be supported for rotation in a simple and inexpensive manner, and yet there is assurance that even upon minor deflection of the cylinder block the valve plate will be maintained in proper relationship therewith.

It is another object of this invention to ensure that as the cylinder block and valve plate cock with respect to the axis of rotation, yet the seal is maintained between the ports in the valve plate and inlet and outlet passageways in the casing.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the

drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a cross sectional view of an embodiment of the invention;

Fig. 2 is a sectional view taken along a plane corresponding to line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken along a plane corresponding to line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view taken along a plane corresponding to line 4—4 of Fig. 1; and

Fig. 5 is an enlarged fragmentary sectional view showing the inlet and outlet ports.

The hydraulic structure includes a rotary cylinder block 1. This cylinder block 1 is mounted for rotation about an axis 2.

A number of radially arranged cylinder bores are provided in the cylinder block 1. In this instance, seven such cylinder bores are shown, which are equiangularly spaced around the axis 2. In the position shown in Fig. 2, cylinder bores 3, 4 and 5 are located above the horizontal plane P, passing through the axis 2. Three other cylinder bores 6, 7, and 8 are disposed below this plane. The seventh bore 9 is shown as having its axis in the plane P.

At the inner ends of these bores enlarged recesses 10 are provided in order to facilitate the provision of ports at the inner ends of the cylinder spaces.

In each of these cylinder bores a piston structure 11 is radially movable. The outer end of each of these piston structures is provided with a convex surface 12, preferably spherical, arranged to cooperate with the sloping or conical surface 13 of an eccentric reaction ring 14. The axis 15 (Figs. 2 and 3) of this reaction ring is shown as disposed in the plane P. Accordingly, as the rotary cylinder block revolves in a clockwise direction, as indicated by arrow 16 of Fig. 2, each piston structure 11 is urged radially inwardly while the piston is moving through an angle of 180° about axis 2, and above the plane P. In a pumping structure, therefore, this corresponds to the pumping stroke.

In the next half revolution below the plane P, each piston 11 is caused to move outwardly of the respective cylinder chambers; and therefore this angular movement corresponds to the intake stroke. In order, therefore, that the mechanism be operated as a pump, the outlet passage is connected to those cylinder spaces which are located above the plane P, and the inlet to the cylinder spaces is connected to those which extend below the plane P, as viewed in Fig. 2.

The walls forming the cylinder spaces 3, 4, 5, etc., are each provided with a semi-circular extension 17 (Figs. 1 and 4), projecting radially of the axis 2. Each semi-circular extension 17 has its concave side facing the reaction ring 14. Thus these extensions provide long guiding surfaces for the piston structures 11, well able to sustain the reaction of the side thrust imposed upon the pistons by the reaction ring 14. Accordingly, the tendency to distort the cylinder bores into an elliptic form is substantially prevented.

The cylinder block 1, as well as the reaction ring 14, is appropriately supported within a casing structure. This casing structure includes the casing 18, of general hollow cylindrical form, and a cover 19. The cover 19 is provided with a flange 20, which rests against a shoulder formed integrally of the casing 18. A plurality of machine screws 21 serve to secure the cover member 19 in

place. An O-ring 22 is disposed in a groove in the flange 20 for providing an appropriate seal.

Extending from the left hand side of the cylinder block 1 a hub structure 23 is provided. This hub structure mounts a pair of inner races 24 and 25 (Fig. 1) for rolling bearing elements, such as the balls 26. These races are placed side by side. The outer races 27 and 28 are mounted in a sleeve member 29. This sleeve member 29 is disposed in an appropriate opening 30 in the end wall of the casing 18. An inwardly directed flange 31 serves to limit movement of the races 27 and 28 axially inwardly. Similarly, a shoulder 32 on hub 23 accomplishes the same function in connection with the inner races 24 and 25.

The sleeve 29 has a flange 33 located in a counterbore 34 at the left hand side of the casing 18. A supplemental cover structure 35 is disposed over the flange 33; and machine screws 36, threaded into appropriate threaded holes in the casing 18, serve to hold the sleeve 29 and the cover member 35 in position with respect to the casing 18. Sleeve 29 is provided with a sealing O-ring 37 located in an outer groove in the sleeve 29. The left hand face of sleeve 29 is similarly provided with a sealing O-ring 38 engaging the right hand face of cover member 35.

Extending beyond the hub 23 is an externally threaded portion 39 formed integrally with the hub 23. A locking nut 40 holds the inner races 24 and 25 tightly against the shoulder 32. The right hand face of cover member 35 similarly acts to hold the outer races 27 and 28 in position.

The cover member 35 is provided with an aperture 41 into which the left hand end of the hub structure 23 extends. The hollow left hand end of hub structure 23 is provided with internal splines 42 adapted to engage corresponding external splines of the driving shaft 43.

The reaction ring 14 which which the pistons 11 cooperate is rotatably mounted by the aid of a plurality of balls 44. These balls 44 are disposed between the reaction ring 14 and an outer race 45. This outer race 45 is mounted on a shoulder 46 formed in the casing 18. The outer race 45 is held against the shoulder 46 by the aid of a channeled ring 47 interposed between the left hand surface of the cover member 19 and the outer race 45.

Each and every one of the cylinder bores 4, 5, 6, etc., is provided with a port 48 (Figs. 1 and 5). All of the ports 48 slope radially inwardly and open in the right hand surface of the cylinder block 1. These ports cooperate with either one or the other of the kidney ports 49 and 50, located in a valve plate 51. These kidney ports 49 and 50 have a slope corresponding with the slope of the ports 48 to form a smooth passageway for the fluid or liquid passing through the ports.

The kidney port 49, being above the plane P, communicates with these cylinder spaces that are in the discharging position. Therefore, this kidney port is in communication with a corresponding port 52 in cover 19 leading to the outlet 53. The kidney port 50 similarly cooperates with a port 54 in cover 19 leading to the inlet opening 55.

Outlet opening 53 and inlet opening 55 are threaded for appropriate pipe connections, and are located in bosses 56 and 57 integral with the cover member 19.

Communication between ports 49 and 52 is effected by a sleeve 58. The right hand end of this sleeve 58 is located in an aperture 59 in the cover member 19, and forming a counterbore for the port 52. Its left hand end is similarly mounted in a recess 60 in the valve plate 51. This sleeve 58 has an axial aperture or port 61 in communication with the ports 49 and 52. There is clearance (shown exaggerated in Figs. 1 and 5) between the ends of sleeve 58 and the opposed shoulders 62 and 63 formed respectively in the cover member 19 and in the valve plate 51. This clearance may be of the order of a few thousandths of an inch. Furthermore, the outer diameter of the sleeve 58 has clearance with the aperture 59 and the recess 60. O-rings 64 and 65 are disposed in external grooves in the sleeve 58 for sealing the sleeve member 58 within its right hand and left hand guiding recesses.

The valve port 50 and the inlet port 54 are similarly in communication by the aid of a sleeve structure 66 of identical construction with the sleeve structure 58. The left hand surface of valve plate 51, as viewed in Figs. 1 and 5, is opposed to the right hand surface of the cylinder block 1. These two elements are maintained in proper cooperative relation by an annular guide structure, carried by the block 1. A ring 67 forms the outer side of this guide structure.

A spacer ring 68 is interposed between the ring 67 and the right hand face of cylinder block 1. In this way a channel is formed for the accommodation of the valve plate 51. The width of this channel is slightly greater than the width of the valve plate 51, so that rotation of block 1 be not restrained by the non-rotary valve plate 51. Furthermore, the ring 67 is urged tightly against the spacer ring 68 by the aid of a clamp ring 69. This clamp ring 69 telescopes over a cylindrical extension 70 of the cylinder block 1. It has an inwardly directed flange 71 engaging the right hand surface of ring 67. A plurality of machine screws 72, threading into block 1, pass through the ring 69 for urging the flange 71 tightly against the ring 67. In order to insure a clamping effect, the width of the clamping ring 69 is such that there is a slight clearance between its left hand surface and the contiguous surface of the block 1, when clamping is fully effected. This clearance is shown exaggerated in Fig. 1.

Due to the seal provisions effected by the O-rings 64 and 65 around each of the sleeves 58 and 66, it is ensured that no leakage of hydraulic fluid can occur into the casing 18—19, even when the plate 51 is cocked with respect to the axis 2.

The ring 69 also serves to support the inner race 73 of a roller bearing structure rotatably supporting block 1. The outer race 74 is supported within the cover member 19. The inner race 73, being mounted on the clamping ring 69, is rotatable with the cylinder block 1. A ring 77 is interposed between the block 1, and the race 73, for appropriately positioning this race in an axial direction.

Any leakage that may occur between the valve plate 51 and block 1 may be discharged through a central opening 82 and a vent 83 (Fig. 1). Venting of any leakage past the sleeves 58 or 66 is effected by the aid of the grooves 80 and 81, formed on the outer peripheries of these sleeves 58 and 66.

The area of the valve plate 51 that is in opposition to the cylinder block 1 is determined by reducing the thickness of the plate at its outer edge, forming an annular depressed area 76 adjacent the outer edge of plate 51. The opposed areas of block 1 and plate 51 determine the cumulative effect of the outlet pressure urging these two elements apart.

The valve plate 51 is quite loosely supported by the aid of a pair of pins 78 and 79 (Fig. 4), rigidly mounted in the cover 19. These pins have substantial clearances in recesses formed in plate 51.

Due to the freedom of movement permitted for the plate 51, it is capable of being maintained in proper operative relationship with the ported side of the cylinder block 1.

The inner wall 63 of recess 60 is subjected to outlet pressure by virtue of the clearance between sleeve 58 and the surface of wall 63. The area subjected to this high pressure is so located and of such size that the resultant force substantially entirely balances the resultant force due to outlet pressure that urges the plate 51 toward the right. Accordingly, this plate is maintained in close contact with the block 1, even if the

block is slightly deflected. The bearing structures for the block, and including the rolling elements 26, 35, and 75, need not be of the precision type; they are made adequately to withstand the stresses imposed upon the block 1.

The relative minor forces due to the inlet pressure, and existing between the valve plate 51 and block 1 is similarly neutralized by the aid of the inner wall of the recess that accommodates sleeve 66.

The inventor claims:

1. In hydrodynamic apparatus including a rotary cylinder block having radial cylinder chambers, piston structures for said chambers, an eccentric reaction ring, said cylinder chambers having ports opening in one of the side surfaces of the block, and a casing for the apparatus, said casing having passages forming an inlet passage and an outlet passage: a non-rotary valve plate having a low pressure port and a high pressure port respectively on opposite sides of a plane passing through the axis of rotation of the block, as well as through the axis of the reaction ring; said plate having recesses respectively communicating with the ports; the plate ports opening in a surface of the plate which cooperates with the ported side of the cylinder block; a pair of apertured sleeves accommodated in said recesses, the apertures in the sleeves communicating respectively with the valve ports, as well as with the passages in the casing; a spacer ring extending around the valve plate and supported by the aid of the cylinder block; and additional means carried by the cylinder block defining, with said spacer ring, a confining groove housing the valve plate and maintaining said cooperating surface of said valve plate and ported side of said cylinder block in a substantially parallel relationship for all operating orientations of said cylinder block.

2. In hydrodynamic apparatus including a casing having inlet and outlet passages, a rotary cylinder block in the casing and having radial cylinder chambers, piston structures in said chambers, and an eccentric ring for causing the pistons to reciprocate in the chambers, said cylinder chambers having ports opening in one of the side surfaces of the block: a non-rotary valve plate having an inlet port and an outlet port opening in one face thereof and cooperating with the cylinder ports; means mounting said valve plate with limited freedom of movement relative to the stationary parts of the apparatus; valve plate engaging means carried by the cylinder block connecting said block and said valve plate for unitary movement in response to cocking action of said block, said engaging means including a spacer element abutting said one surface of said block, and a shoulder element

abutting said spacer element and engaging said valve plate; a first sleeve having a longitudinal aperture and disposed between said inlet port and said inlet passage; and a second sleeve having a longitudinal aperture and disposed between said outlet port and said outlet passage; said sleeves having sealing means for preventing leakage of hydraulic fluid to the interior of the casing.

3. In hydrodynamic apparatus as defined in claim 2: said two sleeves being seated in respective recesses in said valve plate and said casing with limited axial clearance with respect to the end walls of said recesses; and said sealing means comprising packing means about the outer surfaces of said two sleeves located between said sleeves and their respective recesses in said valve plate and said casing.

4. In hydrodynamic apparatus including a rotary cylinder block having radial cylinder chambers, piston structures in said chambers, an eccentric ring, said cylinder chambers having ports opening in one of the side surfaces of the block, and a casing for the apparatus, said casing having a passage to the exterior of the casing: a non-rotary valve plate having a face in opposed substantially parallel relation to said one side surface of the block and having a port in said face for cooperating successively with said cylinder ports; means mounting said valve plate with limited freedom of movement relative to said casing; interlocking means connecting said valve plate and cylinder block for unitary movement in response to cocking action of said cylinder block; whereby said face of said valve plate and said one side surface of said cylinder block are maintained in substantially parallel relationship for all operating orientations of said cylinder block; said valve plate having a recess; a sleeve having a longitudinal aperture and accommodated in the recess, the sleeve intercommunicating the valve port and said passage, said sleeve having clearance with respect to the end surface of said recess; and means cooperating with the exterior surface of the sleeve to seal the passage and the valve port against leakage into the interior of the casing.

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