

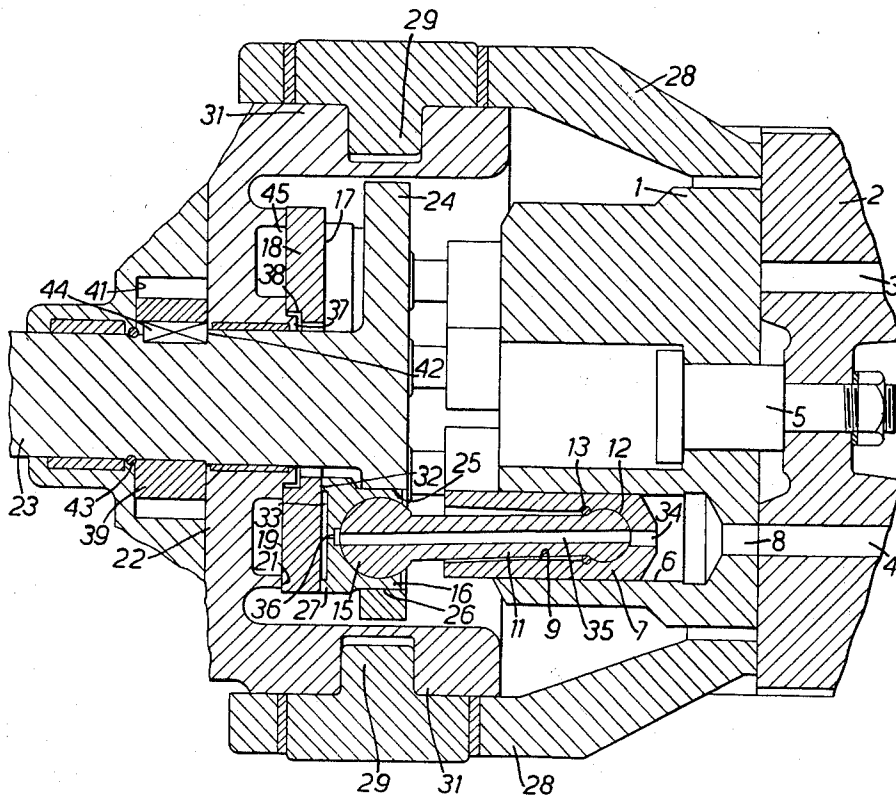
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ROTATING WEAR PLATE

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ROTATING WEAR PLATE

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This invention relates to hydraulic pumps or motors of the swash plate of tilting head type, wherein hydraulically balanced slipper bearings intended for use in conjunction with a flat cam surface produce reciprocating movement of pistons in a cylinder block, with substantial thrust, as a result of movement of the slipper over the cam surface in synchronism with the rotation of a cylinder block and a drive shaft.

The present invention comprises a slipper bearing slidably carried by a rotary drive member for engagement against a flat cam surface disposed perpendicularly to the rotation axis of the drive member, an articulated joint in the slipper from which a connecting rod or like thrust member extends and hydraulic bearing means acting between the cam surface and the slipper, the cam surface being formed by the surface of a wear plate rotatably mounted on a backing member.

The wear plate in this arrangement will be rotated on the backing member by the drag of the slipper at a speed slower than the speed of the drive member, thus reducing the tendency for uneven wear.

Preferably the plate is of uniform thickness and engages against a generally flat surface of the backing member to permit rotation.

The slipper bearing may be rotatably mounted in the drive member so as to rotate about its own axis whilst being driven by the drive member.

The wear plate is preferably of annular form and of a radial width substantially equal to the diameter of the slipper surface which engages the wear plate.

The wear plate is preferably loosely located by a spigot projecting from the backing member which enters a recess in the wear plate to a distance which is greater than the slidable movement of the slipper away from the wear plate whereby the slipper serves to ensure that the wear plate cannot disengage from the projection.

A plurality of slippers may be mounted in an equally spaced manner around the drive member for engagement with the wear plate.

One embodiment of the invention comprising a tilting head hydraulic pump will now be described with reference to the accompanying cross-sectional drawing of the pump.

In this pump a rotary cylinder block 1 is rotatably carried on a valve plate 2 having a pair of ports 3 and 4 which when seen in a cross-section perpendicular to the plane of the drawing are of kidney shape. The cylinder block is mounted for rotation by means of a fixed shaft 5 extending centrally from the valve plate 2. Within the cylinder block 1 a plurality of equally spaced cylinders 6 are formed whose axes are parallel to the axis of rotation. Within each cylinder 6 an elongated piston 7 is located for reciprocative movement. From the valve plate end of the cylinder block a port 8 extends from each cylinder for co-operation with the ports 3 and 4 in known manner during rotation of the cylinder block. A deep bore 9 extends within each piston 7 from the end thereof opposite to the valve plate 2 and within this bore a connecting rod 11 is located. The connecting rod is adapted to exert thrust on the piston through a spherical seating 12 which permits of articulation of connecting rod 11

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relative to the piston 7. In order to retain the connecting rod 11 within the piston a circlip 13 engages the groove around the interior of the bore 9 and loosely engages within a groove around the connecting rod 11. For the purpose of reciprocation of the pistons 7 the opposite end of each connecting rod 11 is formed with a ball joint 15 engaged within a slipper 16 the flat surface 32 whereof in turn engages on the flat surface 17 of a wear plate 18. The wear plate 18 is of uniform thickness and has a flat rear surface 19 which engages upon a flat surface 21 of a backing member 22. The backing member 22 forms the bearing housing for a drive shaft 23. The wear plate 18 is arranged so that its surfaces 17 and 19 extend perpendicularly to the axis of rotation of the drive shaft 23. The drive shaft 23 within the pump is integrally formed with a drive member in the form of a flange 24. Within the flange 24 a plurality of bores 25 are formed, which are angularly spaced at equal intervals to agree with the angular spacings of the cylinder 6. Each slipper 16 includes an exterior cylindrical surface 26 which fits with a small degree of clearance within its bore 25 so as to permit of rotation, as well as axial movement, of each slipper 16 within its bore 25. Each slipper includes a flange 27 located between the wear plate 18 and the flange 24 to prevent the slipper being pulled through the bore by its associated connecting rod 11.

The valve plate 2 and the cylinder block 1 are secured to the body member 22 by means of a pair of arms 28 extending from the valve plate 2 and pivoted by pivot pins 29 within lugs 31 extending from the body member 22. The axis of pivot pins 29 extends diametrically of a circle which includes the centers of ball joints 15. Pivotal movement of the valve plate 2 and cylinder block 1 about the pins 29 is arranged to adjust the inclination between the rotation axes of the flange 24 and the cylinder block 1 in order to determine the stroke of the pistons 7 within their cylinders 6.

The surface 32 of each slipper 16 engaging against the wear plate surface 17 is of circular form enclosing a central circular recess 33. A passage 34 extends from the working space of each cylinder 6 through the piston 7 and connects with the passage 35 extending axially through the associated connecting rod 11. Within the ball joint 15 the passage 35 communicates with a restrictor 36 opening into the recess 33. The recess 33 will thus receive liquid under pressure when the working space of the associated cylinder 6 is under pressure and will form a hydraulic bearing means acting between the surface 17 and the slipper.

The wear plate 18 is formed of a wear resisting material such as hardened steel and is loosely located in position by engagement upon a circular projection 37 extending from the housing 22 around the drive shaft 23. The projection 37 fits loosely within a corresponding recess 38 formed centrally within the wear plate 17. There is sufficient clearance between projection 37 and the recess 38 to permit a small amount of radial movement of the wear plate 18. The axial dimension of the projection 37 is greater than the permitted axial movement of each slipper 16 within its bore 25 in the flange 24 before the flange 27 of the slipper engages the flange 24. This ensures that when the pump is not in use the wear plate will not be able to move in the axial direction away from the body member 22 sufficiently to permit it to disengage from the projection 37. In turn this feature requires that the flange 27 should be substantially located against axial movement. This is conveniently obtained by the location on the shaft 23 of a gear wheel 39 which forms part of a gear pump. The gear pump may be used for supplying liquid at low pressure to one or the other of the ports 3 and 4. The gear 39 rotates within a suitable

recess 41 within the housing 22. The gear 39 is located on the shaft 23 between a shoulder 42 of the shaft and a circlip 43 fitted around the shaft on the opposite side of the gear. The fact that the gear fits closely within its housing 41 ensures location of the shaft 23 and the flange 24 against any substantial end movement. The gear 39 is secured by key 44 to rotate with the shaft 23.

Rotation of the drive shaft 23 will cause rotation of the flange 24 which in turn will drive the slippers 16 and the ball joints 15 in a circular path around the axis of the shaft 23. Such rotation will cause slight inclination of the connecting rods 11 within their pistons 7 until one connecting rod contacts the side of its piston bore to apply rotational drive to the cylinder block 1. The rotational drive to the cylinder block will then depend on successive engagements between connecting rods and their associated piston bores during rotation. In order to cause reciprocation of the pistons 7 within their cylinders 6 the cylinder block 1 and valve plate 2 are moved about the pivot pins 29 to an inclined position relative to the axis of the drive shaft 23. Reciprocation of the pistons 7 will then take place within the cylinders 6 as a result of rotation of the drive shaft 23. Liquid will enter the pump at one of the ports 3 or 4 and will be delivered from the pump under pressure at the other of the ports 3 or 4. Some pressure liquid existing in each cylinder 6 where the piston is descending will pass through the passage in the associated connecting rod to the recess 33 in the slipper. The action of pressure on each piston 7 will produce a thrust in the associated connecting rod and slipper causing the slipper surface 32 to press against surface 17 of the wear plate. The feeding of pressure to the recess 33 will provide a balancing force which opposes the component of the piston thrust parallel to the drive shaft axis. The area of the recess 33 is very slightly larger than the cross sectional area of the piston 7 to give a slight tendency for the slipper 16 to lift away from the surface 17 permitting very slight leakage of liquid over the surface 32. Such leakage of liquid will cause flow through the restrictor 36 and a pressure drop which lowers the pressure in the recess 33 to give an automatic balancing action so that the reduced hydraulic pressure acting in recess 33 and over the surface 32 will always exactly balance the hydraulic force component of piston thrust parallel to the drive shaft. In turn this ensures that in operation there is no substantial contact between slipper surface 32 and the surface 17 of the wear plate. During rotation of the drive shaft 23 and operation of the unit illustrated as the pump the slipper 16 will exert a frictional drag on the surface 17 of wear plate 18, and the wear plate will rotate at a speed less than the speed of rotation of the shaft 23. Such rotation will prevent concentration of wear in particular places of the surface 17. The outer diameter of the surface 32 is arranged to be substantially equal to the radial dimension of the annular surface 17 of the wear plate 18. This feature combined with the feature that each slipper can rotate in its bore 25 and the feature that the wear plate 18 has a small radial clearance on the projection 37 will result in wear taking place on the surface 17 and on the surfaces 32 of the slipper at an even rate so that during the useful life of the pump the surface 17 will remain flat and the surfaces 32 will remain flat. If the outer diameter of the surfaces 32 were narrower than the radial width of the surface 17 it is clear that a groove would be produced as a result of wear in the surface 17 which could prevent accurate seating of the surfaces 32 and in turn increase the leakage from these surfaces to lower the efficiency of the pump.

The surface 21 of the body member 22 on which the wear plate 18 is supported may be provided with a number of recesses 45 whose function is to supply liquid at low pressure between the surfaces 21 and 19 to facilitate rotation of the wear plate 18. Such low pressure liquid might be supplied from the gear pump of which gear 39 is a part, or from any other suitable source.

Whilst in the described embodiment the hydraulic bearing means for each slipper has been shown as the conventional hydrostatic leakage balance bearing, it will be appreciated that it is within the scope of the present invention to use a hydrodynamic kind of hydraulic bearing in which liquid is dragged into the space between the slipper and the surface 17 as a result of rotation of the slippers over the surface 17. In other words the slippers could be arranged to act as Michell pads.

We claim as our invention:

1. A hydraulic pump or motor comprising a rotary cylinder block, having cylinders regularly positioned around the rotation axis, and disposed substantially parallel to such axis, a piston reciprocable in each cylinder, a piston rod articulately secured in each piston and all extending from one end of the block, valve means co-operating with the other end of the block, a rotary drive flange mounted adjacent to the said one end of the block, and disposed during operation with its rotation axis intersecting the block's rotation axis, said drive flange being formed with bores each corresponding to a cylinder, and directed parallel to the flange rotation axis, a plurality of slippers, one for each piston rod, reciprocably mounted each in its bore in the drive flange, a bearing housing for said drive flange, having a surface adjacent and generally parallel to the drive flange, a flat wear plate interposed between the said surface and the drive flange and mounted for rotation relative to each thereof, the bearing surface of each slipper engaging said wear plate, and being formed with a recess, an articulating connection between each slipper and the corresponding piston rod, conduit means, including a restrictor, to feed liquid at pressure from the associated piston to each recess in the slippers' bearing surface, each slipper bearing surface including the recess being of sufficient area that the pressure of liquid acting between the slipper surface and the recess, against the wear plate, is sufficient to balance the hydrostatic force exerted on the piston.

2. A hydraulic pump or motor as claimed in claim 1 wherein the wear plate is of annular form having a radial width substantially equal to the diameter of the surfaces of the slippers engaging the wear plate.

3. A hydraulic pump or motor as claimed in claim 2 including a spigot projecting from the bearing housing which loosely locates in the central recess in the wear plate.

4. A hydraulic pump or motor as claimed in claim 3 wherein the slippers have limited sliding movement in the axial direction relative to the drive flange and the spigot enters the central recess in the wear plate to a distance greater than the limited slidable movement of the slippers relative to the wear plate, whereby the slippers ensure that the wear plate cannot disengage from the spigot.

5. A hydraulic pump or motor as claimed in claim 1 wherein the pistons are formed to limit the articulating movement of their pistons, so that engagement of the connecting rods in their pistons at the limits of their articulating movement effect the rotary drive of the cylinder block from the drive flange.

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