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(54) **HYDROSTATIC AXIAL PISTON MACHINE**

HYDROSTATISCHE AXIALKOLBENMASCHINE

MACHINE HYDROSTATIQUE A PISTONS AXIAUX

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Description

[0001] The invention relates to hydrostatic axial piston machines according to the species of claim 1.

[0002] A hydrostatic axial piston machine according to the species of claim 1 has been disclosed in US 2,391,579 "Reversible Engine". Two support plates are attached immovably on the drive shaft. The known machine consists of a cylinder block with axial pistons inside, mounted on a drive shaft, said axial pistons pressed against the face of a fixed fluid collector providing supply and drainage of working medium. An inclined support plate mounted independently on a shaft together with a piston slipper forms a hydrostatic support for each piston. The hydrostatic support is supplied with working medium from working chamber through a narrow hole in the piston and slipper.

[0003] The main drawback of such a construction and others, where the inclination angle can be changed from 0 to 15-20°, thereby providing stepless control of the stroke of piston, is a large energetic loss caused by influence of the fixed oil collector on a rotating cylinder block. The main components are: friction force caused by hydrostatic unbalance, leakage and pressure drop due to rapid flow deflection in supply and drain channels caused by fast rotation. Together they are responsible for about 50% of total power loss of such a machine.

[0004] The next disadvantage of typical axial piston machines is a big value of dead volume, usually between 100 and 200% of stroke volume when the machine is adjusted at full displacement. Reducing the displacement causes further growth of dead volume.

[0005] Due to volume elasticity of working medium dead volume is a source of a significant volumetric loss and burdensome noise.

[0006] The control of flow by changing the inclination angle of highly loaded machines by the axial force of the piston needs a lot of energy to achieve. The use of a hydraulic servo control mechanism is necessary. This mechanism has a response time usually longer than 0,2 s.

[0007] A linear narrow damping hole through the piston, which supplies the hydrostatic support unit with working medium gives a small pressure drop because of its limited length. The pressure drop is about 1% of working chamber pressure. The pressure drop results in a low stiffness of hydrostatic support and a big leakage through the clearance between the slipper and the support plate.

[0008] The object of the invention is to eliminate the drawback of the prior art and to achieve a machine with low energetic loss.

[0009] In accordance with the invention a hydrostatic axial piston machine with a drive shaft, a cylinder block with pistons and at least one support plate is characterized in that the

- the working chambers are equipped with movable inner sleeves, which have at least one of said holes and a projection and an internal surface,
- each working chamber is formed by the internal surface of the sleeve together with at least one piston head,
- the drive shaft bears an axial cam with a running surface, said running surface supporting said projection of the inner sleeves, where upon rotation of said running surface the sleeves are axially shifted, thereby displacing the holes from full connection of one working chamber to the low pressure channel to a full connection of said chamber to the high pressure channel.

[0010] The cam is axially shiftable and/or rotatable on the shaft, preferably by a pusher which cooperates with an electromagnet.

[0011] Each piston is equipped inside with a screw throttle located on the hydrostatic support inlet of the slipper.

[0012] According to performed tests, full hydrostatic discharge of the controling elements and the cam, their low mass and small friction force between the pistons and the controlling elements caused an unpredictable effect that flow change of the machine by displacement of the cam needs much less energy, less in comparison with all known constructions. Additionally, the dynamic characteristic of the control process is significantly better. It allows to control the flow of the machine by means of a simple low energy mechanism, e.g. a proportional electromagnet.

[0013] The reduction of dead volume to about 8 % stroke volume, thanks to the applied sleeve shaped controlling elements, decreases volumetric loss. Further lowering of the flow volume ratio of the machine does not increase its dead volume, i.e. the dead volume is small independently of the current flow volume ratio as an effect of constant inclination angle of the support plate.

[0014] The cylinder block is fixed. Thus, a fluid collector is eliminated and mechanical loss due to friction between collector and block together with pressure drop due to fluid stream deflection are excluded.

[0015] Successively, screw throttles assembled in the pistons not only reduce the dead volume, but also enable to obtain pressure drop of 10-15 % of the pressure of the working chamber, which improves the hydrostatic support characteristics and decreases leakage through clearance between the slipper and the support plate.

[0016] As a result this invention allows to obtain a compact construction with a high power-to weight ratio of several kW/kg, high overall efficiency higher than 90% and considerably reduced working noise. Working pressure exceeds 42 MPa. The machine as a pump is self-sucking.

[0017] The Figur shows an axial cross-section of an embodiment of the invention, i.e. a machine with sleeves.

[0018] The Figur illustrates a case 1 with a drive shaft 2 and two support plates 3 symmetrically attached on it. Said support plates have fixed inclination angles. Immovably assembled in case 1 between plates 3 is the cylinder block 4 with double pistons 5. The shaft 2 is equipped with an axial cam 6. Each piston 5 ends with a ball joint 7 connecting it with a slipper 8 hydrostatically supported on plate 3. The pistons 5 are placed inside sleeves 9. The internal surface of the sleeve 9 together with the heads of the pistons form the working chamber. Each sleeve 9 is equipped with a hole 10 in shape of circumferential, parted clearance. A projection 11 is an element controlling the flow of working medium between working chambers and low pressure 12 or high pressure 13 channels. The projection 11 is supported on the running surface of the cam 6. In an axial boring in shaft 2 there is a pusher 14 which cooperates with a proportional electromagnet 15 to shift axially and/or rotate said cam 6 on the shaft 2.

[0019] Inside every piston 5 there is a screw throttle 16 located on the inlet of hydrostatic support between slipper 8 and plate 3.

[0020] The machine driven by energy in the form of a torque which drives shaft 2 acts as a pump transporting working medium between channels 12 and 13 through the working chambers, in direction depending on the rotation direction of shaft 2. Otherwise, the supply of energy in form of pressurized fluid stream to channels 12 or 13 causes rotation of the shaft 2 in direction depending on the flow direction of the fluid and machine acts as a motor.

[0021] The drawn construction is characterized in that the cam 6, rotating together with the shaft 2 and the support plates 3, shifts due to the shape of the running surface the sleeve 9 axially, thus displacing the hole 10 from full connection of the working chamber to channel 12 to a full connection of this chamber to channel 13.

[0022] Displacement of the cam 6 along and/or around the axis of the shafts 2 shortens this phase of working cycle, while the working chamber is connected to the high pressure channel 12 and simultaneously lengthens the period of the connection of the working chamber to the low pressure channel 13. As a result a part of working medium reaches the low pressure channel 13 instead of the high pressure channel 12, thus allowing to reduce steplessly the flow of the machine until the working chamber is continuously connected to the low pressure channel 13.

[0023] In this construction symmetrical arrangement of two support plates 3 cooperating with two sets of pistons 5 allows to relief the bearings of the shaft 2 from axial forces of the piston 5.

Claims

1. Hydrostatic axial piston machine comprising

   - a cylinder block (4) with pistons (5),
   - a drive shaft (2) with at least one support plate (3), attached immovably on the drive shaft with fixed inclination angle on which support plate pistons are ending with a joint (7),
   - a working medium flowing between working chambers containing the pistons and from and to low and high pressure channels (12, 13) connected to the working chambers through at least one hole in each of said working chambers,

   characterized in that

   - the working chambers are equipped with movable inner sleeves (9), which have at least one of said holes (10) and a projection (11) and an internal surface,
   - each working chamber is formed by the internal surface of the sleeve together with at least one piston head,
   - the drive shaft (2) bears an axial cam (6) with a running surface, said running surface supporting said projection (11) of the inner sleeves, where upon rotation of said running surface (6a) the sleeves (9) are axially shifted, thereby displacing the holes (10) from full connection of one working chamber to the low pressure channel (12) to a full connection of said chamber to the high pressure channel (13).

2. A machine according to claim 1, characterized in that the cam (6) is axially shiftable and/or rotatable on the shaft (2).

3. A machine according to claim 2, characterized in that the cam (6) is axially shiftable and/or rotatable by a pusher (14) which cooperates with an electromagnet.

Patentansprüche

1. Hydrostatische Axialkolbenmaschine umfassend

   - einen Zylinderblock (4) mit Kolben (5),
   - eine Antriebswelle (2) mit wenigstens einer Stützplatte (3), welche unbeweglich an der Antriebswelle (2) mit einem festen Neigungswinkel befestigt ist und an welcher Stützplatte die Kolben in einem Gelenk (7) enden,
   - ein Arbeitsmedium, das zwischen Arbeitskammern, die die Kolben aufnehmen, sowie von und zu Nieder- und Hochdruckkanälen (12, 13) fließt, die mit den Arbeitskammern durch wenigstens eine Öffnung in jeder der Arbeitskammern verbunden sind,

dadurch gekennzeichnet, daß

- die Arbeitskammern mit beweglichen inneren Buchsen (9) ausgerüstet sind, die wenigstens eine der Öffnungen (10), einen Vorsprung (11) und eine innere Oberfläche aufweisen,
- jede Arbeitskammer durch die innere Oberfläche der Buchse zusammen mit wenigstens einem Kolbenkopf gebildet ist,
- die Antriebwelle (2) einen axialen Nocken (6) mit einer Lauffläche trägt, wobei die Lauffläche die Vorsprünge (11) der inneren Buchsen aufnimmt und wobei durch Rotation der Lauffläche (6a) die Buchsen (9) axial verschoben werden, wodurch die Öffnungen (10) von einer Vollverbindung einer Arbeitskammer mit dem Niederdruckkanal (12) zu einer Vollverbindung der Arbeitskammer mit dem Hochdruckkanal (13) versetzt werden.

2. Axialkolbenmaschine nach Anspruch 1, dadurch gekennzeichnet, daß der Nocken (6) auf der Antriebswelle (2) axial verschieblich und/oder rotierbar ist.

3. Axialkolbenmaschine nach Anspruch 2, dadurch gekennzeichnet, daß der Nocken (6) durch einen Schieber (14), der mit einem Elektromagnet zusammenwirkt, axial verschieblich und/oder rotierbar ist.

Revendications

1. Machine hydrostatique à pistons axiaux comprenant :

- un bloc cylindre (4) avec des pistons (5),
- un arbre de transmission (2) avec au moins une plaque support (3), disposée de façon fixe sur l'arbre de transmission avec un angle d'inclinaison déterminé, plaque de support sur laquelle les pistons se terminent par un joint (7),
- un fluide de travail s'écoulant entre des chambres de travail contenant les pistons, de et vers des canaux à basse et haute pressions (12, 13) connectés aux chambres de travail à travers au moins un orifice dans chacune desdites chambres de travail,

caractérisée en ce que :

- les chambres de travail sont équipées de bagues internes mobiles (9), qui ont au moins un desdits orifices (10) et une saillie (11) et une surface interne,
- chaque chambre de travail est formée par la surface interne de la bague ainsi qu'avec au moins une tête de piston,
- l'arbre de transmission (2) porte une came axiale (6) qui a une surface courante, ladite surface courante supportant ladite saillie (11) des bagues internes, où lors de la rotation desdites surfaces courantes (6a) les bagues (9) sont décalées axialement de manière à déplacer les orifices (10) d'une connexion complète de l'une des chambes de travail au canal à basse pression (12) vers une connexion complète de ladite chambre au canal à haute pression (13).

2. Machine selon la revendication 1, caractérisée en ce que la came (6) peut être déplacée axialement et/ou mise en rotation sur l'arbre (2).

3. Machine selon la revendication 2 caractérisée en ce que la came (6) est déplacée axialement et/ou mise en rotation à l'aide d'un poussoir (14) qui coopère avec un électro-aimant.

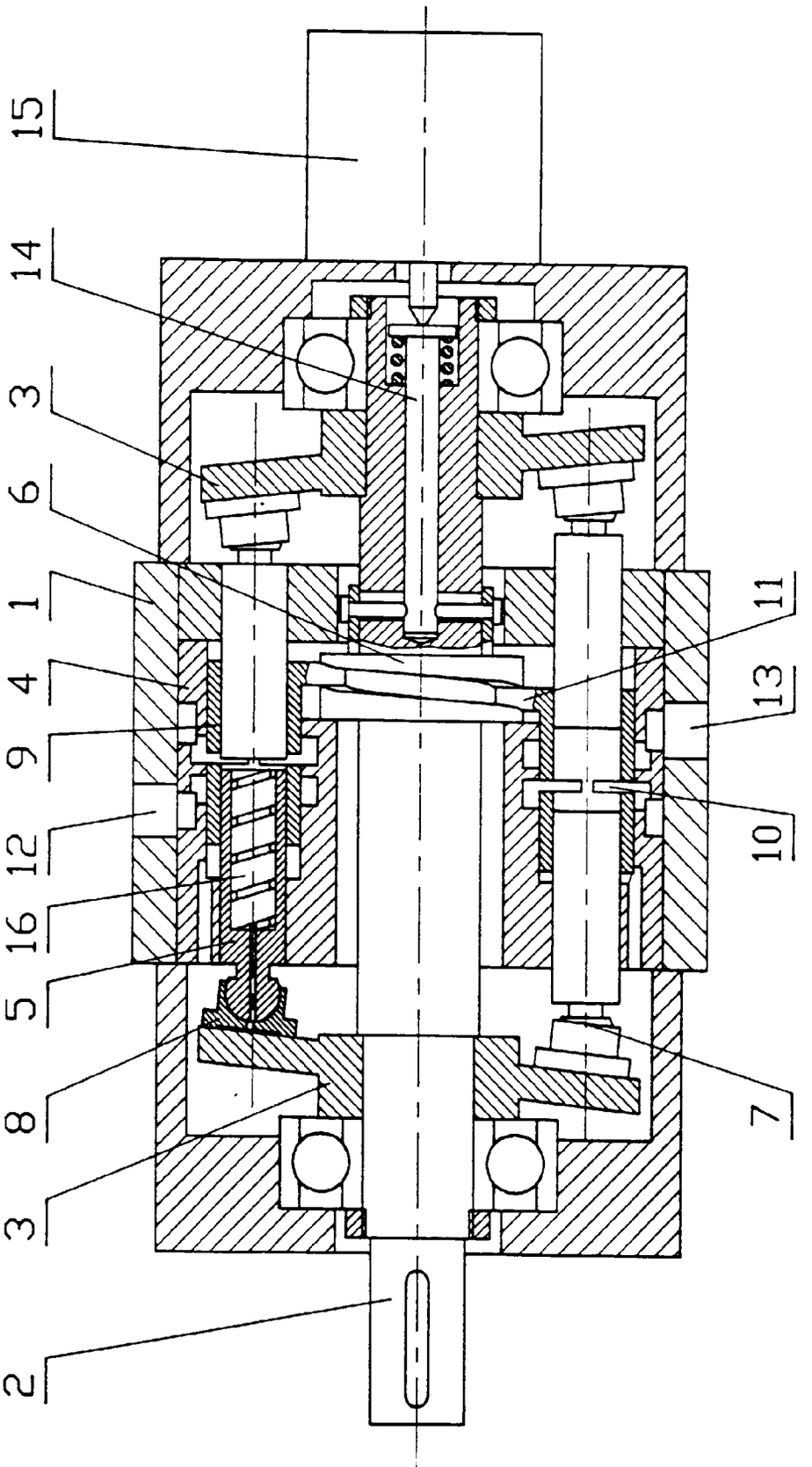

Fig. 1