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(54) OUTPUT SHAFT OF CYCLOID HYDRAULIC MOTOR AND SHAFT VALVE FLOW-DISTRIBUTION CYCLOID HYDRAULIC MOTOR

(57) Disclosed are an output shaft (1) of a cycloid hydraulic motor and an axle valve flow-distribution cycloid hydraulic motor having same, belonging to the technical field of mechanical transmission. The main body of the output shaft includes a larger-diameter section (1-2) assembled in a casing (10) of the cycloid hydraulic motor and a smaller-diameter section (1-1) extending out of the casing. An engaging structure transmissibly connected with a linkage shaft (21) of the cycloid hydraulic motor is disposed in an inner hole of the larger-diameter section (1-2), and a dynamic engaging portion (1-2-1) is disposed on an external surface of the larger-diameter section for dynamically engaging with the casing (10), the dynamic engaging portion (1-2-1) includes at least two circumferential intermittent oil grooves (1-2-2); a groove bottom of each intermittent oil groove is formed by an eccentric arc about the center O' that deviates from the center O of an excircle of the dynamic engaging portion by a process eccentricity e, the radius R of the eccentric arc is greater than the radius r of the excircle of the dynamic engaging portion. The output shaft and the cycloid hydraulic motor can improve the working efficiency and reduce the manufacture cost, and can form a better oil film, enhance the radial bearing capacity, and ensure the lubrication and seal.

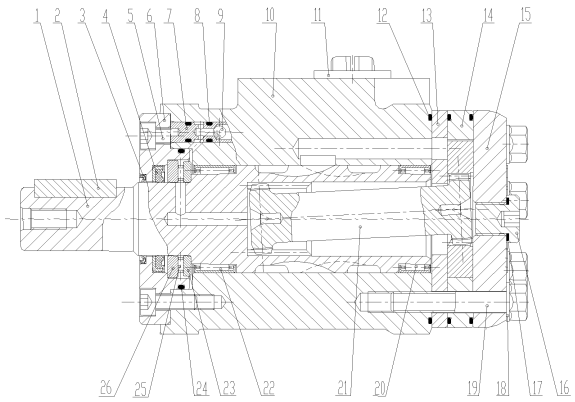


Fig.1

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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of the priority of Chinese Patent Application No. 201310584115.5, filed on November 20, 2013, entitled "Axle Valve Flow-distribution Cycloid Hydraulic Motor", and the priority of Chinese Patent Application No. 201310584259.0, filed on January 17, 2014, entitled "Output Shaft of Cycloid Hydraulic Motor and Processing Method thereof", the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to an output shaft of a cycloid hydraulic motor, and also relates to an axle valve flow-distribution cycloid hydraulic motor having the output shaft of the cycloid hydraulic motor, belonging to the technical field of hydraulic transmission.

BACKGROUND

[0003] A cycloid hydraulic motor is a motor with a low speed and a high torque, having advantages of small size, large unit power density, high efficiency, wide range of rotating speed and so on, and is widely used. Especially, the axle-flow-distribution cycloid hydraulic motor is suitable for the applications that need lower pressure levels and higher cost performances, as it has a simple structure and low cost. In order to ensure the lubrication of the axle-flow-distribution valve, and to form the desired flow-distribution oil film and the reliable seal, circumferential annular oil grooves are disposed on the output shaft, but the configuration of such oil grooves is unfavorable for the radial bearing capacity of the output shaft.

[0004] The basic configuration of the cycloid hydraulic motor includes a liquid feed port and a return port disposed on the casing or the rear cover; the cycloid hydraulic motor has a cycloidal gear pair and a flow-distribution mechanism installed at one end, wherein the flow-distribution mechanism may be placed ahead of or behind the cycloidal gear pair, typically it adopts the axle valve flow-distribution when it is placed in the front, and it adopts the plane flow-distribution when it is placed in the rear, and the cycloid hydraulic motor has an output shaft at the other end. The rotor of the cycloidal gear pair is engaged with an external gear installed on one end of a linkage shaft through internal keys, and the other end of the linkage shaft is transmissibly connected with the output shaft.

[0005] When in operation, by means of the flow-distribution mechanism, the liquid feed port is communicated with an extended engaging cavity of the cycloidal gear pair, and the shrunk engaging cavity of the cycloidal gear pair is communicated with the return port. As a result, pressurized liquid enters the casing or the rear cover through the liquid feed port, then enters the extended engaging cavity formed by the cycloidal gear pair, causing the volume of the extended engaging cavity expanded gradually, at the same time, the liquid in the shrunk engaging cavity formed by the cycloidal gear pair returns through the return port. In this process, the rotor of the cycloidal gear pair is driven to rotate by the pressure difference between the extended engaging cavity and the shrunk engaging cavity, and the rotation is transmitted to the output shaft through the linkage shaft and is output from the output shaft, thereby the hydraulic energy is converted into the mechanical energy. Meanwhile, the flow-distribution mechanism (also called as the axle valve) is also driven to rotate by the linkage shaft, and is switched between a closed state and an opened state again and again, so that the converting process is continued, and the motor outputs the torque continuously.

[0006] As far as the applicant knows, the prior art compact axle valve flow-distribution cycloid hydraulic motor is developed rapidly (such as the products BM1, BMP and BMR manufactured by the applicant). Although the sliding bearing of the flow-distribution mechanism of the prior art hydraulic motor can bear a certain radical force, as limited by its structure, it is not suitable for driving an external engaging gear or chain gear or directly driving other components having larger radical force, even if a radial needle bearing or a ball bearing is added (e.g., Chinese patent No. 200720041824.9 disclosed that radical needle bearings with different size are installed at the front and the rear as supporting elements, and Chinese patent No. 201220454428.X disclosed that a ball bearing is installed at the front end of the output shaft for bearing radical force), the capacity of bearing large radical force still cannot be improved remarkably, whereas the leakage may be increased.

SUMMARY

[0007] The major objectives of the present disclosure are as follows: in view of the above-mentioned existing problem in the prior art, by modifying the configuration, to provide an output shaft of a cycloid hydraulic motor, which is beneficial for ensuring the radial bearing capacity, and allows for simple and convenient processing procedures, has better sealing and lubricating effects; also to provide a method for processing the output shaft of the cycloid hydraulic motor.

[0008] In order to achieve the above major objectives, the present disclosure provides an output shaft of a cycloid hydraulic motor, comprising a main body, said main body includes a larger-diameter section assembled in a casing of the cycloid hydraulic motor and a smaller-diameter section extending out of the casing; an engaging structure transmissibly connected with a linkage shaft of the cycloid hydraulic motor is disposed in an inner hole of the larger-diameter section, and a dynamic engaging portion is disposed on an external surface of the larger-diameter section for dynamically engaging with the casing, the dynamic engaging portion includes at least two circumferential intermittent oil grooves; a groove bottom of each intermittent oil groove is formed by an eccentric arc about a center point that deviates from a center point of an excircle of the dynamic engaging portion by a process eccentricity e, a radius of the eccentric arc is greater than a radius of the excircle of the dynamic engaging portion.

[0009] Wherein, according to a preset radius of the eccentric arc, maximum height of the intermittent oil groove and the radius of the dynamic engaging portion, the process eccentricity is determined by following equation:

eccentricity is determined by following equation:

$$e=R+h-r;$$

wherein, e is the process eccentricity (mm);
R is the radius of the eccentric arc (mm);
h is the maximum height of the intermittent oil groove (mm);
r is the radius of the dynamic engaging portion (mm).

[0010] With respect to the above process eccentricity e and the radius R of the eccentric arc, according to the preset maximum height h of the intermittent oil groove and the length 1 of the outer arc of the intermittent oil groove or its corresponding central angle, and the radius r of the dynamic engaging portion, it is not difficult to find the geometric relationship between these parameters, then obtain simultaneous equations to solve for the process eccentricity e and the radius R of the eccentric arc.

[0011] Further, the larger-diameter section has a front necked-down portion for installing a front needle bearing on the external surface at one end, and has a rear necked-down portion for installing a rear needle bearing on the external surface at the other end, the dynamic engaging portion for dynamically engaging with the inner hole of the casing is disposed between the front necked-down portion and the rear necked-down portion, and is closer to the front necked-down portion.

[0012] Further, a cross-section of the intermittent oil groove is dovetail-shaped, which has a narrowed opening and a wider bottom.

[0013] Therefore, the steps of processing the intermittent oil grooves are as follows:

Step 1, clamping the primarily processed output shaft in a rotational turning or grinding fixture with its axis deviating from the rotating center of the turning or grinding fixture by the amount of the process eccentricity e;
Step 2, driving the turning or grinding fixture to rotate;
Step 3, when the turning tool or the grinding wheel contacts with the main body, processing according to the maximum height of the oil groove until a first intermittent oil groove is processed;
Step 4, on the premise of retaining the process eccentricity unchanged, turning the main body to the angular position of the adjacent intermittent oil groove, then clamping the output shaft at this position, and processing for the subsequent intermittent oil groove in the same way as described in the above Step 2 and Step 3.

[0014] By adopting the configuration of the output shaft of the cycloid hydraulic motor, the present disclosure prevents the output shaft from being disconnected by the annular oil groove, thus it is beneficial for enhancing the radial bearing capacity. And by means of common fixtures such as a four-jaw chuck (or a special tool), the desired oil groove can be processed directly, and there is no need to adopt the complicated milling process as required for processing the equi-depth circumferential intermittent oil grooves, therefore, it is beneficial for improving the efficiency remarkably, and reducing the manufacturing cost. Additionally, the present disclosure replaces the prior art equi-depth oil groove having the concentric arc bottom with the oil groove having the eccentric arc bottom and having a varying height decreasing gradually from the center to both ends, which is beneficial theoretically and practically for enabling oil contained in the oil groove flowing from both ends of the oil groove to the excircle area of the dynamic engaging portion of the main body between adjacent oil grooves, and then further diffusing to both sides, so that better oil film can be formed to ensure the lubrication and seal. With regard to the oil groove to be processed after the heat treatment, tooling equipment similar to a four-jaw chuck is adopted to grind the oil groove on a grinder.

[0015] A further objective of the present disclosure is to provide an axle valve flow-distribution cycloid hydraulic motor by modifying the configuration, which remains compact in structure, has an improved radial bearing capacity, an enhanced

sealing effect, and has a good processability.

[0016] In order to achieve the above further objective, the present disclosure provides an axle valve flow-distribution cycloid hydraulic motor, comprising: a front cover and a casing, which are fixedly connected with each other, and a cycloidal gear pair formed by a stator and a rotor; the cycloidal gear pair is fixedly connected to a casing through a diaphragm at one end, and fixedly connected with a rear cover at the other end; an output shaft is arranged in the casing, an outer end of the output shaft extends out of the casing, the output shaft is transmissibly connected to the rotor through an linkage shaft; wherein, an inner hole of the casing is a through-hole with same inner diameter; a front needle bearing is installed on a front portion of the output shaft and a rear needle bearing is installed on a rear end of the output shaft; the front needle bearing has a same outer diameter but a greater length as compared with the rear needle bearing; a shoulder of the output shaft corresponding to a front end of the front needle bearing is abutted against a rear retaining ring of a plane thrust bearing; a dynamic engaging portion is disposed behind the front needle bearing on the output shaft for dynamically engaging with the casing, the dynamic engaging portion includes at least two circumferential intermittent oil grooves; a groove bottom of each intermittent oil groove is formed by an eccentric arc about a center point that deviates from a center point of an excircle of the dynamic engaging portion by a process eccentricity e, a radius of the eccentric arc is greater than a radius of the excircle of the dynamic engaging portion.

[0017] Further, a front retaining ring of the plane thrust bearing is installed against an end face of an stepped hole in the front cover, a shaft seal is arranged in the stepped hole and ahead of the front retaining ring.

[0018] Further, the output shaft includes a larger-diameter section assembled in the casing, and a smaller-diameter section extending out of the casing; the larger-diameter section has a front necked-down portion for installing the front needle bearing on an external circular surface at one end, and has a rear necked-down portion for installing the rear needle bearing on the external circular surface at the other end; a dynamic engaging portion for dynamically engaging with the inner hole of the casing is disposed between the front necked-down portion and the rear necked-down portion, and is closer to the front necked-down portion; three intermittent oil grooves distributed uniformly in a circumferential direction are disposed on the dynamic engaging portion.

[0019] Further, the shaft seal includes a metallic frame having an L-shaped cross-section, a polytetrafluoroethylene retaining ring having a rectangular cross-section, which is tightly adhered to an inner end face of the metallic frame and is sealedly engaged with the external surface of the output shaft, and a rubber seal lip that half surrounds the metallic frame and the polytetrafluoroethylene retaining ring.

[0020] Further, the rubber seal lip includes one seal engaging surface fit with the inner surface of the stepped hole in the front cover and another seal engaging surface fit with the external surface of the output shaft.

[0021] Further, the rubber seal lip is filled between the external surface of the polytetrafluoroethylene retaining ring and the metallic frame.

[0022] According to the axle valve flow-distribution cycloid hydraulic motor of the present disclosure, since the inner diameter of the casing is constant, it is very convenient for processing and assembling; as the bearings are arranged reasonably in consideration of the larger load on the front section, and the organic combination of the front needle bearing and the plane thrust bearing, the bearing capacity of the front needle bearing can be further improved. Therefore, as compared with the prior art, on the premise that the structure remains compact, the radial bearing capacity of the cycloid hydraulic motor is improved, and the axial bearing capacity is improved at the same time, and the cycloid hydraulic motor allows for convenient processing and has good assembling processability.

[0023] The dynamic engaging portion for dynamically engaging with the inner hole of the casing is located behind the front needle bearing installed on the output shaft, the dynamic engaging portion includes at least two circumferential intermittent oil grooves; the bottom of said intermittent oil groove is formed by an eccentric arc about a center point that deviates from a center point of an excircle of the dynamic engaging portion by a process eccentricity e, a radius of the eccentric arc is greater than a radius of the excircle of the dynamic engaging portion. Therefore, the present disclosure prevents the output shaft from being disconnected by the annular oil groove, thus it is beneficial for enhancing the radial bearing capacity. And by means of common fixtures such as a four-jaw chuck (or a special tool), the desired oil groove can be processed directly, and there is no need to adopt the complicated milling process as required for processing the equi-depth circumferential intermittent oil grooves, therefore, it is beneficial for improving the efficiency remarkably, and reducing the manufacturing cost. Additionally, the present disclosure replaces the prior art equi-depth oil groove having the concentric arc bottom with the oil groove having the eccentric arc bottom and having a varying height decreasing gradually from the center to both ends, which is beneficial theoretically and practically for enabling oil contained in the oil groove flowing from both ends of the oil groove to the excircle area of the dynamic engaging portion of the main body between adjacent oil grooves, and then further diffusing to both sides, so that better oil film can be formed to ensure the lubrication and seal.

[0024] In the present disclosure, the front retaining ring of the plane thrust bearing is installed against the end face of the stepped hole in the front cover, a shaft seal is arranged in the stepped hole and ahead of the front retaining ring, so as to ensure the reliably sealing effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The present disclosure will be described in more details with reference to the accompanying figures.

Fig. 1 is a schematic structural diagram illustrating the embodiment 1 of the present invention;
Wherein the elements are denoted as follows: output shaft 1, key 2, dust seal 3, shaft seal 4, screw 5, front cover 6, valve body 7, seal ring 8, valve ball 9, casing 10, oil port cap 11, O-ring 12, diaphragm 13, cycloidal gear pair 14, rear cover 15, plug 16, gasket 17, steel gasket 18, bolt 19, rear needle bearing 20, linkage shaft 21, front needle bearing 22, rear retaining ring 23, O-ring 24, plane thrust bearing 25, front retaining ring 26;
Fig. 2 is a schematic structural diagram illustrating the output shaft in the embodiment of Fig.1;
Fig. 3 is a cross-section view of a rotor-stator pair in the embodiment of Fig.1;
Fig. 4 is an illustrative geometric relationship diagram of the relevant parameters in a cross-section of the intermittent oil grooves taken along the direction of the arrows at the dynamic engaging portion shown in Fig. 2;
Fig. 5 is an enlarged view of the shaft seal in the embodiment of Fig. 1;
Fig. 6 is a schematic structural diagram illustrating the embodiment 2 of the present invention;
Fig. 7 is a cross-section view of a rotor-stator pair in the embodiment of Fig. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1:

[0026] Figs. 1 and 3 illustrate the basic configuration of the axle valve flow-distribution cycloid hydraulic motor of this embodiment. Similar as the prior art, the present disclosure comprises a front cover 6 and a casing 10, which are fixedly connected with each other, and a cycloidal gear pair formed by a stator and a rotor; the cycloidal gear pair is fixedly connected to the casing 10 through a diaphragm 13 at one end, and fixedly connected with a rear cover 15 at the other end. An output shaft 1 is arranged in the casing 10, the outer end of the output shaft extends out of the casing, the internal key of the output shaft is transmissibly connected to the internal key of the rotor through a linkage shaft 21.

[0027] The inner hole of the casing 10 is a through-hole with the same inner diameter. A front needle bearing 22 is installed on the front portion of the output shaft 1 and a rear needle bearing 20 is installed on the rear end of the output shaft 1; the front needle bearing 22 has the same outer diameter but a greater length as compared with the rear needle bearing 20. The shoulder of the output shaft 1 corresponding to the front end of the front needle bearing 22 is abutted against the rear retaining ring 23 of the plane thrust bearing 25.

[0028] As shown in Fig. 2, the output shaft 1 includes a larger-diameter section 1-2 assembled inside the casing 10 of the cycloid hydraulic motor, and a smaller-diameter section 1-1 extending out of the casing. A key groove is disposed on the smaller-diameter section 1-1, so that power and motion can be transmitted through the key-connection. An internal key engaging structure transmissibly connected with the linkage shaft 21 of the cycloid hydraulic motor is disposed in the inner hole of the larger-diameter section 1-2; the larger-diameter section has a front necked-down portion for installing the front needle bearing 22 on the external circular surface at one end, and has a rear necked-down portion for installing the rear needle bearing 20 on the external circular surface at the other end; a dynamic engaging portion 1-2-1 for dynamically engaging with the inner hole of the casing 10 is disposed between the front necked-down portion and the rear necked-down portion, and is closer to the front necked-down portion; additionally, other components are provided between the front necked-down portion and rear necked-down portion for forming the axle-flow-distribution, these components are the same as those of the prior art, and are not described here for brevity. Three intermittent oil grooves 1-2-2 distributed uniformly in the circumferential direction are disposed on the dynamic engaging portion 1-2-1. As shown in Fig. 4, the groove bottom of each intermittent oil groove 1-2-2 is formed by an eccentric arc about the center O', said center O' is deviated from the center O of the excircle of the dynamic engaging portion by a process eccentricity e, the radius R of the eccentric arc is greater than the radius r of the excircle of the dynamic engaging portion 1-2-1. It is evident that, e=R+h-r; wherein, e is the process eccentricity (mm); R is the radius of the eccentric arc; h is the maximum height of the intermittent oil groove, which is generally between 0.3mm to 1.0mm; r is the radius of the dynamic engaging portion. The radii of the flow-distribution axles of different series of hydraulic motors are different, for example, the radii of BMP and BMR series are ranged from 21 mm to 21.5 mm. When it is designed, the radius r of the dynamic engaging portion, the length 1 of the outer arc of the intermittent oil groove (or its corresponding central angle A, which is generally between 30° and 65°), and the maximum height h are identical to those of the prior art circumferentially-spaced oil grooves with the concentric arc bottom and the same height. According to common mathematic knowledge, such as cosine law and so on, and with reference to Fig. 3, it is not difficult to find the geometric relationship between these parameters, then obtain simultaneous equations to solve for the process eccentricity e and the radius R of the eccentric arc.

[0029] The front retaining ring 26 of the plane thrust bearing 25 is installed against the end face of the stepped hole

in the front cover 6, a shaft seal 4 is arranged in the stepped hole and ahead of the front retaining ring 26. The specific structure of the shaft seal is shown in Fig. 5, which includes a metallic frame 4-1 having an L-shaped cross-section, a polytetrafluoroethylene retaining ring 4-2 having a rectangular cross-section, which is tightly adhered to the inner end face of the metallic frame 4-1 and is sealedly engaged with the external surface of the output shaft 1, and a rubber seal lip 4-3 that half surrounds the metallic frame 4-1 and the polytetrafluoroethylene retaining ring 4-2. Said rubber seal lip 4-3 includes one seal engaging surface fit with the inner surface of stepped hole in the front cover 6 and another seal engaging surface fit with the external surface of the output shaft. The rubber seal lip 4-3 is filled between the external surface of the polytetrafluoroethylene retaining ring 4-2 and the metallic frame 4-1.

[0030] In addition, an oil return circulation channel communicated with the inner cavity is disposed in the casing 10, and two unidirectional valves are arranged in the oil return circulation channel, each unidirectional valve includes a valve body 7, a seal ring 8 and a valve ball 9. One end of one unidirectional valve is connected with the oil feed port and one end of another unidirectional valve is connected with the oil return port, the other ends of the two unidirectional valves are communicated with the inner cavity of the motor via the inner unidirectional valve oil return channel between the front cover 6 and the casing 10. Such arrangement helps to protect the shaft seal.

[0031] In processing, since the inner hole of the casing 10 is a straight-hole with the same diameter, only one pass is needed for processes such as lathing, grinding, and so on; it is very convenient for processing, and the dimensional accuracy and geometrical accuracy can be ensured. The steps of processing the intermittent oil grooves on the output shaft are as follows: Step 1, clamping the primarily processed output shaft in an index chuck, specifically, the output shaft is clamped in a four-jaw chuck of a lathe with its axis deviating from the rotating center of the turning fixture of the lathe by the amount of the process eccentricity e; Step 2, starting the lathe, driving the four-jaw chuck to rotate; Step 3, employing a lathe tool with a cutting tip conforming to the shape of the cross-section of the intermittent oil groove; when the cutting tip contacts with the output shaft, feeding the lathe tool according to the maximum height of the oil groove, then a first intermittent oil groove is processed; Step 4, on the premise of retaining the process eccentricity unchanged, successively turning the output shaft by 120° and 240° relative to the angular position of the four-jaw chuck, clamping the output shaft at each position, and processing for the second intermittent oil groove and the third intermittent oil groove in the same way as described in the above Step 2 and Step 3.

Embodiment 2:

[0032] As shown in Figs. 6 and 7, the basic configuration of the axle valve flow-distribution cycloid hydraulic motor of this embodiment is similar to that of the embodiment 1. The embodiment 2 is different from the embodiment 1 mainly in that, the cycloidal gear pair in the embodiment 2 is an embedded column type rotor-stator pair, while the cycloidal gear pair in the embodiment 1 is an integrated rotor-stator pair.

[0033] Experiments have proved that, since a series of modifications seemingly tiny but effective were made in the above-mentioned embodiments, the radial bearing capacity of the hydraulic motor has been improved by nearly 40%, meanwhile the axial bearing capacity has been improved. The hydraulic motor has compact structure, smaller size, better machining and assembling processes, thereby the cost performance is further improved as compared with the traditional products.

Claims

1. An output shaft of a cycloid hydraulic motor, comprising a main body, wherein, said main body includes a larger-diameter section assembled in a casing of the cycloid hydraulic motor and a smaller-diameter section extending out of the casing; an engaging structure transmissibly connected with a linkage shaft of the cycloid hydraulic motor is disposed in an inner hole of the larger-diameter section, and a dynamic engaging portion is disposed on an external surface of the larger-diameter section for dynamically engaging with the casing, the dynamic engaging portion includes at least two circumferential intermittent oil grooves; wherein, a groove bottom of each intermittent oil groove is formed by an eccentric arc about a center point that deviates from a center point of an excircle of the dynamic engaging portion by a process eccentricity e, a radius of the eccentric arc is greater than a radius of the excircle of the dynamic engaging portion.

2. The output shaft of the cycloid hydraulic motor according to claim 1, wherein, according to a preset radius of the eccentric arc, maximum height of the intermittent oil groove and the radius of the dynamic engaging portion, the process eccentricity is determined by following equation:

equation:

$$e=R+h-r;$$

wherein, e is the process eccentricity (mm);
R is the radius of the eccentric arc (mm);
h is the maximum height of the intermittent oil groove (mm);
r is the radius of the dynamic engaging portion (mm).

3. The output shaft of the cycloid hydraulic motor according to claim 1 or 2, wherein, the larger-diameter section has a front necked-down portion for installing a front needle bearing on the external surface at one end, and has a rear necked-down portion for installing a rear needle bearing on the external surface at the other end, the dynamic engaging portion for dynamically engaging with the inner hole of the casing is disposed between the front necked-down portion and the rear necked-down portion, and is closer to the front necked-down portion.

4. The output shaft of the cycloid hydraulic motor according to claim 3, wherein, a cross-section of the intermittent oil groove is dovetail-shaped, which has a narrower opening and a wider bottom.

5. An axle valve flow-distribution cycloid hydraulic motor, comprising: a front cover and a casing, which are fixedly connected with each other, and a cycloidal gear pair formed by a stator and a rotor; the cycloidal gear pair is fixedly connected to a casing through a diaphragm at one end, and fixedly connected with a rear cover at the other end; an output shaft is arranged in the casing, an outer end of the output shaft extends out of the casing, the output shaft is transmissibly connected to the rotor through a linkage shaft; wherein, an inner hole of the casing is a through-hole with same inner diameter; a front needle bearing is installed on a front portion of the output shaft and a rear needle bearing is installed on a rear end of the output shaft; the front needle bearing has a same outer diameter but a greater length as compared with the rear needle bearing; a shoulder of the output shaft corresponding to a front end of the front needle bearing is abutted against a rear retaining ring of a plane thrust bearing; a dynamic engaging portion is disposed behind the front needle bearing on the output shaft for dynamically engaging with the casing, the dynamic engaging portion includes at least two circumferential intermittent oil grooves; a groove bottom of each intermittent oil groove is formed by an eccentric arc about a center point that deviates from a center point of an excircle of the dynamic engaging portion by a process eccentricity e, a radius of the eccentric arc is greater than a radius of the excircle of the dynamic engaging portion.

6. The axle valve flow-distribution cycloid hydraulic motor according to claim 5, wherein, a front retaining ring of the plane thrust bearing is installed against an end face of an stepped hole in the front cover, a shaft seal is arranged in the stepped hole and ahead of the front retaining ring.

7. The axle valve flow-distribution cycloid hydraulic motor according to claim 6, wherein, the output shaft includes a larger-diameter section assembled inside the casing, and a smaller-diameter section extending out of the casing; the larger-diameter section has a front necked-down portion for installing the front needle bearing on an external circular surface at one end, and has a rear necked-down portion for installing the rear needle bearing on the external circular surface at the other end; a dynamic engaging portion for dynamically engaging with the inner hole of the casing is disposed between the front necked-down portion and the rear necked-down portion, and is closer to the front necked-down portion; three intermittent oil grooves distributed uniformly in a circumferential direction are disposed on the dynamic engaging portion.

8. The axle valve flow-distribution cycloid hydraulic motor according to claim 7, wherein, the shaft seal includes a metallic frame having an L-shaped cross-section, a polytetrafluoroethylene retaining ring having a rectangular cross-section, which is tightly adhered to an inner end face of the metallic frame and is sealedly engaged with the external surface of the output shaft, and a rubber seal lip that half surrounds the metallic frame and the polytetrafluoroethylene retaining ring.

9. The axle valve flow-distribution cycloid hydraulic motor according to claim 8, wherein, the rubber seal lip includes one seal engaging surface fit with the inner surface of the stepped hole in the front cover and another seal engaging surface fit with the external surface of the output shaft.

10. The axle valve flow-distribution cycloid hydraulic motor according to claim 9, wherein, the rubber seal lip is filled between the external surface of the polytetrafluoroethylene retaining ring and the metallic frame.

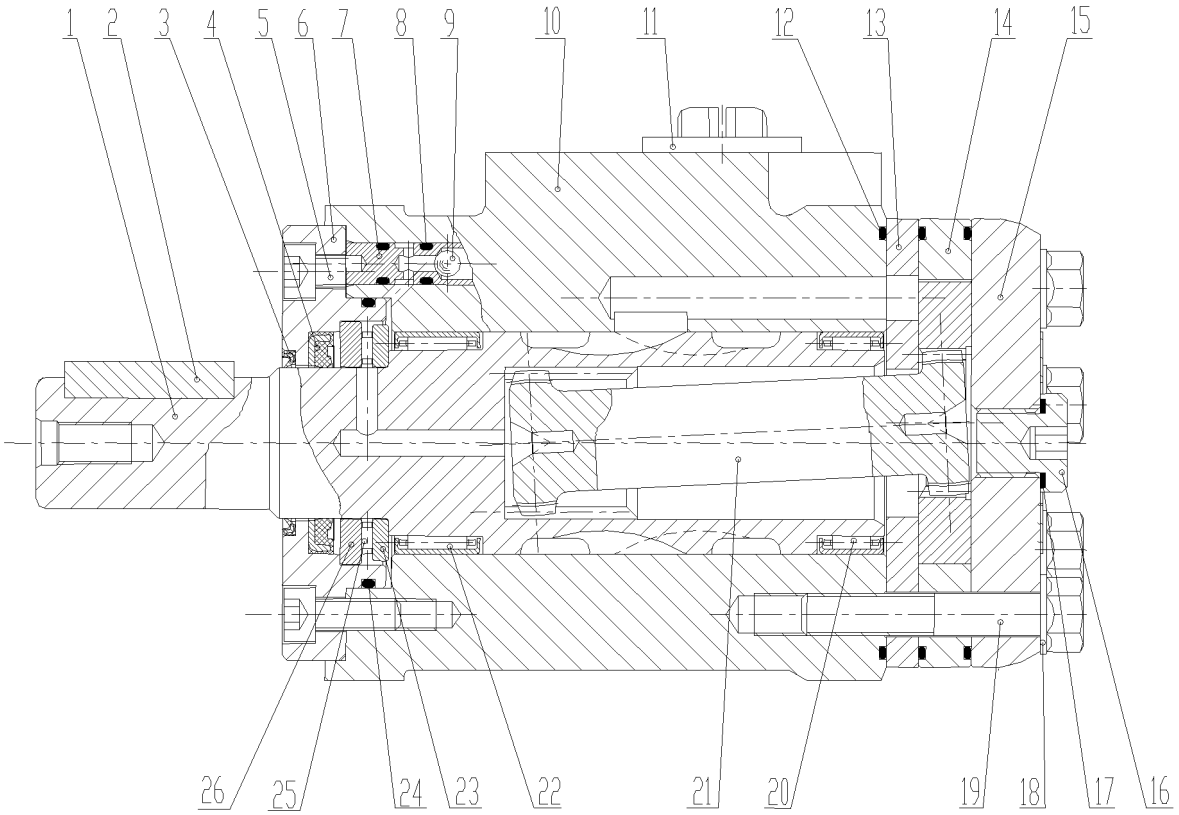

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Fig.1

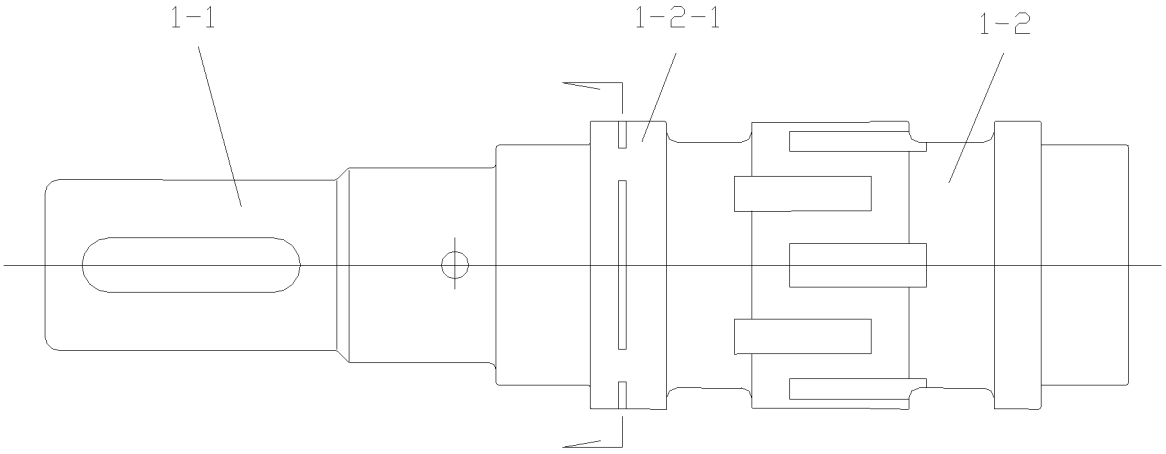

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Fig. 2

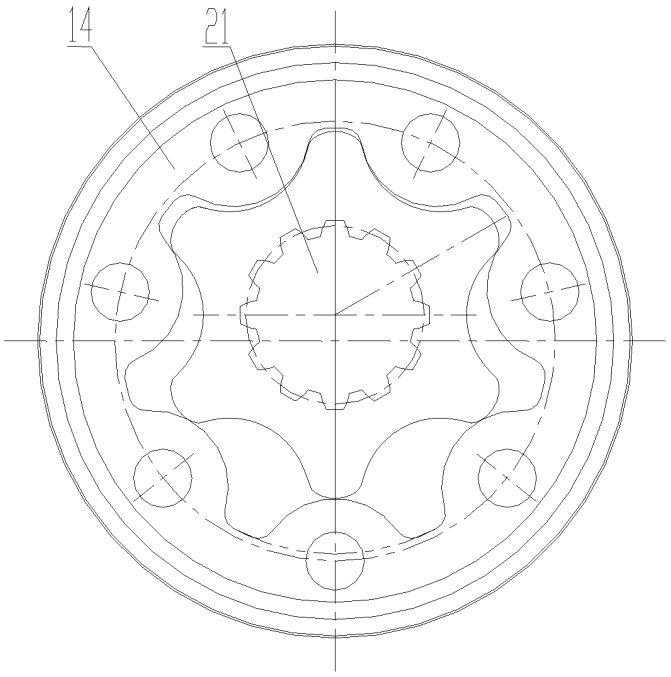


Fig. 3

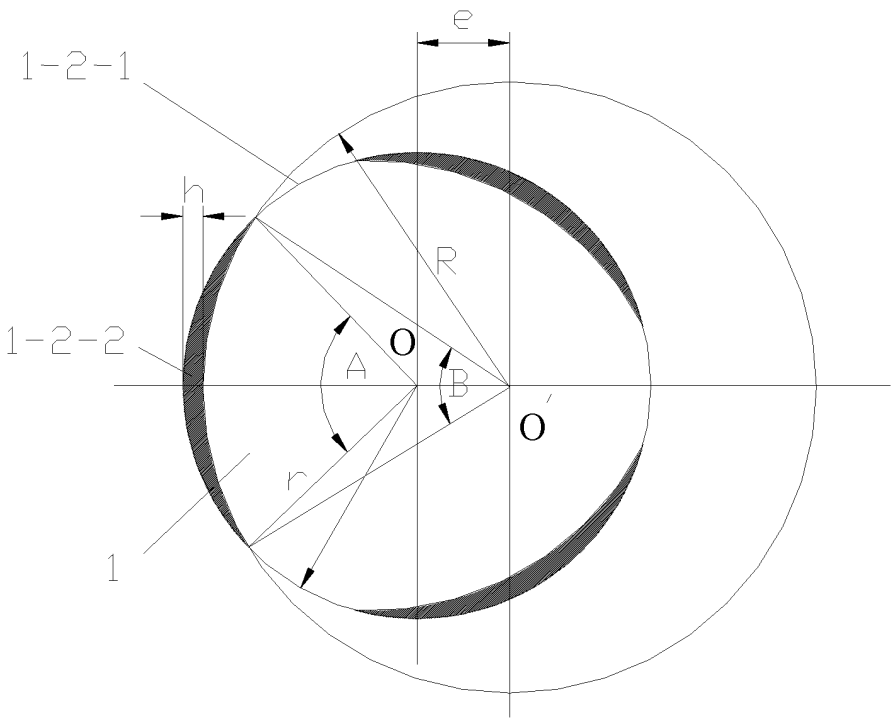


Fig. 4

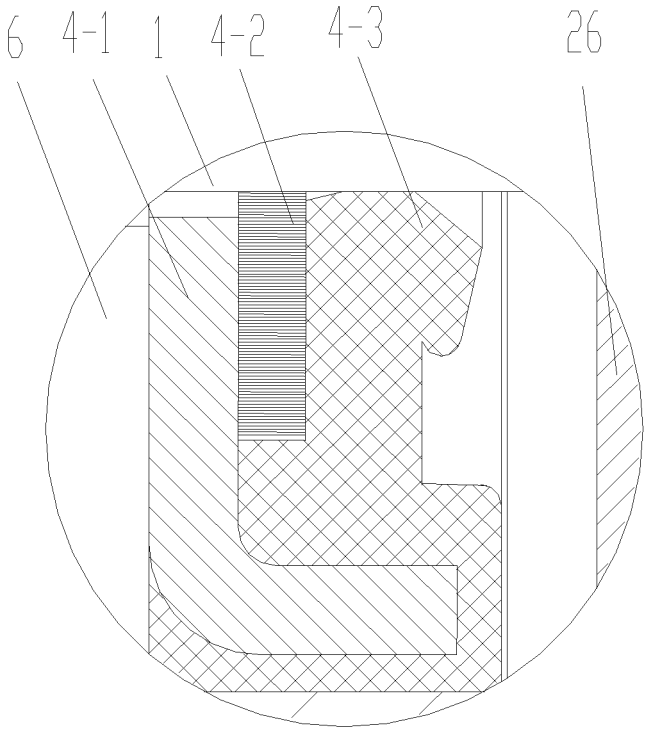


Fig. 5

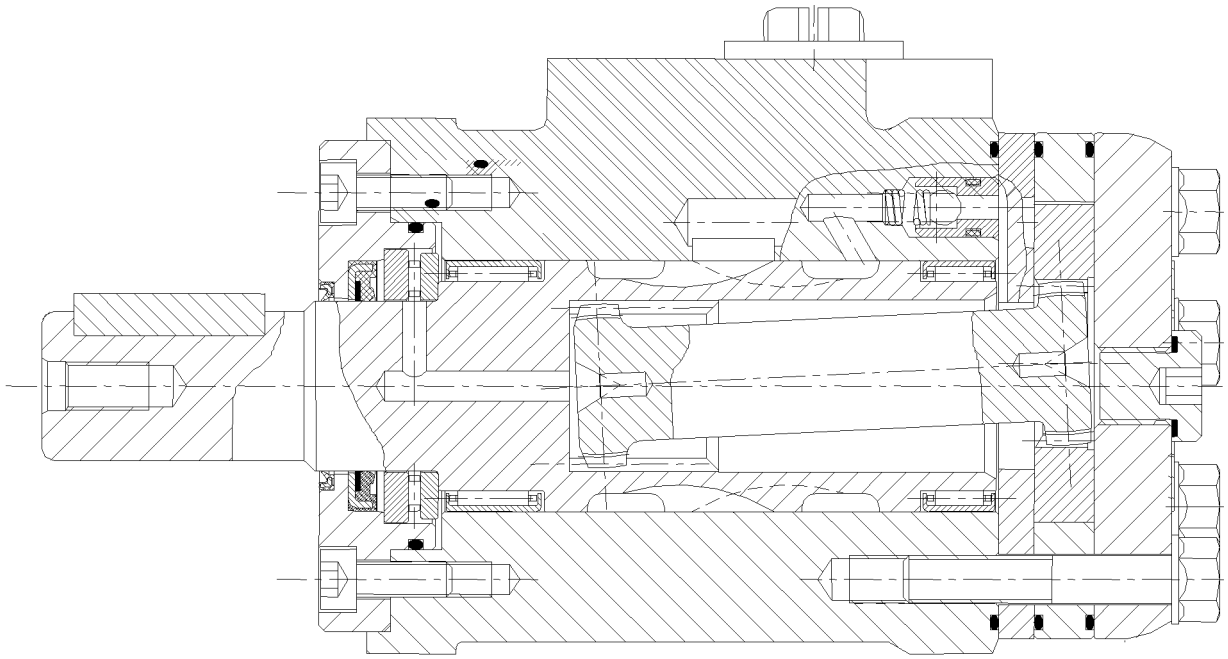


Fig. 6

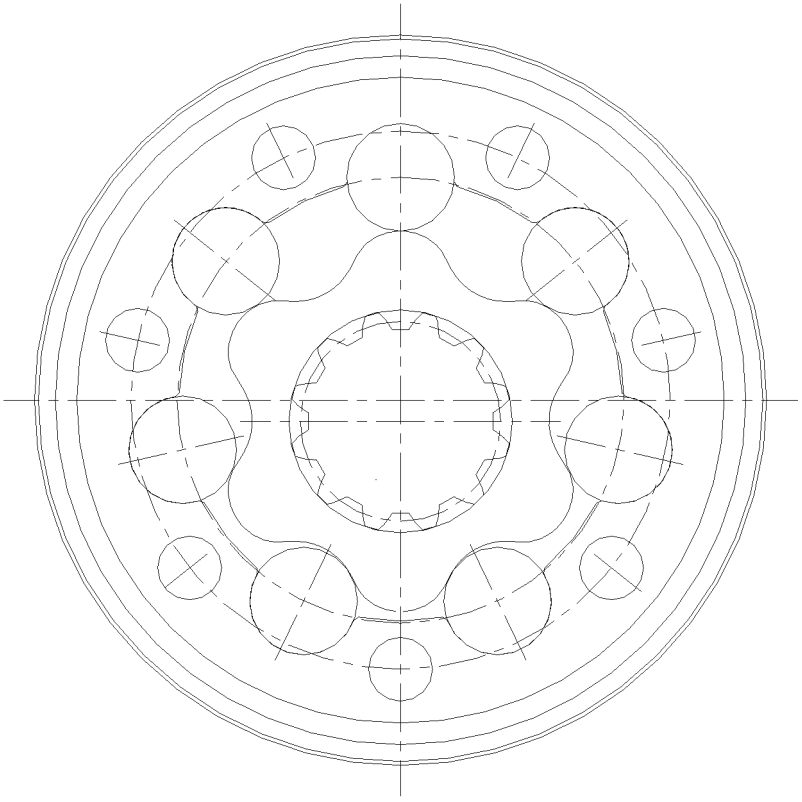


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/083430

A. CLASSIFICATION OF SUBJECT MATTER

F16C 3/02 (2006.01) i; F03C 2/08 (2006.01) i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16C; F03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, CNPAT, CNKI: output, shaft, hydraulic+, motor, oil, passage?, groove?, slot?, eccenri+, radius, bearing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 10362902 A (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 12 March 2014 (12.03.2014) see description, paragraph [0014] to paragraph [0028], and figures 1-7	1-10
PX	CN 203584678 U (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 07 May 2014 (07.05.2014) see description, paragraph [0014] to paragraph [0031], and figures 1-7	1-10
PX	CN 103671465 A (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 26 March 2014 (26.03.2014) see description, paragraph [0011] to paragraph [0018], and figures 1-3	1-7
PX	CN 203627077 U (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 04 June 2014 (04.06.2014) see description, paragraph [0022] to paragraph [0037], and figures 1-3	1-7

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2014	03 November 2014
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer ZHANG, Min Telephone No. (86-10) 62084136

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/083430

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 203670433 U (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 25 June 2014 (25.06.2014) see description, paragraph [0016] to paragraph [0026], and figures 1-3	1-2
A	CN 2760279 Y (EATON FLUID POWER JINING CO LT) 22 February 2006 (22.02.2006) see description, page 1 and page 2, and figures 1-3	1-10
A	CN 2545386 Y (ZHONGYI HYDRAULIC MOTOR CO LTD) 16 April 2003 (16.04.2003) see the whole document	1-10
A	CN 201121555 Y (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 24 September 2008 (24.09.2008) see the whole document	1-10
A	CN201650916 U (WHITE CHINA DRIVE PRODUCTS CO LTD) 24 November 2010 (24.11.2010) see the whole document	1-10
A	CN 102588203 A (ZHENJIANG DALI HYDRAULIC MOTOR CO LTD) 18 July 2012 (18.07.2012) see the whole document	1-10

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/083430

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103629042 A	12 March 2014	None	
CN 203584678 U	07 May 2014	None	
CN 103671465 A	26 March 2014	None	
CN 203627077 U	04 June 2014	None	
CN 203670433 U	25 June 2014	None	
CN 2760279 Y	22 February 2006	None	
CN 2545386 Y	16 April 2003	None	
CN 201121555 Y	24 September 2008	None	
CN201650916 U	24 November 2010	None	
CN 102588203 A	18 July 2012	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201310584115 **[0001]**
- CN 201310584259 **[0001]**
- CN 200720041824 **[0006]**
- CN 201220454428X **[0006]**