Jan. 7, 1958 E. STURM 2,818,707

ROTARY PUMP AND MOTOR HYDRAULIC TRANSMISSION

Original Filed Oct. 9, 1950 2 Sheets-Sheet 1

Fig. 1

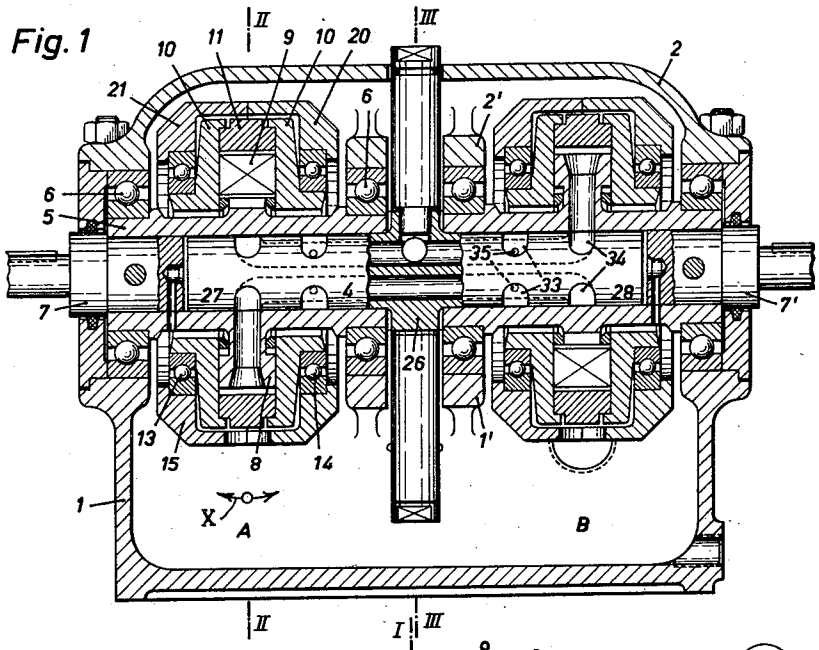
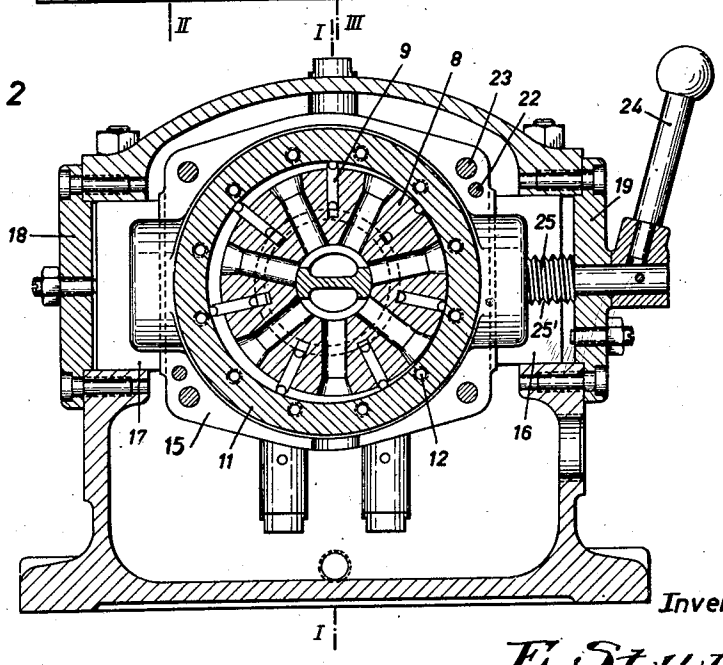


Fig. 2



Inventor:

E. Sturm

by Glascock Downing & Seebold

Attorneys

ROTARY PUMP AND MOTOR HYDRAULIC TRANSMISSION

Original Filed Oct. 9, 1950 2 Sheets-Sheet 2

Fig. 3

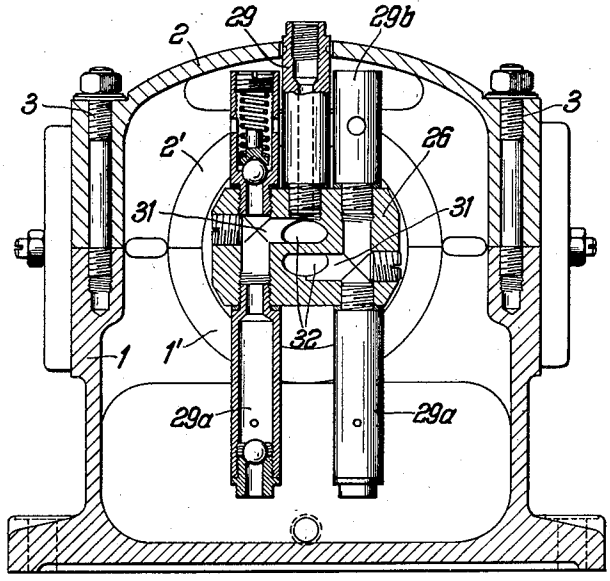
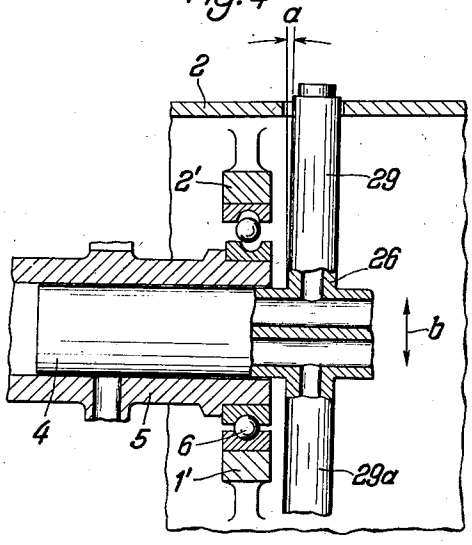


Fig. 4



Inventor:
E. Sturm
By Glascock Downing & Seibold
Attys.

United States Patent Office

2,818,707

Patented Jan. 7, 1958

2,818,707

ROTARY PUMP AND MOTOR HYDRAULIC TRANSMISSION

Erwin Sturm, Boll, near Goppingen, Germany

Original application October 9, 1950, Serial No. 189,207, now Patent No. 2,750,895, dated June 19, 1956. Divided and this application April 24, 1956, Serial No. 580,281

2 Claims. (Cl. 60—53)

The present invention is a division of my co-pending application Serial No. 189,207, filed October 9, 1950, now Patent No. 2,750,895, dated June 19, 1956.

This invention relates to a rotary pump and motor hydraulic transmission, in which the vane drums of both the pump and the motor, including the vanes, are enclosed by freely rotatable casings, which are eccentrically adjustable relative to said drums and which define the working chambers of the pump and the motor. By this known arrangement the friction between said rotary casing on the one hand and the vanes on the other is restricted to a limited motion which is due to the eccentricity between the rotary casing and the vane drum. Therefore, frictional losses are extremely small.

The rotary casing makes it possible to use higher pressures of the driving medium. However, this important advantage has been limited by the fact that the guide shaft or distributor shaft connecting the working chambers of the pump and the motor, was capable within certain limits only to absorb higher pressures of the driving medium, since it was found that the rotary vane drum after a certain period of time would seize the distributor shaft and thus become immobilized thereto.

It is an object of this invention to prevent the rotatable vane drum from seizing the stationary distributor shaft and to decrease the wearing of the pivots of the distributor shaft in such a manner that it remains within permissible deviation.

A further object of the invention is to prevent admission of air through the suction passage of the distributor shaft into the working chambers of pump and motor with the result, that higher pressures may be used and the output may be increased.

The inventor has discovered that the rigid attachment of the distributor shaft within the machine housing as proposed in his U. S. A. Patent 2,049,092 of July 28, 1936, and which has been customary practice for several decades, introduces said serious drawbacks and he has found that according to his invention said drawbacks can be eliminated and further advantages are attainable by a pump and motor hydraulic drive, in which the vane drums of both the pump, and the motor are enclosed by freely rotatable casings which are eccentrically adjustable relative to said drums in combination with a distributor shaft, which connects by transfer passages therein the working chambers of the pump and motor and is supported in the hubs of the vane drums without fixed connection with the outer housing and so being adapted to follow movements of the vane drums. Said distributor shaft is also provided with at least one projection which is in loose contact with the machine housing to prevent the rotation of the distributor shaft but to give it limited movement relative to the machine housing.

An object of the present invention is to overcome above mentioned disadvantages of hydraulic drives in a satisfactory manner.

Another object of the present invention is to improve on the art of rotary machines as now ordinarily made.

Other objects and structural details of the invention will be apparent from the following description when read in conjunction with the accompanying drawings forming part of this specification, wherein:

Fig. 1 is a vertical sectional view of a hydraulic drive according to the invention, taken on line I—I of Fig. 2;

Fig. 2 is a sectional view of the hydraulic device, taken on line II—II of Fig. 1;

Fig. 3 is a sectional view of the hydraulic drive, taken on line III—III of Fig. 1;

Fig. 4 shows the left portion of the movable mounted distributor shaft and its radial displacement caused by the bearing play of the ball bearings of the vane drums.

Referring now to the drawings, the housing of the hydraulic drive comprises a lower portion **1** and an upper portion **2** connected with each other by a plurality of bolts **3**. As best shown in Fig. 3, the line of separation between said two portions **1** and **2** of the housing is in the same horizontal plane as the main longitudinal axis of the drive. As best shown in Fig. 1, the hydraulic drive has two equal component parts, one of which is employed as a pump, the other as a motor. These component parts are connected with each other, in a manner well known, by conduits extending through the guide or distributor shaft **4** and connecting the working chambers of the pump and the motor. Each component part includes a vane drum, the hub **5** of which encircles the associated end or bearing portion of the guide shaft **4**; each vane drum is rotatably mounted in the housing **1, 2** by means of ball bearings **6**. The inner ball bearings **6** are engaged with semicircular lugs **1'** and **2'** arranged on the lower and upper portions **1** and **2** respectively of the housing. The input—or output—stud **7** is connected with the hub **5** by a pin or the like in a manner known per se. The wheel-like portion **8** of the vane drum receives the vanes **9** in a manner known per se. According to the embodiment shown in the drawings, the vane drum of each component part is provided with seven vanes **9**. A casing comprising two front covers **10** and a jacket **11** rigidly connected with each other by bolts **12** enclose the vane drum and the vanes arranged therein. A ball bearing **13** or **14**, respectively, is arranged between each front cover **10** of the casing and a support **15**. The inner races of said ball bearings **13** and **14** snugly fit on the hubs of the casing **10, 11**, while the outer races of said ball bearings snugly fit into the recesses of the support **15**. Said support **15** is provided with two journals **16** and **17** (see Fig. 2), inserted into apertures of the housing closed by covers **18** and **19**. Furthermore, as best shown in Fig. 1, the outer surfaces of the covers **10** of the rotary casing **10, 11** beyond their contact with the inner races of the ball bearings **13, 14** are of conical shape, while the inner surfaces of the support **15** are in a plane perpendicular to the longitudinal axis of the vane drum, whereby spaces increasing in width towards the circumference of the casing **10, 11** are formed between the covers **10** and the inner walls of the support **15**. Therefore, the support **15** being slidably mounted in the housing **1, 2** by the journals **16, 17** (Fig. 2) may perform oscillations in the direction of the double arrow X (see Fig. 1) about an axis of rotation determined by the line of intersection between the horizontal center plane located in the axis of the vane drum and a vertical center plane located centrally with reference to the ends of the vane drum.

The support **15** of the casing **10, 11** comprises two symmetrical halves **20** and **21** connected with each other by set pins **22** and bolts **23**. The cylindrical journals **16** and **17** are integral with the associated support **15** of the casing **10, 11**.

To adjust the support **15** of the casing **10, 11** eccentrically to the main axis of the drive, the threaded end of

a spindle **25** rotatably arranged in a bore of the cover **19** and provided with a setting handle **24** is engaged with a threaded bore of the support **15**. Thus, the support **15** may be displaced by a rotation of the handle **24** along an axis of adjustment identical with the above described axis of rotation of the support.

The guide or distributor shaft **4** consists of a center piece **26** and cylindrical bearing portions **27** and **28**, respectively, into which the center piece **26** continues axially at each of its sides, said center piece **26** is integral with said bearings portions **27** and **28**. Said bearing portions of the distributor shaft **4** snugly fit into the bores of the hubs of the vane drums with a minimum of operating clearance, which secures a tight fitting without disturbing the rotation of the vane drums. At least one projecting piece **29** carried by the center piece **26** passes through an aperture of the portion **2** of the housing **1, 2** of the drive in loose contact therewith, whereby the distributor shaft **4** is prevented from rotation.

Check valves **29***a* projecting into the oil chamber are arranged at the lower side of the center piece **26**; one of said check valves **29***a* is associated with the suction conduit, the other one is associated with the pressure conduit. In a similar manner two safety valves **29***b* are arranged at the upper side of said center piece **26**, one of said safety valves **29***b* being associated with the suction conduit, the other one being associated with the pressure conduit. As the bearing portions **27** and **28** fit into the bores of the hubs of the vane drums with the smallest play and the distributor shaft is not in any rigid connection with the housing, the distributor shaft may follow the radial movements of the vane drums caused by the bearing play of the ball bearings.

The projecting piece **29** communicates with the suction and pressure conduits **32** by means of bores **31** extending transversely through the center piece **26**. To obtain a pressure relief, the bearing portions **27** and **28** of the shaft **4** are formed with arcuate shallow recesses **33** corresponding, with respect to area, to the openings of the suction and pressure conduits **32**. In Fig. 1, it will be seen that each of the recesses **33** is connected with the opposite conduit by a bore **35** whereby the pressure in the opposite conduit is led to the associated recess. This particular arrangement is a contributing factor in reducing to a minimum the friction between the shaft **4** and the vane drums.

It is well known, that ball bearings require a certain amount of operating clearance or play, which will increase in the course of time due to wear. For several decades it has been practice rigidly to connect the distributor shaft with the machine housing as shown especially in Figs. 1 and 4 of my earlier U. S. A. Patent No. 2,049,092 of July 28, 1936. That known arrangement has the drawback that the differences in the operating clearance of the ball bearings of the vane drums cannot equalize, therefore the operating clearance between the pivots of the distributor shaft and the bores in the hubs of the vane drums must be made wider than the minimum of clearance to obtain a tight fitting in said bores. Though it is admitted that the operating clearances amount to fractions of a millimeter only, the increased clearance is necessary to avoid a seizing of the distributor shaft, but is sufficiently great to permit air to enter into the suction sides of the working chamber and such to cause air to be entrained by the driving medium. The commingling of air with the driving medium causes both a reduction in efficiency and an increase in noise level.

This is the point at which the invention comes into its own, according to which the distributor shaft **4** is no longer rigidly mounted in the machine housing but is supported in the hubs of the vane drums with a minimum of operating clearance. It is evident, that by this arrangement the distributor shaft **4** and the two vane drums rotatably mounted upon their pivots **27** and **28** form a movable system, being only under the influence of the

operating clearances of the ball bearings **6** by which the vane drums are supported. In said movable system the distributor shaft **4** is adapted to perform a radial displacement and a tilting movement as far as these movements are permitted by said operating clearances of the ball bearings **6**. The distributor shaft is provided with at least one projection **29** in loose contact with the machine housing **2**, whereby the distributor shaft **4** is prevented from rotation but is not prevented from following radial and tilting movements of said vane drums.

In order to explain the operation of the new arrangement, the Fig. 4 shows in a schematic manner the left portion of the distributor shaft **4**, the adjacent hub **5** of the vane drum and the inner ball bearing **6** of the vane drum, whereby the upper balls of the ball bearing **6** are in a tipped up position in consequence of the operating clearance shown in exaggerated scale. Therefore, the distributor shaft **4**, which is no more in a rigid connection with the machine housing, can follow the radial displacements *b* and slopes of the vane drums. Such a position of the distributor shaft is shown in Fig. 4 and marked by the angle *a*. Now the pivots **27** and **28** of the distributor shaft may snugly fit into the bores of the vane drums with a minimum of operating clearance. Thus, even when the vane drums are loaded unidirectionally, the clearance on the suction side will no longer be increased, the result being that on the suction side no air can any longer be drawn in between the vane drum and the distributor shaft. This amounts to an increase in the efficiency of such transmissions by up to 10 percent, while in addition the operating noise is reduced considerably.

Now the danger that the vane drum might seize the distributor shaft has thus been eliminated. As a result it is now possible to use very high pressures of the driving medium. Only now can the full benefits be derived from the advantages afforded by the rotary casing. From this fact there will be appreciated the inherent relationship between the arrangement of an eccentrically adjustable freely rotatable casing enclosing the vane drums of both the pump and the motor of a hydraulic drive in combination with a distributor shaft which has transfer passages extending between the pump and the motor, whereby said distributor shaft is supported by the hubs of the vane drums, said distributor shaft being provided with at least one projection being in loose contact with the machine housing to prevent the rotation of the distributor shaft but to give it free for a movement relative to the machine housing.

Preferably, oil is used as driving medium for the hydraulic drive described above. The operation of hydraulic drives of this kind is known, so that a detailed description there of is unnecessary.

The construction, according to the invention may also be applied to drives equipped with pumps or motors with rotating pistons.

I claim:

1. A hydraulic drive comprising a housing, ball bearings mounted in the housing, a liquid pump and a liquid motor, said pump and motor each including a vane drum, a hub for each drum rotatably supported by the bearings, an axial bore in each hub, said hubs and bores being axially aligned, a casing surrounding each vane drum, a carrier supporting each casing for free rotation, means slidably mounting each carrier in the housing, each casing being adjustable eccentrically with respect to its vane drum by sliding movement of each carrier, each of said casings and its vane drum defining a working chamber, means forming alternate radial slots and passages in each vane drum, a vane slidably mounted in each of said radial slots, a distributor shaft closely fitted into the bores of the hubs, said distributor shaft having longitudinal passages therein to establish communication between the working chambers of the pump and motor through the radial passages in said vane drums, and complemental

means on the distributor shaft and housing preventing rotation of the shaft yet allowing the shaft to follow radial movements and tilting movements of the vane drums.

2. The hydraulic drive as defined in claim 1, wherein said complemental means includes a projection on the distributor shaft extending perpendicularly therefrom and of a length to project through an opening of greater perimetric area in the housing.

References Cited in the file of this patent

UNITED STATES PATENTS

2,255,963	Benedek	Sept. 16, 1941
2,344,115	Sturm	Mar. 14, 1944
2,750,895	Sturm	June 19, 1956