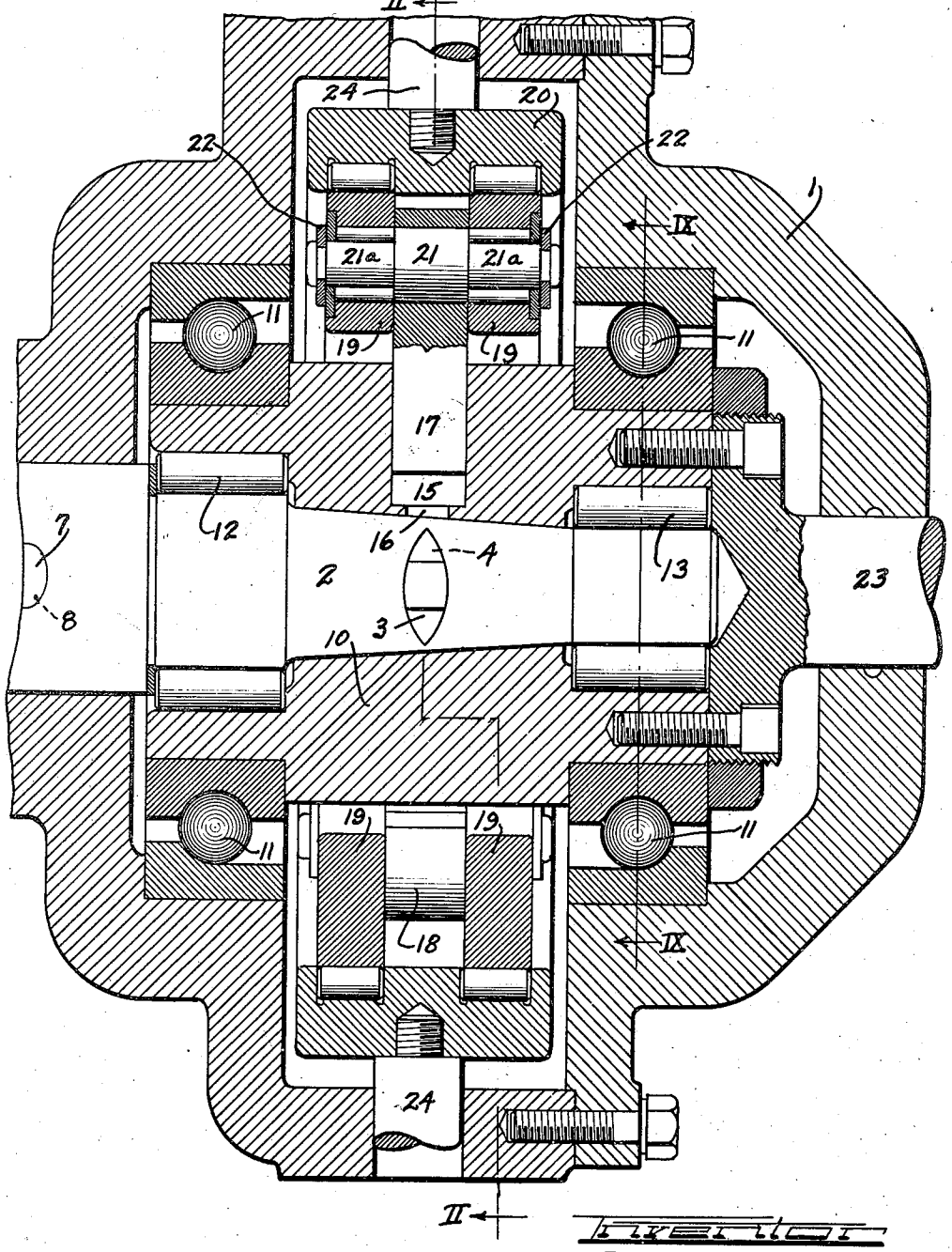
July 8, 1941. E. K. BENEDEK 2,248,738

HYDRAULIC PUMP OR MOTOR

Original Filed Nov. 20, 1935 5 Sheets-Sheet 1

Fig. 1.



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By Charles O. Miller Atty.

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Fig. 2.

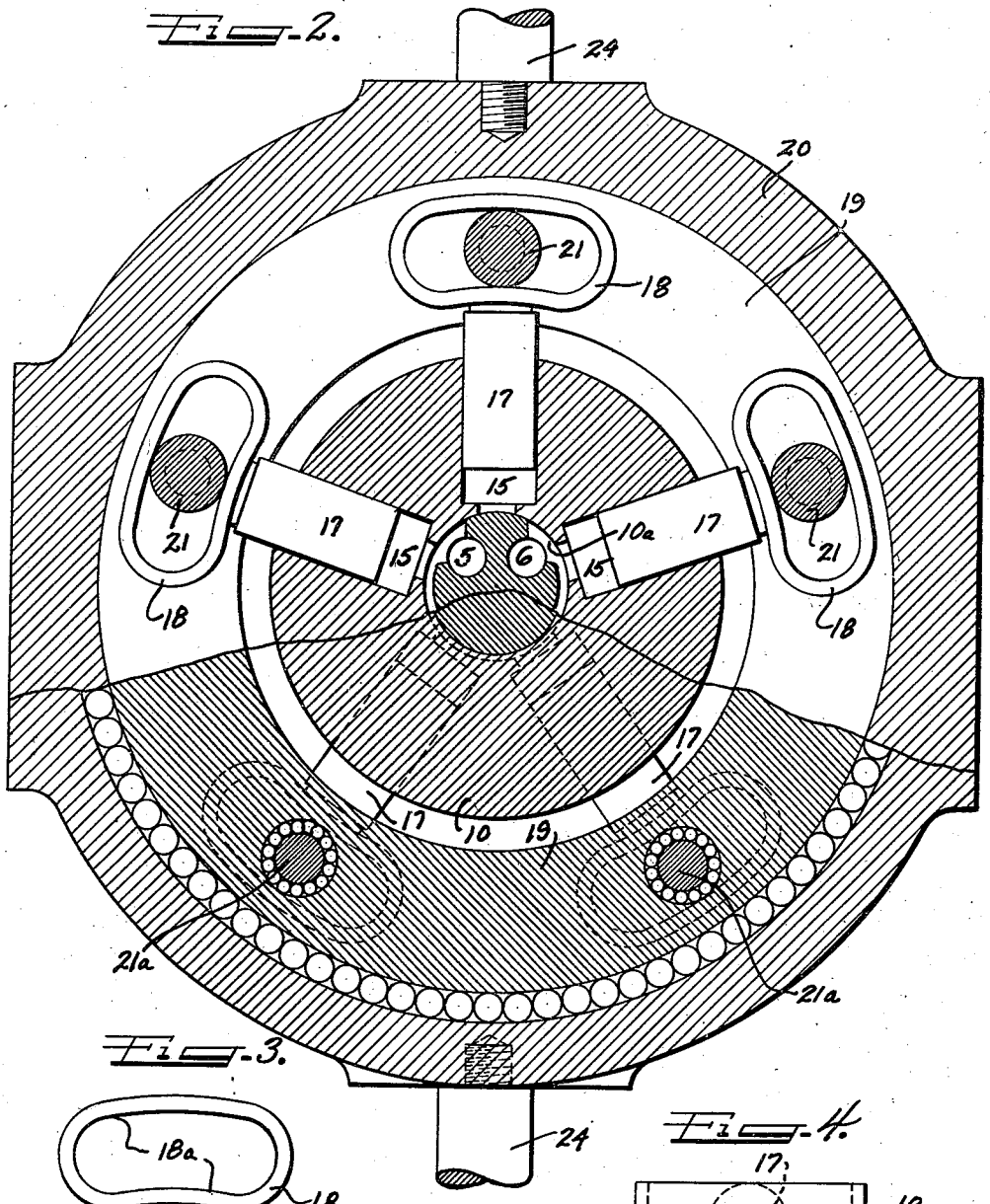
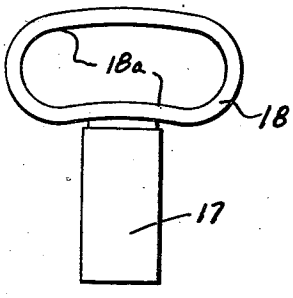


Fig. 3.



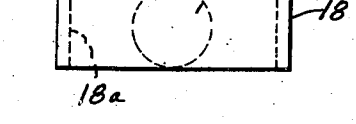


Fig. 4.

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Fig. 5.

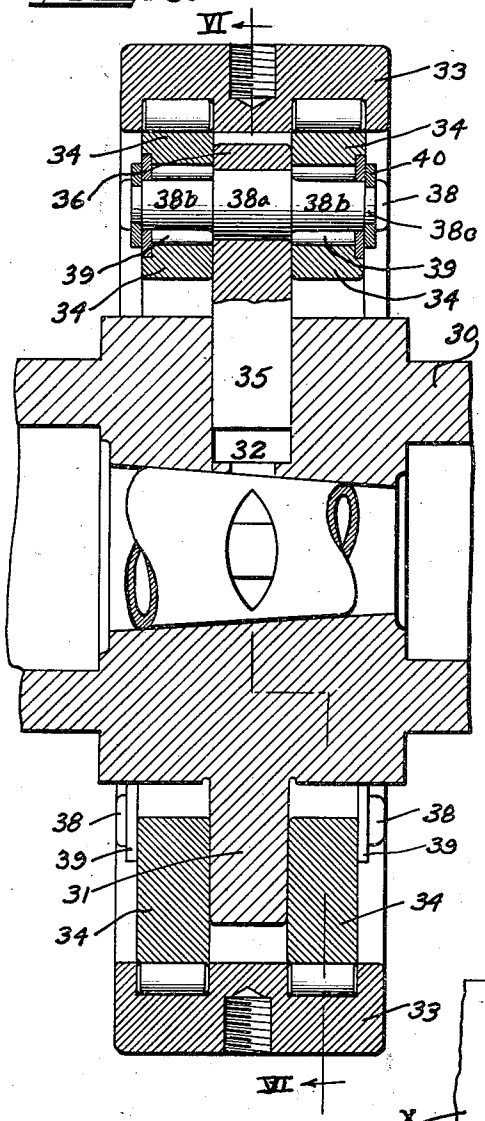


Fig. 10.

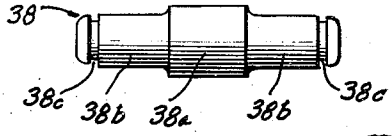


Fig. 9.

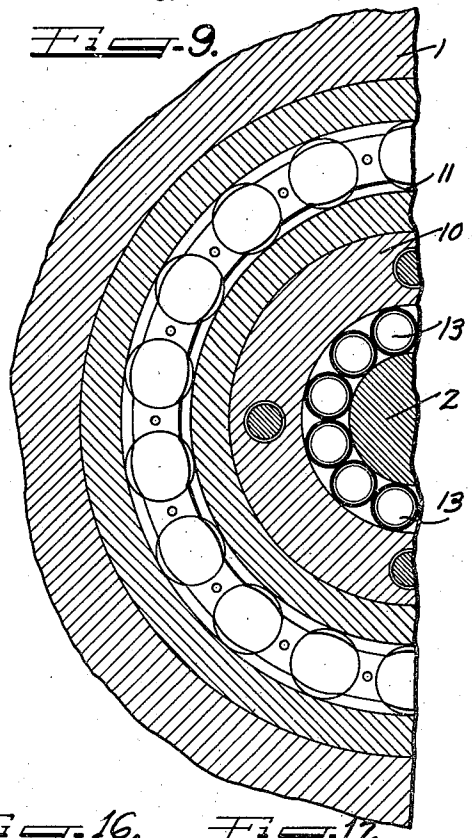


Fig. 16.

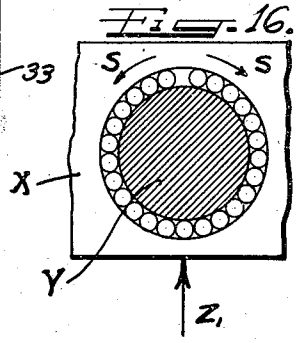
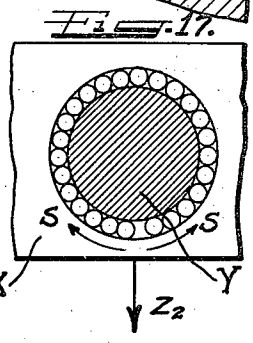


Fig. 17.



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Fig. 6.

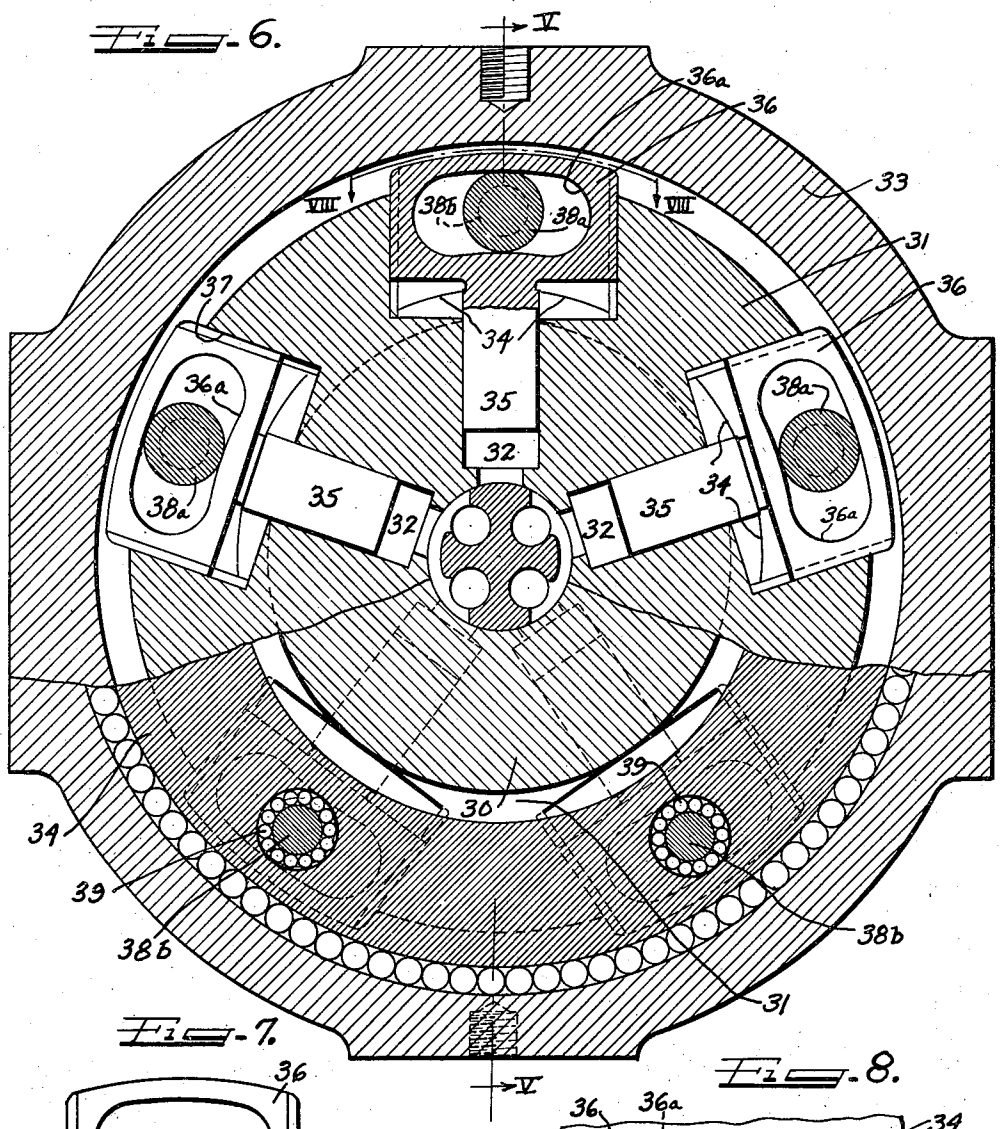


Fig. 7.

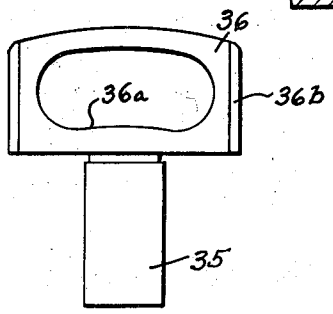
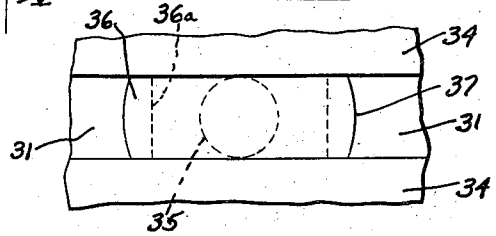


Fig. 8.



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HYDRAULIC PUMP OR MOTOR

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Fig. 11.

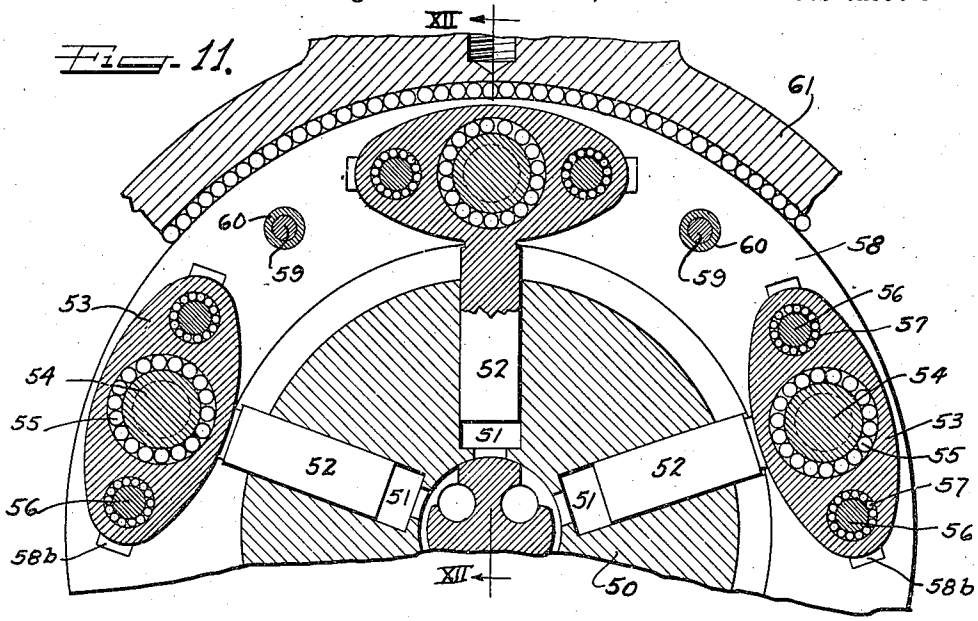


Fig. 13.

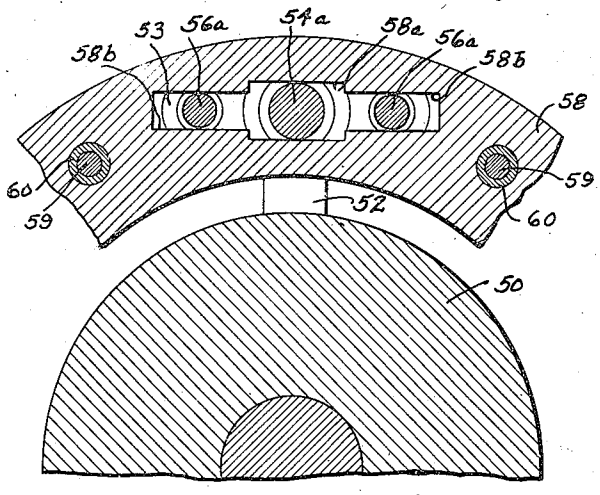


Fig. 12.

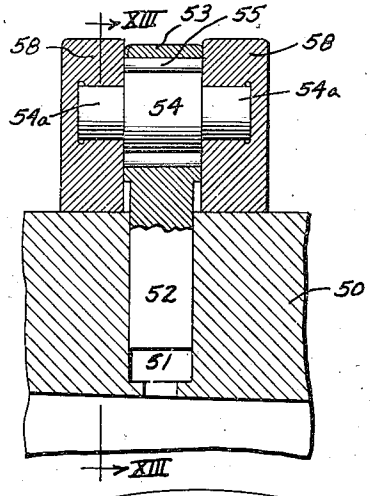


Fig. 14.

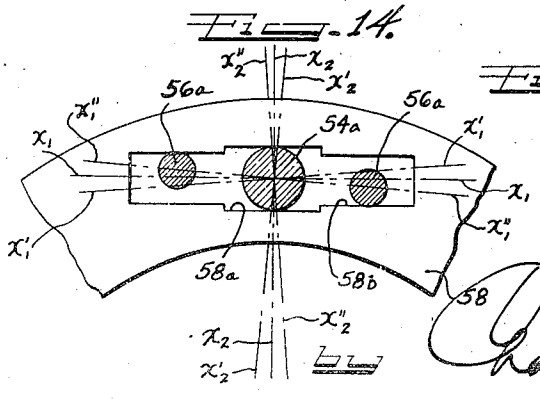
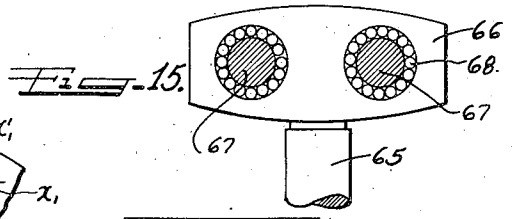


Fig. 15.



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Fig.

Patented July 8, 1941 2,248,738

UNITED STATES PATENT OFFICE

2,248,738

HYDRAULIC PUMP OR MOTOR

Elek K. Benedek, Bucyrus, Ohio

Original application November 20, 1935, Serial No. 50,671. Divided and this application November 20, 1939, Serial No. 305,395

8 Claims. (Cl. 103—161)

This invention relates to high pressure variable displacement, reversible, radial piston pumps and motors and particularly to efficient driving and load connections between the piston and cylinder assemblies and the reactance means.

One of the principal objects of the present invention is to provide a connection between the pistons and associated reactance in which the mass and inertia of the reciprocating parts of the connection is so reduced that mass and inertia forces resulting from high speed reciprocation are reduced to a minimum.

A correlative object is to accomplish this result without a sacrifice in strength of the reciprocating parts.

Another object is to reduce the number of parts necessary for the connection between the piston and reactance to a minimum.

Another and more general object is to provide for anti-friction driving transmission between the barrel and the reactance in a manner such that high efficiency can be provided at high commercial pressures and speed and accurate synchronization of the speeds of the rotors can be maintained under all conditions of operation.

Other objects and advantages will become apparent from the following specification wherein reference is made to the drawings in which:

Figure 1 is a longitudinal sectional view of a pump or motor embodying the principles of the present invention;

Figure 2 is a cross sectional view taken on the plane indicated by the line 2—2 in Figure 1;

Figures 3 and 4 are an elevation and a plan view respectively of one of the pistons and cross heads shown in Figure 2;

Figure 5 is a longitudinal cross sectional view of part of a modified form of pump or motor structure and is taken on a plane indicated by the line 5—5 of Figure 6;

Figure 6 is a cross sectional view taken on a plane indicated by the line 6—6 of Figure 5;

Figure 7 is an elevation of one of the pistons and associated head shown in Figure 6;

Figure 8 is a fragmentary plan view of a portion of the barrel and associated piston shown in Figure 6, as viewed from the plane indicated by the line 8—8 of Figure 6;

Figure 9 is a cross sectional view taken on a plane indicated by the line 9—9 in Figure 1 and illustrates the barrel mounting thereof as well as the mounting of the barrel shown in Figure 5;

Figure 10 is an elevation of one of the cross pins utilized in the structure shown in Figure 5;

Figure 11 is a fragmentary sectional view similar to Figure 2 illustrating a modified piston head and reactance combination;

Figure 12 is a cross sectional view taken on a plane indicated by the line 12—12 in Figure 11;

Figure 13 is a sectional view taken on the plane indicated by the line 13—13 in Figure 12;

Figure 14 is a fragmentary view of the reactance ring shown in Figure 13 illustrating certain operating characteristics and relations of the ring and cross pins for load and torque transmission;

Figure 15 is an elevation of a piston and cross pin illustrating a slight modification of the structure of Figure 11; and

Figures 16 and 17 are enlarged diagrammatic illustrations of the needle roller mountings of the cross pins of the present invention, and illustrate also operating characteristics of other needle bearings shown herein.

This application is a division of my application Serial No. 50,671, filed November 20, 1935, upon which Patent No. 2,180,343 was granted on November 21, 1939.

Referring first to Figures 1 to 4 inclusive, the present invention is shown embodied in a pumping structure wherein a rotary reactance is employed, its use in connection with pumps and motors of the oscillating type being apparent therefrom. The pump includes a rigid housing or casing 1, which serves as a frame and in which is mounted a valve pintle 2, the valve pintle having reversible valve ports 3 and 4 for valving cooperation with the cylinders, as described below. The ports 3 and 4 are connected by suitable pairs of ducts 5 and 6 respectively, with diametrically opposite main ports 7 and 8 respectively in the pintle. The main ports, in turn, are connected through suitable ducts, not shown, formed in the housing 1 with an external fluid circuit.

A cylinder barrel 10 having an axial bore 10a is rotatably mounted in the casing on heavy duty full complement ball bearings 11, arranged one set at each end of the barrel and securing the barrel in fixed axial and radial position within the housing. Positive but slight radial clearance between the barrel bore and pintle 2 is maintained by sets of elongated free rollers 12 and 13 respectively, arranged one set at each end of the pintle and operating on raceways formed directly on the pintle.

The barrel has a plurality of radial cylinders 15, each having a cylinder port 16 for cooperation successively with the ports 3 and 4 as the barrel rotates. Mounted one in each cylinder are pistons 17, each having an enlarged head 18 elongated fore and aft from the axis of the as-

sociated piston, and of greater dimension radially of the pump or motor than transversely, that is, than parallel to the rotative axis.

The piston heads 18 lie between reactance rings 19, which are mounted for independent axial and floating movement in a stator 20 on free cageless rollers operating in and guided at the ends by circumferential recesses in the stator. The rings 19 have aligned bores which receive rolling cross pins 21. Each of the pins 21 has an enlarged central portion and reduced end portions 21a. The reduced end portions 21a of each pin are mounted on capillary cageless rollers in aligned bores of the rings 19 and extend beyond the outer radial faces of the rings 19. The ends of the pins are recessed to receive snap washers 22 which engage the outer radial faces of the rings and constrain them from axial operation. The larger central portions of the pins 21 provide radial shoulders for retaining the capillary rollers in the respective bores and for maintaining the rings in proper axially spaced relation by rolling engagement therewith.

Each head 18 has an arcuate slot or operating way 18a which accommodates the enlarged central portion of the associated pin 21 and is in rolling engagement therewith, slight operating clearance being provided. The operating ways are segments of circles concentric with the rings 19. The axis of the pin 21 is parallel with the axis of rotation of the barrel and rings 19 and normal to the longitudinal axis of the head. The central portion of the pin 21 is of such diameter relative to the piston that the radial hydraulic piston load will be applied within the projected area of the piston in the arcuate way of the head so that there is a rigid, non-yielding load application between the piston and pin. The tangential rolling reciprocation of the pin in the way 18a will not be more than the diameter of the piston and as a result of this manner of applying the load, a very light crosshead structure can be utilized so that the inertia of the high speed rotation and reciprocation is reduced. For this same reason, the pistons may be made of duraluminum.

Another very important feature is the simplified movement and relation between the cylinder barrel and the reactance rotor rings. The pistons and heads are preferably made of a single piece of material forged to the proper shape. Due to the fact that the rolling pins 21 are mounted anti-frictionally in the rings 19, the resistance to rotation thereof in the rings is less than the rolling frictional engagement of the pins with the operating surfaces of the ways 18a as a result of which anti-friction rolling cooperation is provided and binding and sliding of the pins in the ways are eliminated.

The cylinder barrel 10 is connected to a drive shaft 23 which it drives when the device is functioning as a motor and by which it is driven when the device is functioning as a pump. Relative movement between the piston 17 and the cylinder 15 is secured by placing the stator 20 in an eccentric position with respect to the pintle 2 and the cylinder barrel 10. Control rods 24 secured to the stator 20 and projecting out through the ends of the casing 1 are provided for this purpose.

Referring to Figures 5 to 10 inclusive, there is illustrated a barrel 30 having a radial flange 31 and radial cylinders 32 in the zone of the flange. The reactance comprises a stator 33 which rotatably supports axially spaced reactance rings 34. Mounted in each cylinder is a piston 35 having a crosshead 36 which is accommodated between the rings 34 with operating clearance only. The flange 31 has a plurality of radial guideways 37 aligned with the cylinders respectively, the guideways having cylindrical end walls snugly engaging complementary end walls of the heads 36 so as to prevent lateral rocking of the heads and for transmitting torque.

Each head 36 has an arcuate slot or way 36a corresponding to the way 18a of the structure of Figure 10. Correspondingly cross pins 38 having relatively large central portions 38a and reduced end portions 38b are mounted in the reactance rings 34 by the reduced end portions. The central portion 38a of each pin is in rolling cooperation with the walls of the way 36a, the reduced end portions 38a being received in aligned bores in the rings 34 and mounted therein on capillary cageless needles 39. The outermost ends of the pins 38 are provided with recesses 38c in which are disposed suitable snap washers 40 for maintaining the pins in the rings 34 and constraining the rings against axial separation. Here again, due to the anti-friction mounting of the ends 38b of the pins 38 in the rings 34, rolling cooperation only between the central portion 38a of the pins and the ways 36a is provided.

In this construction there is combined the load application to the piston along a circular path and a piston cross head which is fixed in relation to the piston, whereas heretofore piston structures in which the load is applied along an arcuate path employed the pistons which were separated from the heads so as to provide for self-adjustment. This structure is made possible by the cooperation of the head and guideways 37. When the piston and head are separated, as in prior structures, there is a rocking movement with respect to the cross pin and the piston so that the crosshead describes a semi-crank motion which imposes a substantial destructive tangential component of load on the piston through the cross pin, and upon the cylinder walls. In the present structure, however, since the load is well guided and supported by the guideways 37, and unnecessary heavy reciprocating parts are eliminated by mounting the pins in the reactance rings instead of directly in the head, this rocking action is reduced or eliminated and is prevented from reaching the pistons in a degree sufficient to cause wear and binding. The ways 36a necessarily lighten the reciprocating head so that high speed and high pressures as may be necessary may be used. In all the forms of the invention hereinbefore illustrated, the axes of the rolling pins and the operating ways are disposed at the normal neutral axis of the associated heads.

Another form of the invention is illustrated in Figures 11 to 14 inclusive, this form of the invention being provided with pistons with crossheads having separate load transmitting and torque transmitting rolling pins. In this structure, a barrel 50 having radial cylinders 51 is provided, each cylinder 51 carrying a radial piston 52 having a head 53 corresponding in shape generally to the head 18 heretofore described. The head 53 is also tapered from the mid portion toward the ends so as to provide as near as may be a constant strength beam.

Rotatably mounted in the head 53 with its axis intersecting the piston axis is a load transmitting rolling pin 54 having reduced diameter end portions 54a. The pin is mounted in the

nead 53 on capillary cageless needle rollers 55. In advance of and to the rear of the pin 54 and equidistant from the axis thereof are torque transmitting rolling pins 56 each having reduced diameter end portions 56a. The pins 56 are also mounted on capillary cageless needle rollers 57 in the head 53. The rollers 56 are disposed with their axes in a plane through the axis of the roller 54 and normal to the piston axis. The rolling pin 54 acts as rolling load transmitting means and since each pin carries the direct thrust of the associated piston substantially in the line of the piston axis, each pin 54 acts as means for reinforcing the associated piston head substantially in the zone of the piston axis.

Rotary reactance rings 58 are provided for coaction with the piston heads and pins and lie alongside the opposite faces of the heads, the rings being secured together by suitable bolts 59, the accurate axial spacing of the rings 58 being maintained by spacers 60. The rings, in turn, are rotatably mounted in a stator 61 which operates in the usual manner. The rings 58 have axially aligned chordal ways, each way comprising a radially wide portion 58a for rolling and oscillating coaction with the ends 56a of the load pin 54, and symmetrical end portions 58b of less radial dimension, the end portions coacting with ends 56a of the torque transmitting rolling pins 56.

The specific operation of this structure is best illustrated in Figure 14. Assuming the barrel to be driven in a clockwise direction, it is apparent that the hydraulic load will be taken by the pin 54 which, though oscillating along its slots 58a, applies the load within the projected area of the piston. In effecting the torque transmission, there is a very slight rocking of the head which causes engagement of the leading roller 56 with the radially inward operating surfaces of the ways 58b, and the trailing rollers 56 with the outer operating surfaces of the associated ways 58b, thus providing positive torque transmission. Necessarily any such rocking is about the axis of the pin 54, as illustrated by the various positions of the lines X_1 and X_2 in Figure 14, the line X_1 representing the plane of the axes of the pins 56 and the line X_2 representing the axis of the piston 52. However, irespective of such rocking, the plane X_1 of the axes of the pins 56 is perpendicular to the axis X_2 of the piston at all times.

In Figure 14, the actual clearance between the ends 56a and cooperating surfaces of the ways 58b is greatly exaggerated for purposes of clearness in illustration. The actual clearance is such that if the radial clearance for the pin thrust or load pin 54 is given, the clearance for the pins 56 would be very slightly more so as to assure that the load will be primarily applied by the pin 54 and not by the pins 56.

Obviously, in such a structure, excessive wear would affect the operation and consequently all surfaces are made of non-wearing material such as nitralloy or the equivalent. Preferably nitralloy pins having a surface hardness of 1000 Brinell and reactance rings having corresponding hardness are used, as the wear in such instance is not sufficient to appreciably affect the operation.

A simpler form of the invention just described is illustrated in Figure 15. In this form of the invention, the cross pins are rotatably mounted in the head of the piston with the operating ways in the reactance. For example, in Figure 15 each piston 65 has a crosshead 66 disposed with the major axis of its cross section parallel to the piston axis. Rolling thrust pins 67 are mounted on capillary rollers 68 in the head 66, the axis of the rollers 68 lying in a plane normal to the piston axis. The two thrust pins 67 are similar to the thrust pins 54 in the form of the invention illustrated in Figures 11 to 14 and cooperate with chordal ways in reactance rings lying at either side of the piston head 66, the chordal ways being of uniform width and the remainder of the structure being similar to that illustrated in Figures 11 to 14.

Referring to Figures 16 and 17, an unusual operating phenomenon results from the use of capillary rollers mounted as shown between two members X and Y which are relatively rotatable, one such member being a reactance ring or piston head, and the other being a thrust pin. The capillary cageless rollers are disposed between the members X and Y with a total circumferential clearance equal from slightly less than 1 to about 2 needles. For example, the needles may be packed between the members X and Y and then one or two needles of the full complement removed. The needles operate in an oil bath, which, in the present pump, is provided by slip fluid. Assuming the load to be applied to the member X, in the direction of the arrows Z_1 and Z_2 in Figures 16 and 17 respectively, an unexpected reaction occurs. It is found that the needles crowd to the loaded zone instead of being driven away or squeezed out from under the load. The needles opposite the loaded zone correspondingly separate circumferentially as indicated by the arows *s*. Upon the separating of the needles, as indicated by the arrows *s*, the resultant clearance space between the unloaded needles sucks in oil. Obviously in a reciprocating member wherein the load is first applied in one direction as indicated in Figure 16 and then in the opposite direction as indicated in Figure 17, full complement bearing for load is provided with a separation of the needles at the unloaded side for receiving oil. Upon reversal of the operation, as upon the suction stroke, the opposite side becomes loaded and the needles rush to the said opposite side, again assuming the load and separating the first, and now unloaded side, again replenishing the oil. Thus each needle of the set may rotate freely about its own axis unconstrained by adjacent needles and remain in rolling engagement with both races due to capillary oil films, and full rolling bearing surface at the instantaneous loaded side is provided.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a rotary radial piston pump or motor, a rotatable barrel having radial cylinders therein, valve means for the cylinders, pistons in the cylinders respectively, heads on and rigid with the pistons respectively, a rotary reactance surrounding the barrel in eccentric rel on thereto and having radial walls lying alongs. the heads of the pistons, each head having an arcuate operating way concave toward the axis of rotation, rollers rotatably mounted at their ends in the said wall portions and having portions in load transmitting rolling engagement with the operating ways of the heads respectively.

2. In a rotary radial piston pump or motor, a rotatable barrel having radial cylinders therein, valve means for the cylinders, pistons in the cylinders respectively, heads on and rigid with the pistons respectively, a rotary reactance surrounding the barrel in eccentric relation thereto and having radial walls lying alongside the heads of the pistons, each head having an arcuate operating way concave toward the axis of rotation, rollers rotatably mounted at their ends in the said wall portions and having portions in load transmitting rolling engagement with the operating ways of the heads respectively, said last mentioned roller portions being of such diameter relative to the eccentricity and diameter of the piston as to have its axis always within the projected piston area.

3. In a rotary radial piston pump or motor, a rotatable barrel having a plurality of radial cylinders, valve means for the cylinders and a rotary reactance in eccentric relation to the barrel and surrounding the same, radial guide means on the barrel, heads on the pistons reciprocable in and guided by said guideways, arcuate operating ways in the heads, load transmitting rollers rotatably mounted at the ends in said reactance means and in rolling engagement with the operating surface of said ways.

4. In a radial piston pump or motor, a plurality of radial cylinders, valve means for the cylinders, pistons in the cylinders respectively, heads on the pistons, a rotary support having radial walls lying alongside the heads of the pistons, load transmitting rollers antifrictionally mounted at the ends in the radial walls and extending parallel to the axis of rotation of the support, arcuate operating ways extending through said heads and having their radius of curvature coincident with the axes of the associated pistons and being concentric with the support, and engaging the central portions of said pins for rolling coaction therewith.

5. In a hydraulic machine of the class described including radial pistons, a rotary support having radial portions lying alongside the plane of the pistons, and connecting means extending parallel to the axis of rotation of the pistons and carried by said rotary support, rigid heads on the piston and lying between said radial portions of said rotary support, said heads having arcuate slots embracing said connecting means.

6. In a hydraulic machine of the class described including radial pistons, a rotary support having radial portions lying alongside the plane of the pistons, and connecting means extending parallel to the axis of rotation of the pistons and carried by said rotary support, rigid heads on the piston and lying between said radial portions of said rotary support, said heads having arcuate slots substantially concentric with said rotary support and embracing said connecting means.

7. In a hydraulic machine of the class described including a rotary block with radial cylinders, radial pistons in the cylinders, a segmental piston head supporting flange on said block having segments projecting radially between said cylinders, a rotary support having radial portions lying alongside said segments, and connecting means extending parallel to the axis of rotation of said block and carried by said rotary support, rigid heads on said pistons, said heads fitting slidably between said supporting flange segments and having arcuate slots embracing said connecting means.

8. In a hydraulic machine of the class described including radial pistons, a rotary support having radial portions lying alongside the plane of the pistons, and connecting means extending parallel to the axis of rotation of the pistons and carried by said rotary support, rigid heads on the pistons and lying between said radial portions of said rotary support, said heads having arcuate slots embracing said connecting means and being located in the plane of said pistons solely by said pistons and said connecting means.

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