July 9, 1929. W. J. STERN 1,720,577

ROTARY PUMP MACHINE

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Fig. 1.

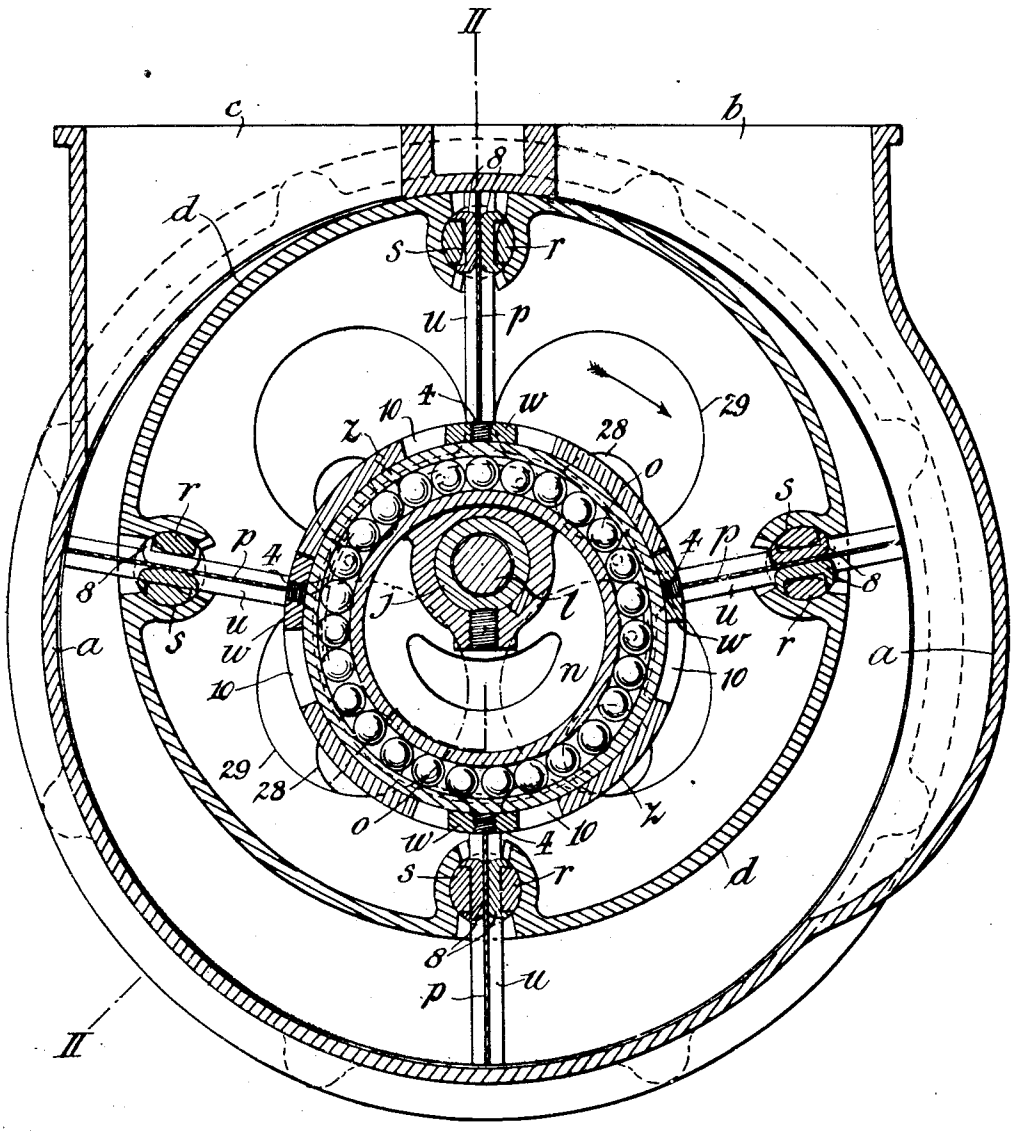

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Fig. 2.

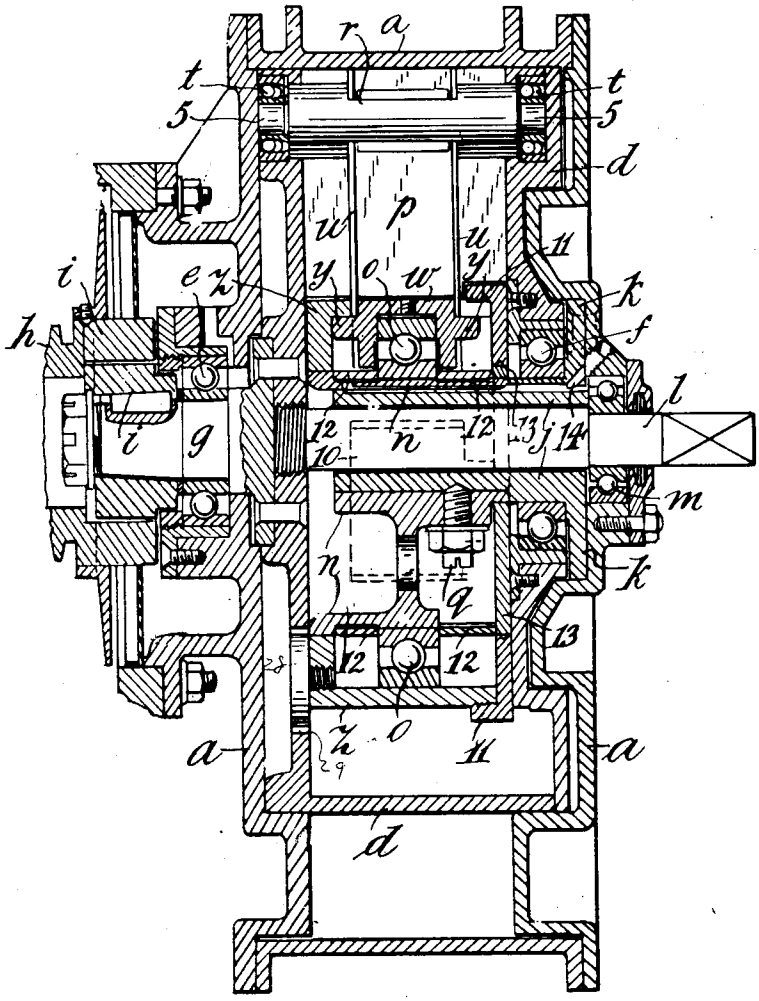

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Fig. 3.

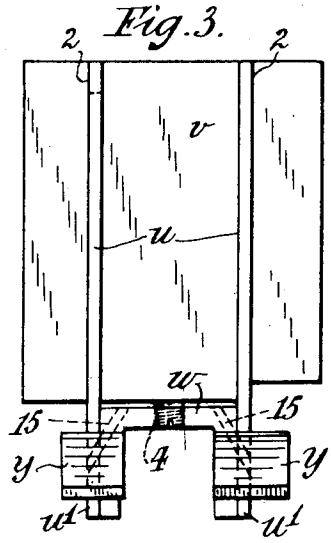


Fig. 4.

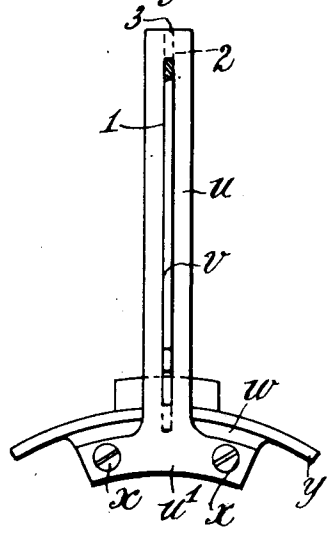


Fig. 5.

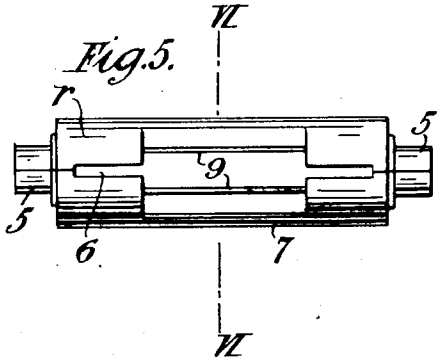


Fig. 6.

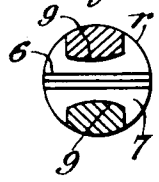
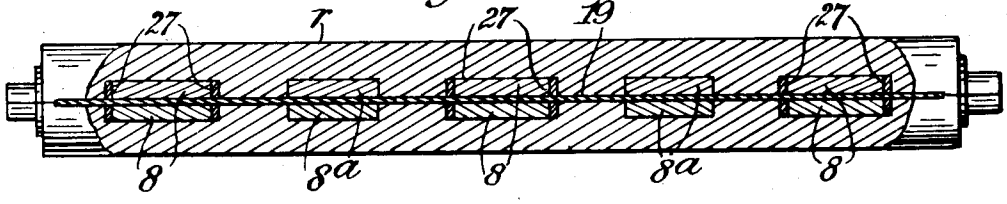


Fig. 10.



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ROTARY PUMP MACHINE

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Fig. 7.

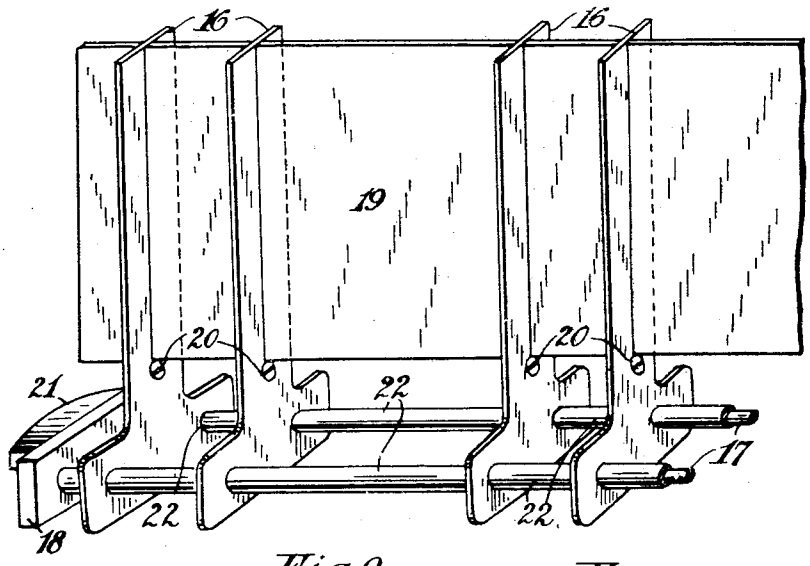


Fig. 9.

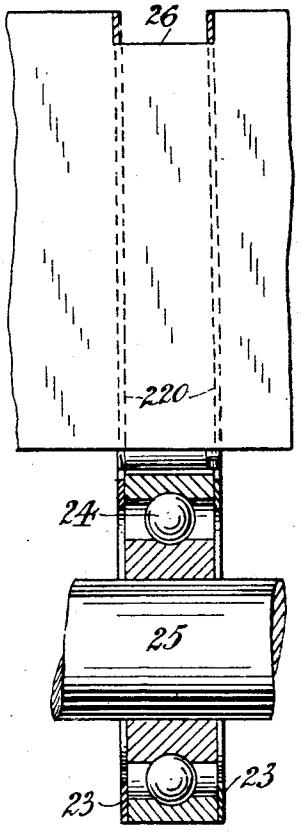
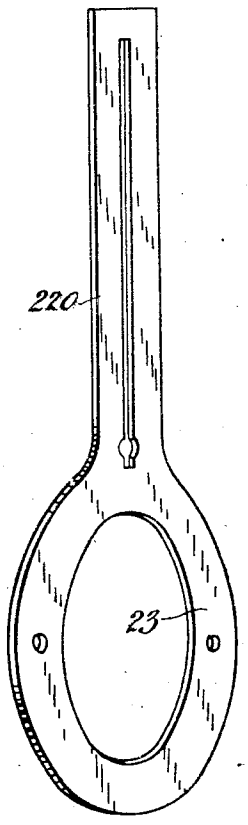


Fig. 8.



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Patented July 9, 1929. 1,720,577

UNITED STATES PATENT OFFICE.

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ROTARY PUMP MACHINE.

Application filed April 8, 1927, Serial No. 182,042, and in Great Britain April 24, 1926.

This invention comprises improvements in and connected with rotary pump machines and is concerned with pump machines of the co-called crescent chamber class. In this class of pump machine the piston or rotor is an eccentrically mounted body formed with spaced slots for vanes to work in, these slots being in some cases fitted with oscillatory trunnion blocks formed with slots in which the vanes have a sliding movement relative to the rotor. In using these machines as pumps or compressors, it is generally advantageous to drive the rotor, the vanes being engaged with centric means such as a lay shaft.

In the specification belonging to my prior Patent No. 1,616,285, I have described constructions according to which the vanes were fitted with so-called thrust members, these members being advantageously in the form of rib members adapted for stiffening the vanes and for taking the stresses due to the reaction between the piston body and the vanes.

The object of the present invention is to lighten the construction of the vanes while at the same time enabling them to withstand various stresses to which they are subjected in the operation of these machines, for it is of the utmost importance to have vanes of the lightest possible construction so as to reduce friction losses.

According to this invention, the vane blades are provided on each face with a series of ribs of small thickness but of relatively great depth so as to resist bending of the blade, the ribs being also adapted, if desired, to take up centrifugal stresses. The ribs are advantageously constituted by thin metal plates which may be slotted centrally to fit on to the blades and be formed with base or ring portions for operatively connecting them with the centric means.

In order to enable the invention to be readily understood, reference is directed to the accompanying drawings, in which:—

Figure 1 is a transverse sectional elevation of a rotary compressor embodying improvements in accordance with this invention.

Figure 2 is an irregular longitudinal section of the compressor, taken on the line II—II of Figure 1.

Figure 3 is an elevation of a piston vane assemblage.

Figure 4 is a sectional side elevation of Figure 3.

Figure 5 is a plan view of a suitable form of oscillatory trunnion block for use with the piston vanes.

Figure 6 is a cross-section on the line VI—VI of Figure 5.

Figure 7 is a perspective view illustrating a modified form of piston vane assemblage.

Figure 8 is a perspective view of a modified construction of vane rib.

Figure 9 is a fragmentary sectional view, illustrating the practical application of the form of vane rib shown in Figure 8, and

Figure 10 is a plan section of a trunnion rocker and vane blade showing the application of intermediate bearing members as hereinafter referred to.

In Figures 1 and 2, *a* is the outer casing of the compressor formed with inlet and exhaust ports or ducts *b* and *c* respectively and *d* is the piston body or rotor mounted eccentrically in the outer casing upon ball bearings *e* and *f*. *g* is the rotor shaft which runs in the bearing *e* and is driven from the power shaft *h* through a coupling *i*. The bearing *f* is supported by a hollow shaft or sleeve *j* with flange *k* at one end for securing it in the casing *a*. *l* is a stub shaft which may be secured in one end of the rotor in alignment with the rotor shaft *g*, this stub extending through the sleeve *j* and being revolubly supported at the other end by a ball bearing *m* mounted in the casing *a*. Upon the sleeve *j* is keyed a supporting member *n* for the inner race of a ball bearing *o* which constitutes a centric revoluble bearing for the piston vanes *p* of the machine. A screw *q* may be provided as an additional securing means for the member *n*, and the vanes *p*, as is usual in these machines, have sliding engagement with the slots of cylindrical rockers or trunnion blocks such as *r* mounted in longitudinal recesses or slots *s* in the rotor body and revolubly supported at the ends in ball bearings *t* in the ends of the rotor.

The machine illustrated in Figures 1 and 2 has four piston vanes but there may be only two or any other desired number greater than two. The rib members *u* which are fitted to the vane blades in accordance with this invention suitably consist of thin metal plates, which may be steel stampings of a size ⅜″ x .104″ in tranverse section for a vane blade of .064″ thickness. By reference also to Fig-

ures 3 and 4, in which a vane blade is marked *v*, it will be seen that these rib plates are advantageously in the form somewhat of an inverted T, so as to provide a base part or foot *u'*. The rib plates are used on the vane blades in pairs. Only one pair is used for each blade in Figures 1 to 4, and each pair is secured one on each side of a vane foot member *w* by means of screws *x* passing through the foot or base *u'* of the plates. The vane feet *w* comprise arcuate parts *y* for engaging the inner periphery of a blade ring *z* in the manner hereinafter described. The rib plates *u* are slotted as at 1 for the reception of the vane blades. It will be seen from Figure 4 that the slots 1 are slightly longer than the radial width of the vane blades and that the slots extend from a point on a level with the top or outer surface of the arcuate parts *y* of the vane feet to a point situated at a short distance from the outer extremity of the rib plates. The vane blades are notched as at 2 at points spaced apart a distance equal to the distance between the rib plates and it will be seen that a vane blade may have the rib plates applied thereto by passing same through the slots 1 of the plates until the notches 2 come into line with the rib plates. Thereupon, the vane blades can be moved outwardly, so that the solid portions 3 at the extremities of the rib plates are engaged with the notches 2, and when the rib plates have been screwed to the vane feet, upon tightening a grub screw 4 in the vane foot, the blade is held firmly in position in the rib plates which thus serve effectively as blade supports or cradles.

In assembling the pump machine, the vanes are engaged in the slots of the rockers *r* of the rotor and the vane feet are engaged with slots in the blade ring *z* aforesaid as will be described.

For convenience of manufacture, the oscillatory cylindrical trunnion blocks may be made in halves, that is divided longitudinally, as seen for example in Figures 5 and 6, and held together by ferrules, caps or equivalent devices at the ends or by their spigot ends 5 engaging with the inner races of the ball bearings *t* aforesaid as shown in Figure 2. The slots 6 of the trunnion blocks are enlarged at the places where the rib members *u* pass through and preferably the enlargements are made long enough to extend over a pair of rib members as seen by way of example at 7 in Figure 5. The purpose of this is to provide a space between the rib plates for the mounting of rocking bearing members or pads of the rocking type, as shown at 8 in Figures 1 and 2. Both the vane blades and the rib plates or vane cradles have a running fit in the trunnion slots 6, and the vane blades take a bearing on the bearing members 8 which are able to rock in the enlargements 7 of the slots 6, with the movements of the vanes, because the sides 9 of the enlargements are curved as seen clearly in Figure 6.

The vane feet *w* are of saddle form as seen in Figures 2 and 3, so that they may straddle the ball bearing *o* and in this condition, in assembling the vanes in the machine, the blades are passed into T form slots 10 in the blade ring *z* the inner race of the ball bearing *o* being driven on to a suitably machined part of the supporting member *n* aforesaid and the outer race fitting centrally within the ring *z*. There are four slots 10, and when the vanes are in position with the arcuate parts *y* engaged with the inner periphery of the ring *z* as seen in Figure 2, an end cap 11 is screwed on to the blade ring to keep the parts in position. The ball bearing *o* is held by distance rings 12 and a spigot ring 13 of eccentric form which is finally fixed in position secured to the supporting member *n*. The interior of the blade ring *z* may be supplied with lubricant through a duct 14 and the blade feet may have ducts 15 formed therein to allow lubricant to pass under the action of centrifugal force to the channels between the rib plates *u* and so to the rocking bearing members 8 in the trunnion blocks *r*. The vane feet are of sufficient dimensions to overlap the slots 10 in the blade ring *z* and in conjunction with the outer race of the ball bearing *o* prevent escape of lubricant through these slots.

If the vane blades be made of suitable material, the bearing pads 8 can be allowed to bear on them direct as shown and the combination of each pair of rib plates with the blade portion between the members of each pair constitutes a sort of H girder forming a modified construction of thrust member of the nature hereinbefore referred to. Should the vane blades be of material unsuitable for bearing purposes, bearing plates may be inserted between the bearing pads 8 and the vane blades *v* as will be understood without further illustration. These bearing plates could be made integral with the rib plates by machining the combination out of the solid.

The general operation of the machine will be understood without further description, but it may be mentioned that as the rotor, in revolving, carries the vanes round in the casing, the rib plates will prevent any bending of the vane under the peculiar stresses to which the vanes are subjected in this type of machine, while at the same time they will also take up the bearing pressures of the vanes upon the bearing pads 8 under the accelerative and decelerative action of the vanes. Furthermore the rib plates restrain the vane blades against centrifugal stresses which are taken up by the blade ring *z* through the vane feet.

The blade ring, in conjunction with the arcuate parts of the vane feet, offer a space on either side of the ball bearing *o* constituting a common centre from which lubricant can be

efficiently distributed to the bearing surfaces of the blades in the trunnion blocks. The blade ring is able to revolve so that friction between it and the vane feet may be minimized while at the same time the slots 10 allow of any slight movements of the vane feet with respect to the blade ring. Any slight rocking movement of the vanes with respect to the trunnion blocks is allowed for by the fact that the bearing members 8 are able to rock upon the curved portions 9 of the trunnion blocks.

The modification illustrated in Figure 7 is suitable for adoption in the case of blowers or other rotary pump machines of relatively great length. Only part of the vane assemblage is shown and it will be seen that the rib plates 16, in this case, have their feet perforated for engagement with rods 17 extending between a pair of vane feet, one only of which is shown at 18. The vane blades 19 are of similar construction to those previously described, but the slots in the rib plates terminate at the inner end in screw threaded holes adapted to receive grub-screws 20 for retaining the blades in position. These rib plates are disposed along the blades in pairs with suitable intervals between the pairs (as in Figure 10 for example) and the vane feet have arcuate parts 21 adapted to engage in the known grooved rings revoluble on ball-bearings mounted centrically in the pump casing, as shown for example in Figure 1 of the drawings of my Patent No. 1,616.285. Distancing sleeves 22 may be employed for spacing apart the inner ends of the rib plates upon the rods 17.

The construction of rib member shown in Figure 8 is applicable for use in cases where the vanes revolve about a sleeve or shaft mounted centrically in the outer casing. as disclosed for instance in my prior Patent No. 1.616,285. The feet of the rib plates 22 in this construction are in the form of ring-shaped parts 23, adapted to encircle the sleeve or shaft. The plates are used in pairs as shown in Figure 9 and when the vanes are to be mounted to revolve on ball bearings on a centric shaft one rib plate is pinned or otherwise secured on each side of the outer race of a ball bearing 24 mounted on the shaft which is marked 25.

Figure 9 also shows that the use of a notch such as 2 aforesaid in the outer edge of the blade, for each rib plate, is not essential as a single notch such as is shown at 26 in this figure may be used of a width equal to the distance between the outer surfaces of each pair of rib plates. Instead of having notches it will also be understood that the spacing between the thin metal rib plates may be determined by suitable distance pieces which may also be adapted to form a sealing tip as will be understood without further description.

Figure 10 shows how the rib plates marked 27, may be arranged in pairs along the length of a long blade 19 as hereinbefore referred to. This figure also discloses the provision between the different pairs of rib plates of intermediate bearing pads 8^a. The use of these intermediate pads may sometimes be advisable in the case of very long blades and they may be arranged so as to come into operation only in the case of emergency, that is to say, if the vane blades bend unduly.

In the construction shown in Figures 1 and 2 it is not essential to employ a single blade ring such as *z*. For instance, two separate rings independently mounted on anti-friction bearings and grooved for engagement with the arcuate parts *y* of the respective vane feet, may be used. Arrangement may also be made whereby the single blade ring, when employed, may be mounted on two ball bearings instead of one as shown, the object being to prevent any likelihood of the ring becoming canted. The single ring would be positively driven at rotor speed, when used, as by the rollers 28, mounted on the ring taking into holes 29 in the adjacent end of the rotor, but if two independently mounted rings be used it is not necessary to arrange for them to be positively driven.

I claim:—

1. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, vane blades arranged in slots of said piston body and engaged with said centric means, rib members of small thickness and relatively great depth disposed on said blades to resist bending thereof and having a running clearance in said slots, and bearing surfaces for the blades in said slots in the vicinity of said rib members, substantially as set forth.

2. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, vane blades arranged in slots of said piston body and engaged with said centric means, thin metal reinforcing plates fitted on said blades at right angles to the plane thereof and having a running clearance in said slots, and bearing surfaces for the blades in said slots in the vicinity of said reinforcing plates, substantially as set forth.

3. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, vane blades arranged in slots of said piston body and engaged with said centric means, rib members fitted on said blades and comprising thin metal plates slotted centrally to fit on to the blades said rib members having a running clearance in said slots and bearing surfaces for the blades in said slots in the vicinity of said rib members, substantially as set forth.

4. A rotary pump machine comprising a

casing, a piston body mounted eccentrically in said casing, centric means in said casing, vane blades arranged in slots of said piston body and engaged with said centric means and having spaced notches in their outer edge, rib members fitted on said blades and comprising thin metal plates slotted to fit over the blades but having an unslotted part at their outer extremity to engage in said notches of the blades, said rib members having a running clearance in said slots and bearing surfaces for the blades in said slots in the vicinity of said rib members, substantially as set forth.

5. A rotary pump machine comprising a casing, a cylindrical rotor mounted eccentrically in said casing, vane blades arranged in slots of said rotor, centric means in said casing, rib members of small thickness and relatively great depth disposed on said blades to resist bending thereof, and adapted for connection to said centric means, said rib members having a running clearance in said slots and bearing surfaces for the blades in said slots in the vicinity of said rib members, substantially as set forth.

6. A rotary pump machine comprising in combination a casing, a cylindrical rotor mounted eccentrically in said casing, vane blades arranged in slots of said rotor, rib members of thin metal plate disposed on said blades to resist bending thereof, and having base portions at their inner extremity, vane feet operatively connected with said base portions, a ring revoluble centrically in said casing and adapted for operative engagement with said vane feet, said rib members having a running clearance in said slots, and bearing surfaces for the blades in said slots in the vicinity of said rib members, substantially as set forth.

7. A rotary pump machine comprising a casing, a cylindrical rotor mounted eccentrically in said casing, vane blades arranged in slots of said rotor, vane feet comprising arcuate parts, rib members fitted on said blades to resist bending thereof and constructed for connection with said vane feet, a blade ring member centrically mounted in said casing and formed with circumferentially spaced slots for engagement with the respective vane feet which are retained by said arcuate parts thereof, and means for positively driving said ring member at rotor speed, substantially as set forth.

8. A rotary pump machine comprising a casing, a cylindrical rotor mounted eccentrically in said casing, vane blades arranged in slots of said rotor, a blade ring member centrically mounted in said casing, and formed with circumferentially spaced slots, and means for positively driving said ring member at rotor speed, vane feet engaged with the slots of said ring member and comprising arcuate parts of such dimensions as to overlap the slot openings circumferentially, and rib members fitted on said blades to resist bending thereof and constructed for connection with said vane feet, substantially as set forth.

9. A rotary pump machine comprising a casing, a cylindrical rotor mounted eccentrically in said casing, vane blades arranged in slots of said rotor, a blade ring member with circumferentially spaced slots centrically mounted in said casing on an anti-friction bearing device, means for driving said ring member at rotor speed, vane feet of saddle form to straddle said bearing device and comprising arcuate parts for engaging said ring member at the slots thereof, and rib members fitted on said blades to resist bending thereof and constructed for connection with said vane feet, substantially as set forth.

10. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, vane blades arranged in slots of said piston body and operatively connected with said centric means, rib members disposed in pairs on said blades, and individual bearing members of rocking pad type, disposed in the rotor slots between the members of each pair of rib members, substantially as set forth.

11. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, rocking bearing blocks arranged in slots of said piston body, vane blades arranged in slots of said bearing blocks and operatively connected with said centric means, rib members disposed in pairs on said blades and individual bearing members of rocking pad type, disposed in the slots of said bearing blocks between the members of each pair of rib members, substantially as set forth.

12. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, vane blades arranged in slots in said piston body, and individual rocking bearing members of short length arranged at isolated points in said slots to provide bearing surfaces for the vanes only at selected points of their length.

13. A rotary pump machine comprising a casing, a piston body mounted eccentrically in said casing, centric means in said casing, rocking bearing blocks arranged in slots of said piston body, vane blades arranged in slots of said bearing blocks and operatively connected with said centric means, rib members disposed in pairs on said blades, rocking bearing members disposed in the slots of said bearing blocks between the members of each pair of rib members, and additional rocking bearing members disposed in the slots of said bearing blocks intermediately between respective pairs of rib members, substantially as set forth.

14. A rotary pump machine comprising a

cylindrical casing, a cylindrical rotor mounted eccentrically in said casing, cylindrical rocking bearing blocks mounted in slots of said rotor, a slotted blade ring member mounted to revolve centrically on anti-friction bearings in said casing, vane blades arranged in slots of said rocking bearing blocks, rib members of thin metal plate arranged in pairs on said vane blades to resist bending thereof, vane feet connected with said rib members and comprising arcuate parts adapted to engage said blade ring member and of such dimensions as to overlap the slots thereof, and rocking bearing members disposed in the slots of said bearing blocks between the members of each pair of rib members, ducts being formed in said vane feet leading from the space within the blade ring member to the channel between the members of each pair of rib members, substantially as set forth.

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