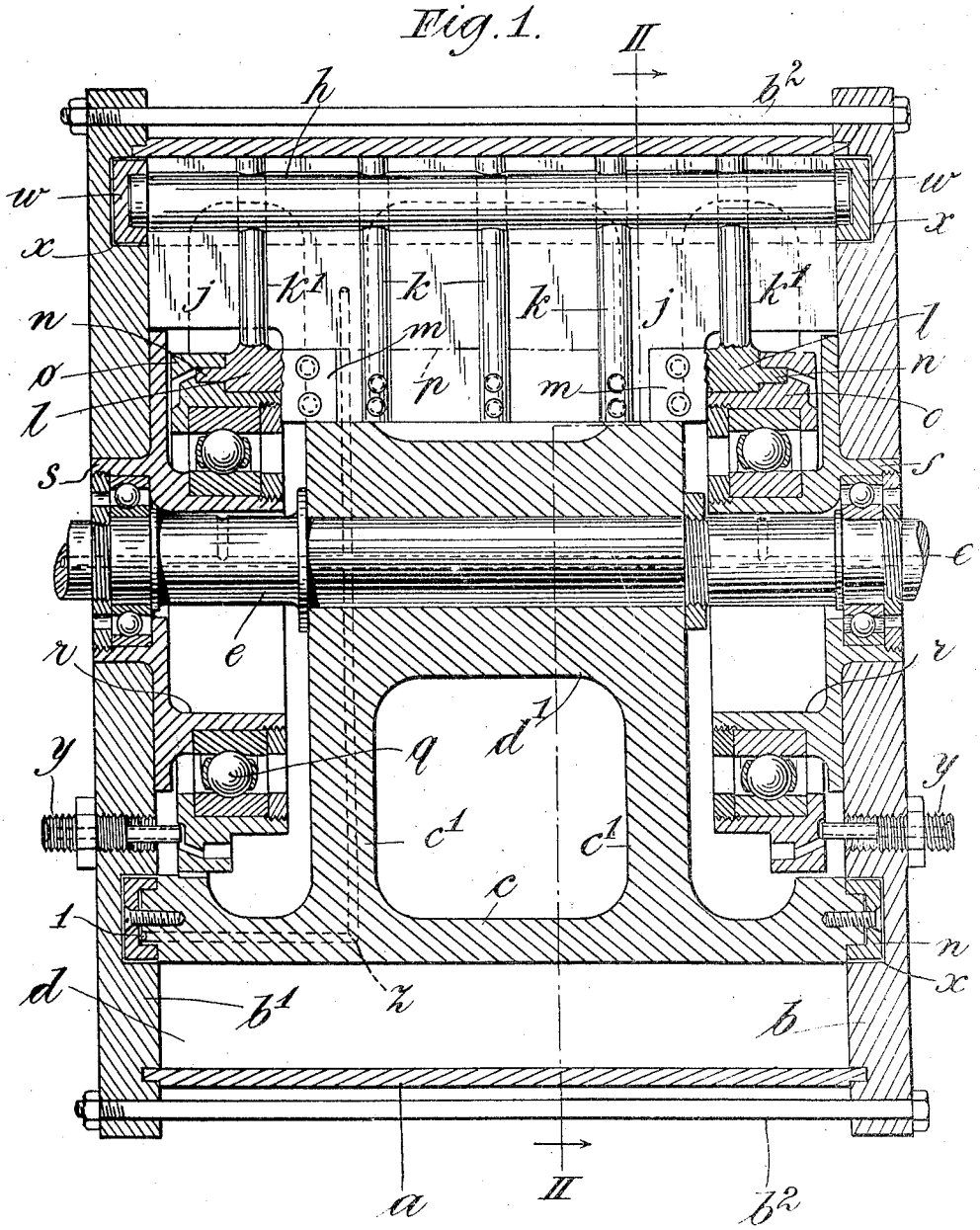
Feb. 1, 1927. 1,616,285

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 1.



Inventor
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By Kenny & Ott Atty

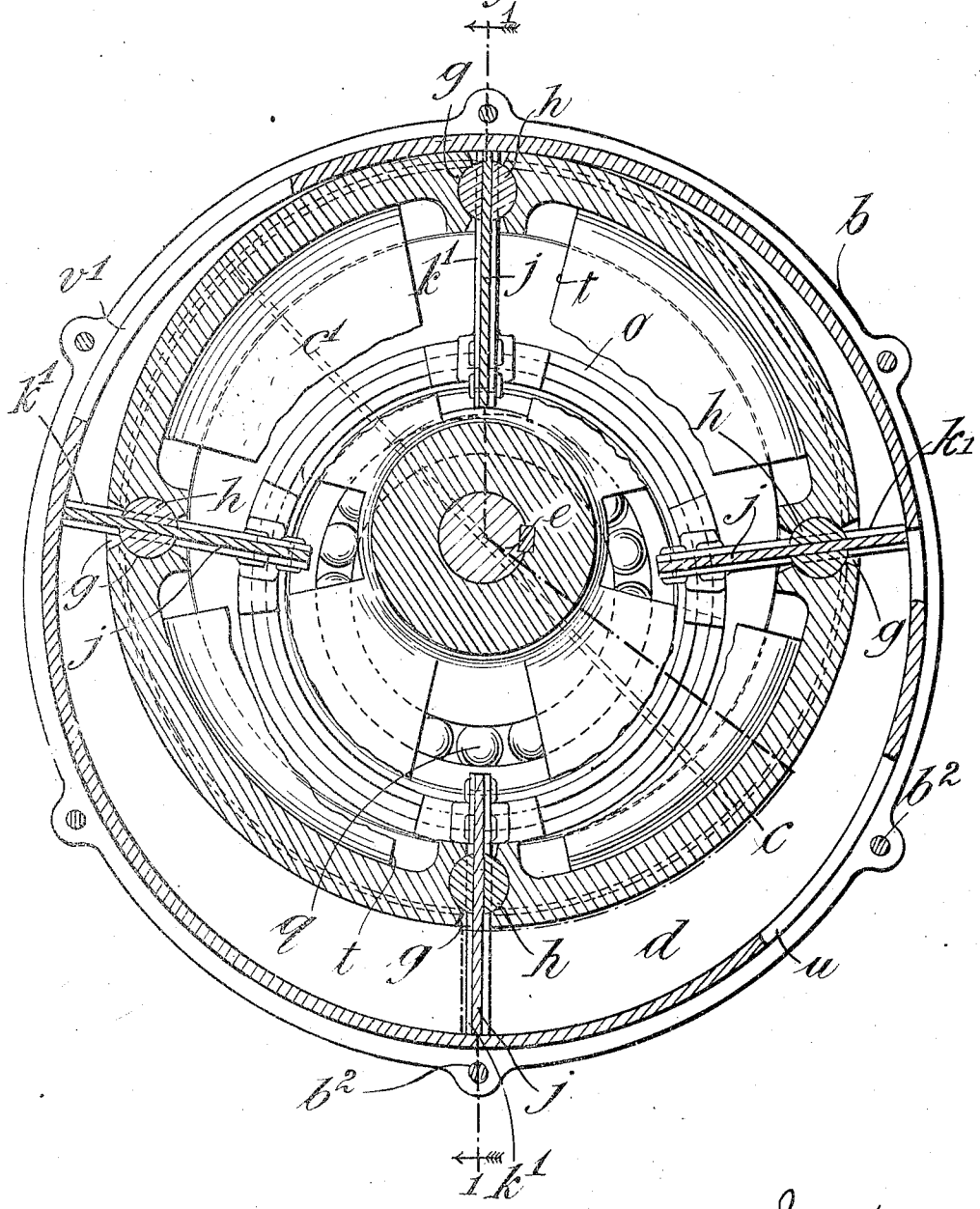
Feb. 1, 1927. 1,616,285

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 2.



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Feb. 1, 1927. **1,616,285**

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 3.

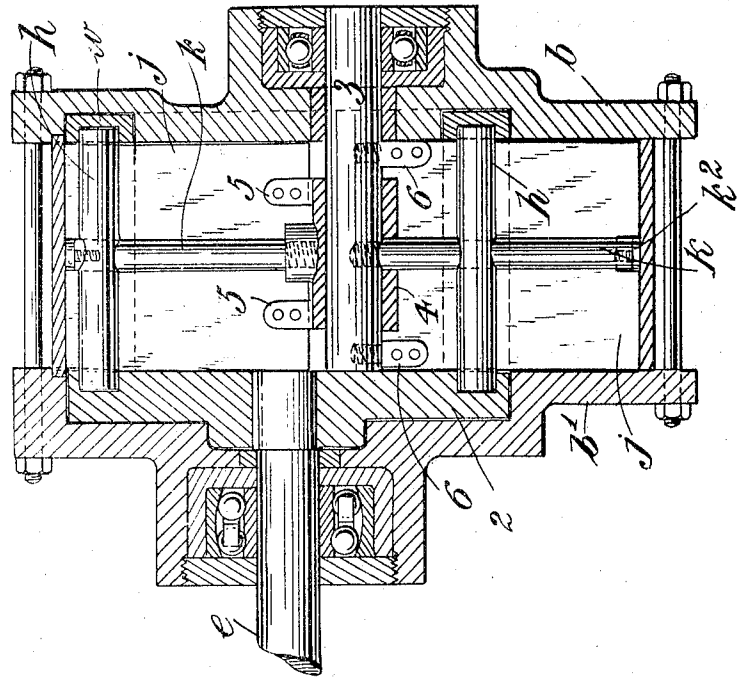
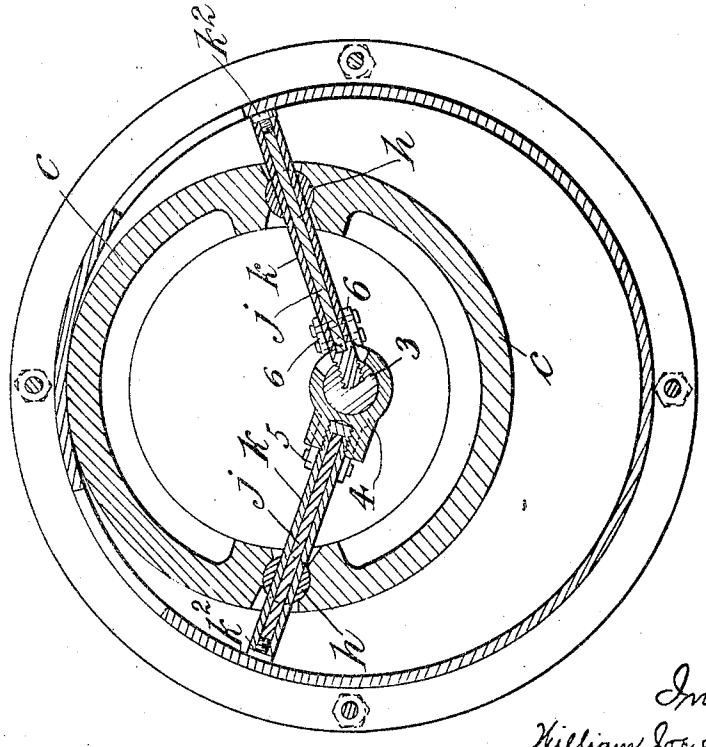


Fig. 4.



Inventor.
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Feb. 1, 1927. 1,616,285

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 5.

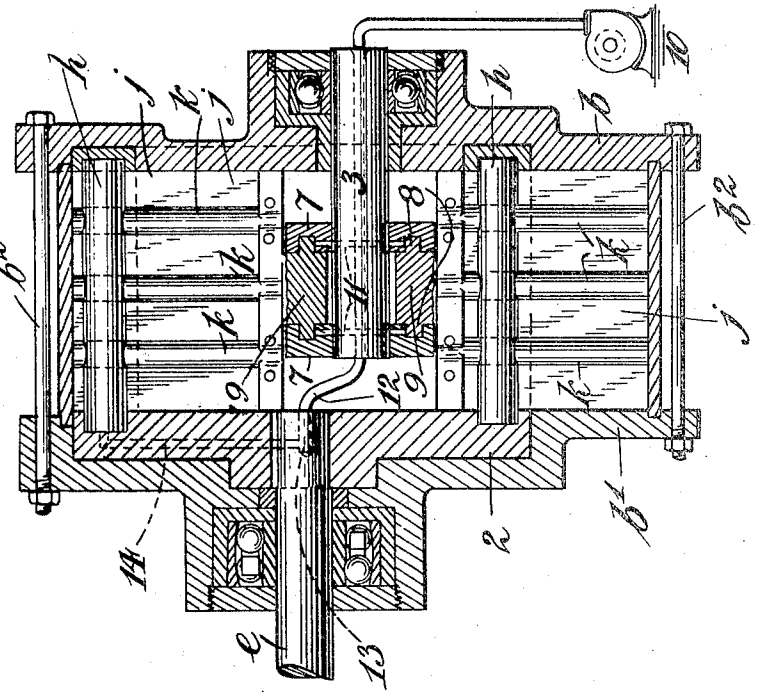
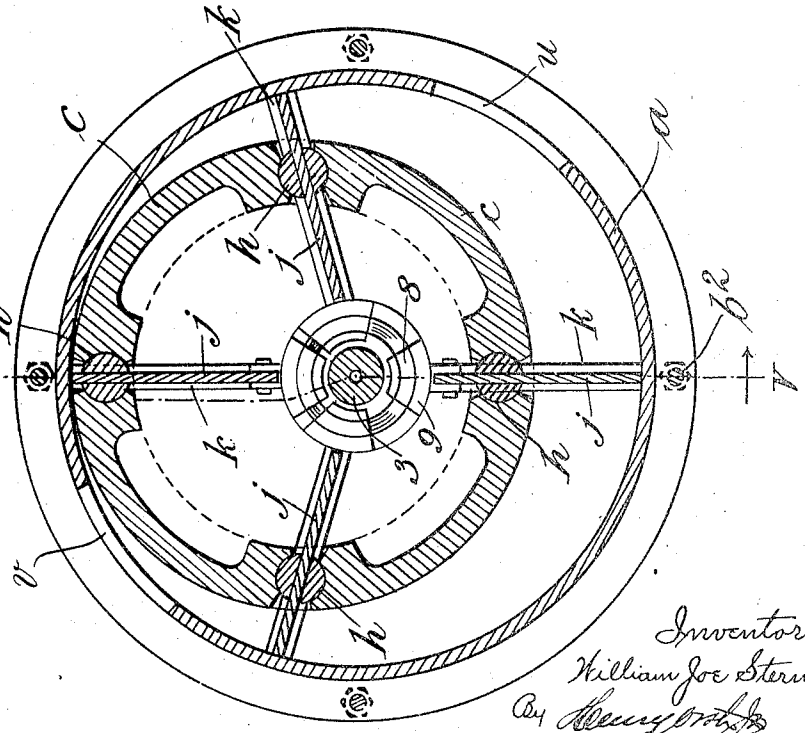


Fig. 6.



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Feb. 1, 1927. 1,616,285

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 8.

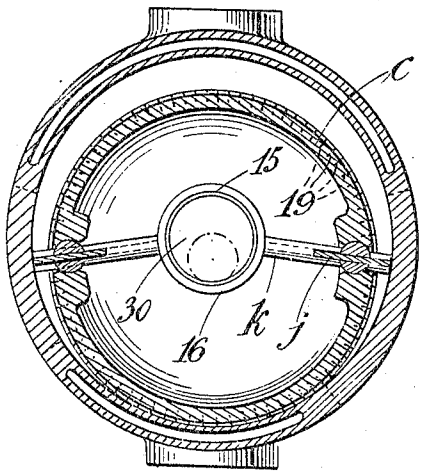
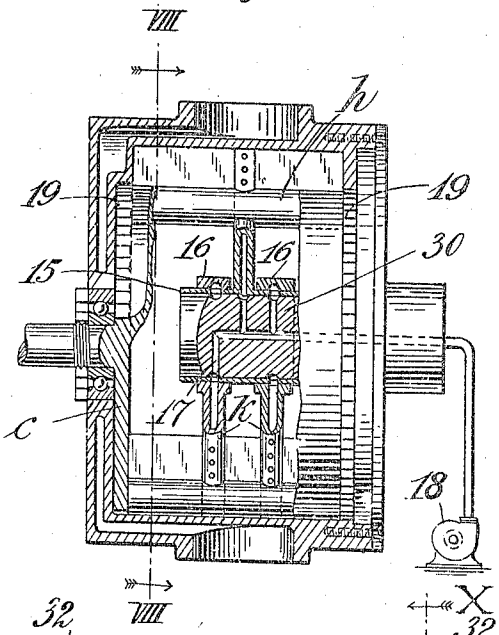


Fig. 7.



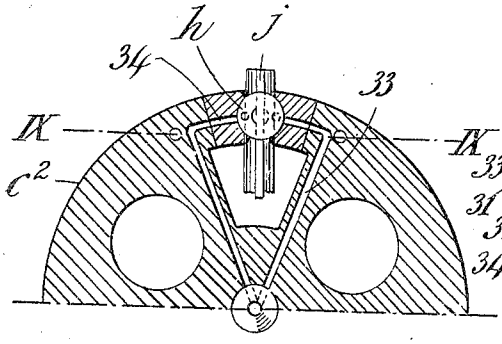


Fig. 10.

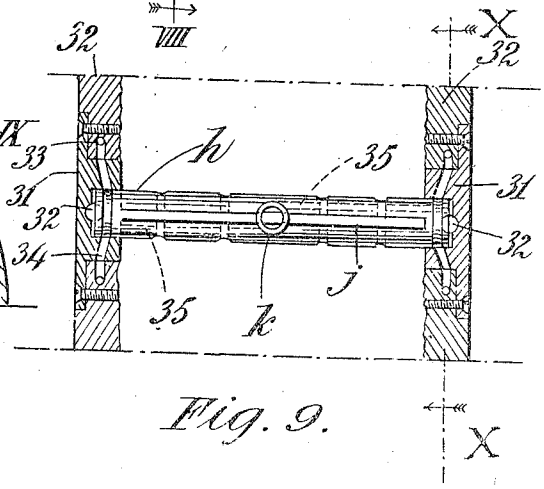


Fig. 9.

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W. J. STERN

ROTARY PUMP MACHINE

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Fig. 11.

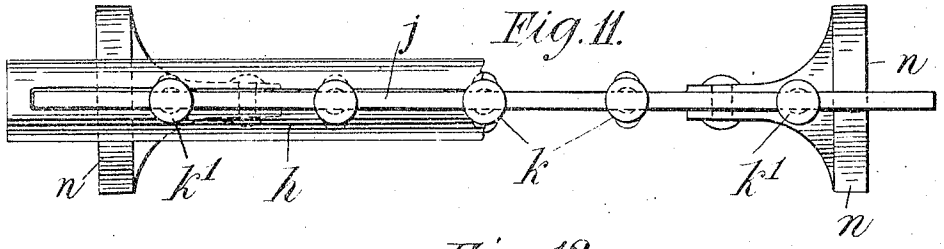


Fig. 12.

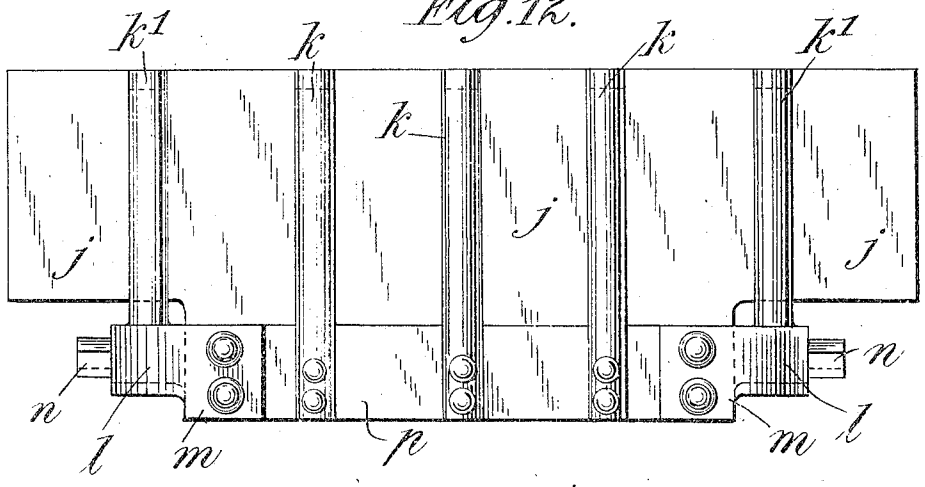


Fig. 13.

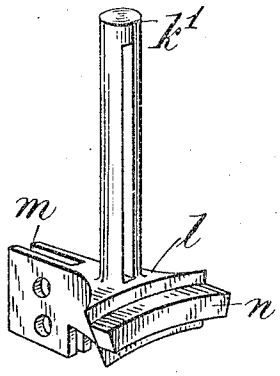


Fig. 14.

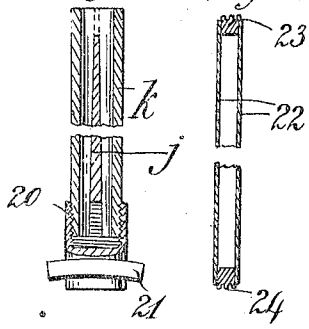


Fig. 15.

Fig. 16.



Fig. 18.

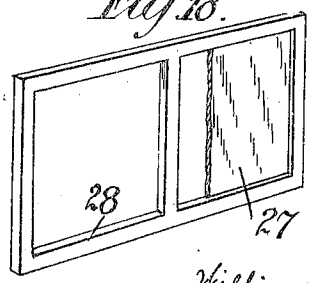
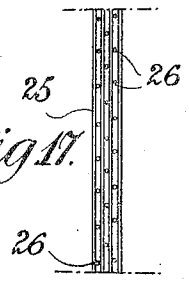


Fig. 17.



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Feb. 1, 1927. 1,616,285

W. J. STERN

ROTARY PUMP MACHINE

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Fig. 19.

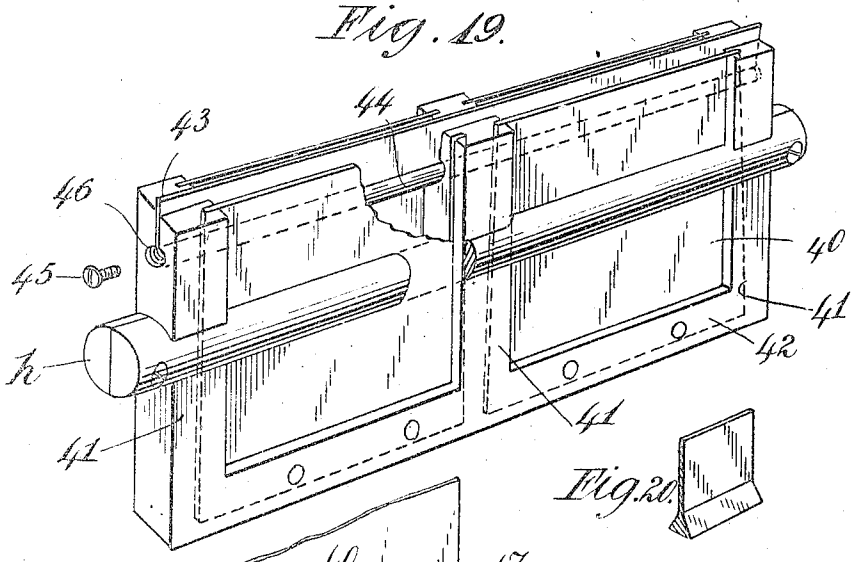


Fig. 20.

Fig. 21.

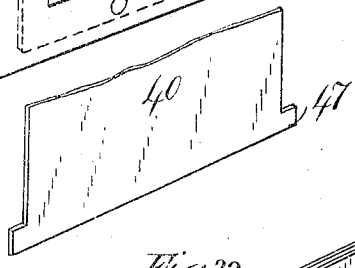
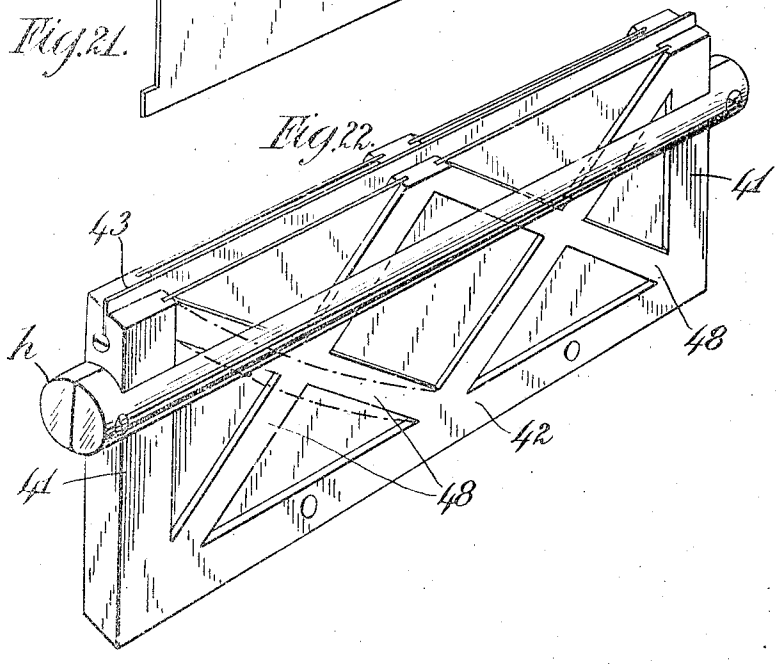


Fig. 22.



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ROTARY PUMP MACHINE

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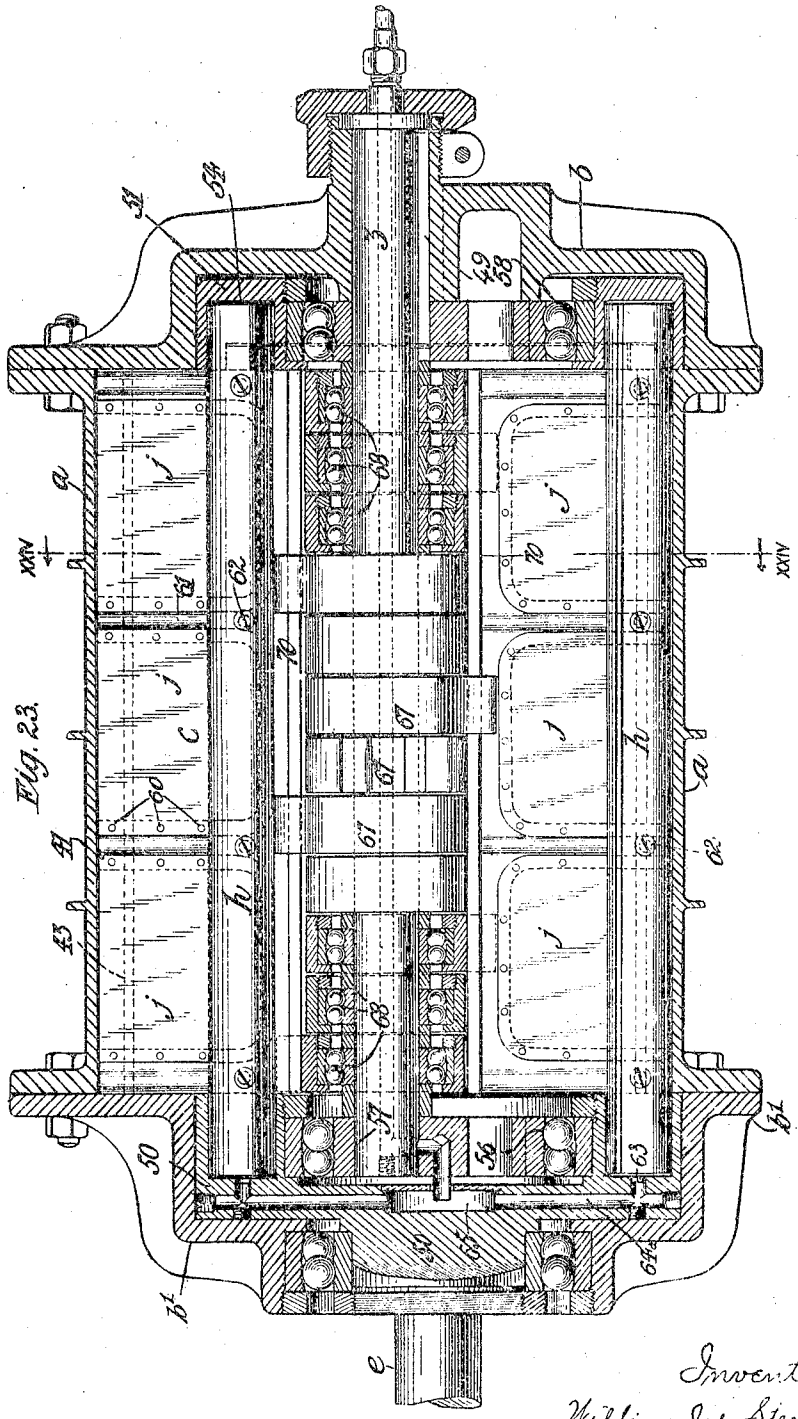


Fig. 23.

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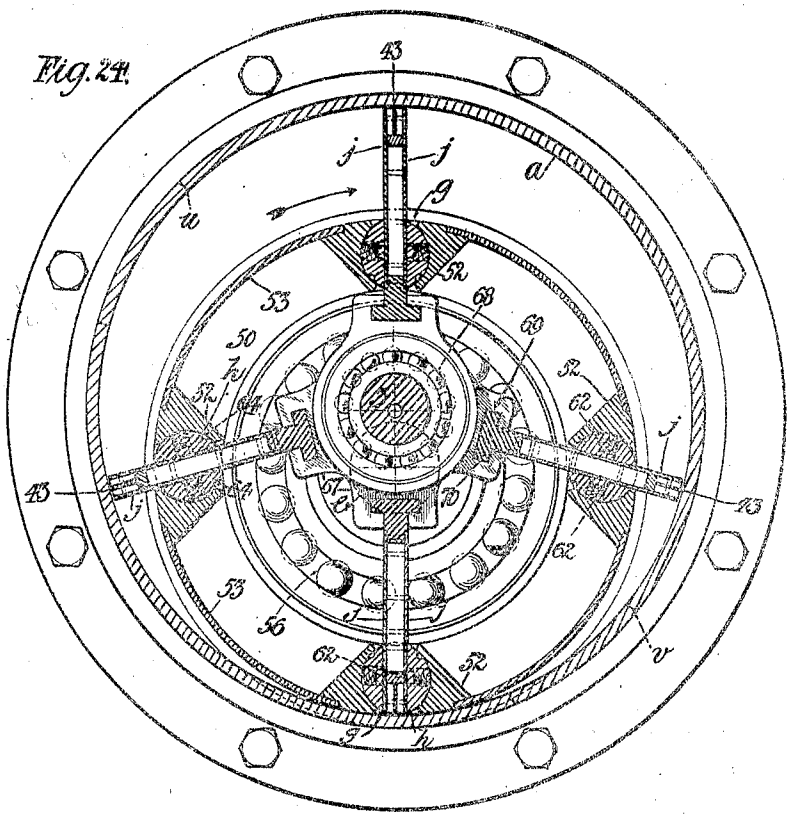
Feb. 1, 1927. 1,616,285

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ROTARY PUMP MACHINE

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Fig. 24.



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W. J. STERN

ROTARY PUMP MACHINE

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Fig. 25.

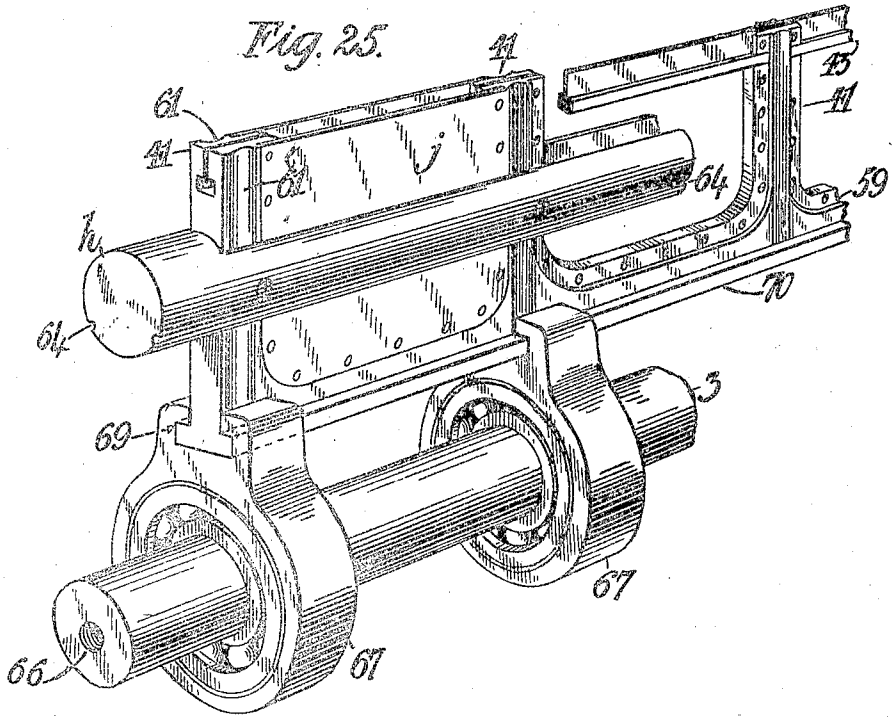
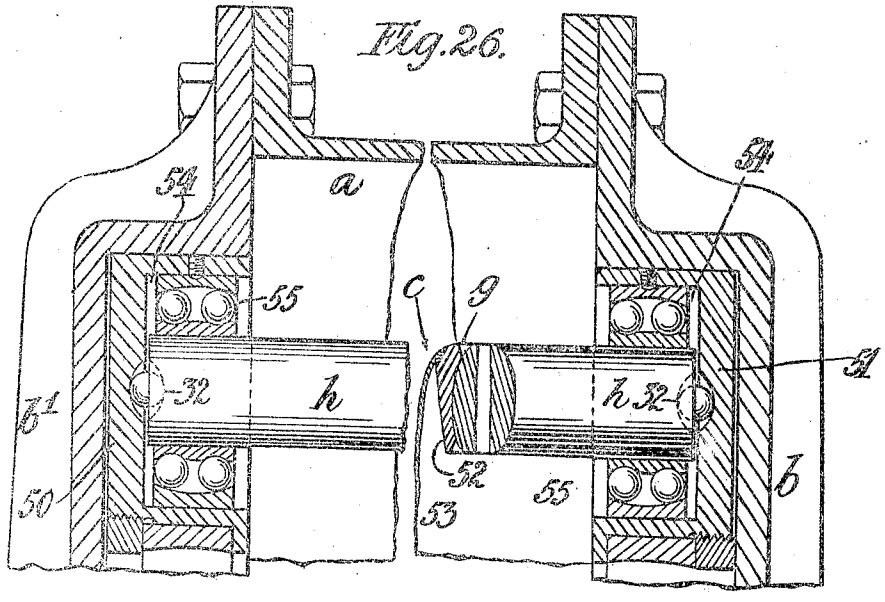


Fig. 26.



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UNITED STATES PATENT OFFICE.

WILLIAM JOE STERN, OF PALMERS GREEN, LONDON, ENGLAND.

ROTARY PUMP MACHINE.

Application filed September 9, 1925, Serial No. 55,295, and in Great Britain September 13, 1924.

This invention comprises improvements in rotary pump machines and is concerned with the so-called crescent class of such machines. More particularly, the invention is concerned with pump machines of the crescent class in which an eccentric piston or rotor body has sliding rocking vanes. In using these machines as pumps or compressors, it is advantageous to drive the rotor, the vanes being connected with centric means such as a lay shaft and working in slots formed in cylindrical blocks mounted to oscillate in peripheral openings in the rotor.

An important object of this invention is to provide for the reinforcement and better mounting of the vanes and to improve their connection with the centric means around which they move.

A further important object is to protect the vanes against undue stresses and wear and tear in their working engagement with the piston body or the oscillatory cylindrical blocks mounted thereon.

Yet another object is to construct vanes for the improved machine so that such vanes have substantial thickness but are nevertheless light and very strong and are adapted for resisting tip and edge leakage, thereby enabling the number of vanes employed to be reduced to a minimum.

Another object is to provide simple and efficient lubricating means for the vanes and particularly for the means provided in connection with such vanes for relieving them of stresses as aforesaid.

Yet another object is to enable lubrication to be largely curtailed by providing anti-friction mountings and bearings for the vanes and associate parts.

These and other objects will be hereinafter fully described by reference to the drawings accompanying this specification and forming part thereof, such drawings illustrating examples of construction embodying these present improvements. In the drawings:—

Figure 1 is an irregular longitudinal section on the line I—I of Figure 2 of a pump machine constructed in accordance with these improvements.

Figure 2 is a cross section on the line II—II of Figure 1, looking in the direction of the arrow parts being broken away to show the centric grooved ring *o*.

Figure 3 is a central longitudinal section and

Figure 4 is a cross section of a modified construction of pump which is suitable for a smaller capacity than that possessed by the pump in Figures 1 and 2.

Figure 5 is a longitudinal section on the line V—V of Figure 6, which is a cross section of another modified construction of pump.

Figure 7 is a longitudinal sectional elevation of yet another modified construction of pump of which Figure 8 is a cross section on the line VIII—VIII looking in the direction of the arrows, the rotor having been turned through an angle of 90°.

Figure 9 is a horizontal section on the line IX—IX of Figure 10 which is a cross section on the line X—X of Figure 9, these being fragmental views illustrating lubrication ducts formed in the end discs of the rotor.

Figure 11 is a plan view illustrating a vane construction somewhat similar to that seen in Figures 1 and 2, one half of a trunnion block in which this vane works being also shown.

Figure 12 is a front elevation of Figure 11, the trunnion block being omitted.

Figure 13 is a perspective view of a combined thrust member and segmental shoe device for fitting to a vane.

Figure 14 is a central vertical section of a modified construction of thrust member and shoe device.

Figures 15, 16, 17 and 18 are sections illustrating different methods of building up light vanes.

Figure 19 is a perspective view of a trunnion block and built up vane, vertical frame bars of the vane acting as thrust members and the vane being fitted with a sealing tongue device. The means for connecting the vane with the lay shaft or centric means are omitted from this figure and any suitable means may be used for the purpose.

Figure 20 is a perspective view of a fragment of a modified sealing tongue.

Figure 21 is a perspective view of a plate which may be used for a built up vane.

Figure 22 is a perspective view similar to Figure 19 but showing a modified construction of frame bars serving as thrust members.

Figure 23 is a central longitudinal section of a modified construction of pump with ball bearing mounting for the centric members upon the lay shaft.

Figure 24 is a central cross section of the pump on the line XXIV—XXIV of Figure 23.

Figure 25 is a fragmentary view in perspective of the vane, centric members and lay shaft used in the machine illustrated in Figures 23 and 24, and

Figure 26 is a fragmentary view illustrating a modified method of mounting the trunnion blocks or rockers of the vanes.

Referring to Figures 1 and 2 of the drawings, *a* is the cylindrical casing of the pump clamped between end covers *b b'* by long bolts b^2. This casing may be jacketed if desired. Owing to the eccentricity of the rotor *c* a crescent space *d* is produced which is a characteristic of this class of machine. In the construction illustrated, the rotor *c* is a cylindrical drum or body carried by centrally disposed discs or webs *c'* on a sleeve or hub *d'* which is fixedly mounted on a shaft *e* extending through the two end covers *b b'*. The drum rotor *c* is formed with four slots *g* spaced 90° apart, each slot being enlarged between its inner and outer openings to form a cavity to receive an oscillatory cylindrical block *h* hereinafter referred to as a trunnion block. Each of these trunnion blocks *h* is formed over the greater portion of its length between its ends with a diametrical slot for the reception of a slidable vane *j*.

The vanes *j* are fitted with what are herein called thrust members *k k'* and in this example each vane is fitted with five such members uniformly spaced. The three middle thrust members *k* are cylindrical rods or tubes slotted to receive the vanes and attached to the latter in the manner hereinafter described. These members extend from the inner to the outer edges of such vanes. The diameter of the members *k k'* is greater than the thickness of the vanes so that portions of such members stand proud of the surfaces of the vanes *j*. The two end thrust members *k'* are lengths of tube or rod slotted for a portion of their length to receive the vanes *j* and are carried on foot portions *l* formed on ont side with clip devices *m* and on the other side with arcuate projections or shoes *n* for engaging in annular grooves of rings *o* constituting the centric means as hereinafter described. The clip devices *m* are riveted to the extended inner portions of the vanes *j* as seen in Figure 1.

Referring to Figures 11 and 12, it will be seen that the thrust members *k'* may be carried at the ends of a girder or stiffener *p* extending along the whole length of the inner end of the vane *j*, the arcual projections or shoes *n* being formed on the ends of the girder or stiffener *p*. As will be seen from these figures, the thrust members *k* are slotted to within a short distance of their outer ends so as to accommodate the vane *j* and the girder or stiffener *p* the fixing of these members being effected by rivets which pass through the members *p* and the inner portion of the vane *j*. The outer edge of the vane *j* is notched to accommodate the unslotted portions of the members *k* and so that the outer ends of these latter coincide with the outer edge of the vane. The slots in the members *k'* are of sufficient length to permit the end portions of the vane to be inserted and then lifted therein to bring the unslotted end portions into the appropriate notches in the outer edge of the vane *j*. If desired, the girder *p* and parts *l m n* may all be made in one piece and the members *k'* may be appropriately secured on the parts *l*. In Figure 1, the girder *p* is indicated by a dotted line as it may or may not be present according to the degree of stiffness desired.

It is advantageous not to secure the clips *m* until the projections *n* are engaged in the centric grooves, a template representing the interior of the casing is then applied, and the vanes *j* are forced outwards by wedges inserted into the slots of the members *k'* between the parts *l* and the vanes *j*, and when the outer edges of the vanes have been adjusted into sufficiently close contact with the template the clips *m* are riveted to the vanes.

As will be seen from Figure 11, the slots in the trunnion blocks *h* are formed with cylindrical recesses at the points corresponding with the disposition of the thrust members *k k'* on the vanes, and the parts are so designed that the thrust members *k k'* have a closer sliding fit in their recesses than the vanes have in the slots. To reduce leakage the inner surface of the slots may be grooved.

In the construction illustrated in Figures 1 and 2, the centric means consist of grooved rings *o* mounted on ball bearing *q* around the extensions *r* of eccentric bushings *s* containing the bearings of the rotor shaft. That is to say the extensions *r* are concentric with the interior of the casing *a* but the bushings *s* are eccentric thereto. Gaps *t* are cut out of the rotor discs *c'* of such dimensions as freely to permit of the inward and outward sliding of the vanes *j* in relation to the rotor and the limited oscillation of such vanes *j*.

In operation, the shaft *e* is driven by any suitable means and the eccentric rotor *c* through the medium of the trunnion blocks *h* carries the vanes *j* around the interior of the casing *a*. As the vanes have a sliding connection with the centric rings *o* owing to the shoes *n* sliding in the grooves of such rings, there will be a relative sliding of the vanes *j* inwards and outwards of the rotor and in the slots of the trunnion blocks *h*.

Also, and for a reason well-known in the art, the vanes will oscillate from one side to the other of the truly radial position as they perform their orbits as will be readily understood from Figure 2. Thus, the rotor *c* and its vanes will produce suction through the ports *u* and delivery through the port *v*, or vice versa, according to the direction in which the shaft is driven. In the revolution of the rotor *c*, the pressure due to the reaction between the rotor *c* and vanes *j* is taken by the thrust members *k k'* to the relief of the vane surfaces, owing to the fact above mentioned that the thrust members have a closer sliding fit in their recesses than the vanes *j* have in the slots in the trunnion blocks *h*.

The rotor *c*, Figures 1 and 2, being slotted at four points on its periphery, it is advisable to provide means for imparting circumferential strength thereto. Also, it is advisable to provide bearings and retaining means for keeping the trunnion blocks in position in their slots. These requirements are met by providing the rings *w* seen clearly in Figure 1, which are formed or provided with suitable bearings for the trunnion ends of the blocks *h* and are bolted on to the ends of the rotor *c* thereby strengthening the latter and retaining the blocks *h* in proper position. The said bearings may be ball bearings and may comprise a rotary and/or a ball end-thrust bearing as hereinafter described with reference to Figures 26 and 9. The rings *w* may stand out from the ends of the rotor and may run in grooves *x* in the end covers *b*, *b'* with fixed clearance.

The slide-way grooves in the rings *b* may be lubricated by forced lubrication through nozzles *y*.

Other parts may be lubricated by introducing lubricant through a duct in the rotor shaft. For example, in Figures 1 and 2, a branch duct *z* communicates on the one hand with a duct or bore in the rotor shaft and on the other hand with a groove 1 formed around the end of the rotor *c*. This groove which is closed by the bolting on of the ring *w* supplies the various trunnion bearings of the blocks *h* as will be readily understood. This lubricating arrangement is shown only on the left hand side of Figure 1 but it would naturally be duplicated by a similar arrangement for the right hand side.

According to the modification illustrated in Figures 3 and 4, the eccentric rotor shaft extends only just through the end cover *b'* where it is fixed to an end disc 2 at the left hand side of the rotor *c*, the end at the right hand side of the rotor being open and not closed by a disc. The centric means in this example consists of a lay shaft 3 introduced through and supported in the opposite cover *b*. According to this modification, the thrust members *k* afford a means of connection between the vanes *j* and the centric means in the manner about to be described. The thrust members *k* are lengths of tube or hollow rod slotted from their outer ends for a portion of their length to receive the vanes *j* which are partly secured by the screwing in of screw plugs k^2. The thrust member *k* in the lower portion of Figure 3 and to the right of Figure 4 has its inner end screwed direct into the lay shaft 3, whereas the thrust member *w* in the upper portion of Figure 3 and to the left of Figure 4, has its inner end screwed into a boss on a sleeve 4 revoluble on the lay shaft 3 and circularly slotted for the first thrust member to pass through. The ends of the sleeve 4 are fitted with clips 5 which are riveted to the appropriate vane *j* when the latter has been adjusted into close contact with the interior of the casing. Also, the shaft 3 is fitted with clips 6 beyond the ends of the sleeve 4 and the clips 6 are riveted to the other vane *j* seen in the lower portion of Figure 3. The shaft 3 being mounted for revolution in anti-friction bearings in the cover *b* and the sleeve 4 having only a limited oscillatory motion on the shaft 3 with which it revolves in company, there is very little friction associated with the revolution and oscillation of the vanes around the centric means. The shaft 3 may be termed a master centric means and the sleeve 4 may be termed a subsidiary centric means. In the case of more than two blades being employed, there may be more than one subsidiary centric means revolving with and oscillating upon the master centric means, in order to minimize friction.

As will be understood from Figure 3, the disc 2 of the rotor revolves in an eccentric cavity formed in the end wall or cover *b'* and the cylindrical blocks *h* at one end extend into bearing recesses in the disc 2. After the cylindrical blocks *h* have been inserted into their bearing slots in the rotor *c* from the open end of the latter, a ring *w* is applied to the rim of such open end, the said ring *w* being formed with bearings for the reception of the trunnion ends of the cylindrical blocks *h* as will be readily understood from Figure 3. The ring *w* runs in an eccentric annular groove formed in the cover *b'*.

In the modification illustrated in Figures 5 and 6 the rotor *c* is attached by a disc 2 at one end only to a shaft *e* which extends through one cover *b'* only, the lay shaft 3 being introduced through and supported in the opposite end cover *b*. In this modification there are four vanes *j* and the centric means comprises annularly grooved rings 7 fixed on the revoluble lay shaft 3, and the middle thrust members *k* are extended inwardly and formed or fitted at their

inner ends with hub segments 9 having projections 8 for engaging with the grooves of the centric rings 7. The lay shaft 3 may be formed with an oil duct supplied with oil by a suitably arranged pump 10 lateral ducts 11 providing oil for the lubrication of the grooves in the rings 7. A tube 12 is connected between the inner end of the shaft 3 and a bearing cap, not shown, on the rotor shaft. Thus, a duct 13 in the rotor shaft is supplied and branch ducts 14 leading from the duct 13 may deliver lubricant to the trunnion bearings of the blocks *h* or to other parts as desired. The modification illustrated in Figures 7 and 8 is in some respects similar to that illustrated in Figures 3 and 4. In the upper portion of Figure 7, however, it will be seen that the inner end of the thrust member *k* is connected with a sleeve 15 revoluble on the lay shaft 30. There are two thrust members *k* for the vane in the lower portion of Figure 7 and these have their inner ends attached to rings 16 revoluble on the sleeve 15. Thus, inasmuch as the sleeve 15 and rings 16 mainly rotate in company, only the friction between the sleeve 15 and the lay shaft 30 comes into consideration assuming that the lay shaft 30 is fixed. However, the lay shaft may be revolubly mounted. If more than two vanes were employed, the centric ring or sleeve of one of them could be arranged to revolve on the lay shaft like the sleeve 15, and the centric rings 16 or sleeves of all other vanes could be revoluble on the sleeve 15 so as to avoid friction losses by friction on the shaft 30.

For lubricating the parts, the lay shaft 30 may be formed with oil ducts 17 and these may be supplied from a pressure supply, as for example an oil pump diagrammatically indicated at 18. Branch ducts radiating from central duct may supply lubricant to the interior of the sleeve 15 and also to the bore of the thrust members *k*. The said bore may be stopped before the outer end is reached and a radial hole formed communicating with the bore at a point in the length that reciprocates through the cylinder block *h*. In this way, lubricant is supplied in a very simple and efficient menner to the thrust members and their bearing surfaces, as will be readily understood.

To prevent or minimize end leakage past the rotor, the latter may be lifted at its ends with small paddles or vanes 19 which are engaged to set up a pressure at the ends of the rotor *c* in such a manner as to discourage leakage past the ends of the rotor. These paddles will be very light and may be allowed to rub under centrifugal action in the fixed clearance space of the rotor end rings.

According to Figure 9, the trunnion block in which may be similar to those seen in Figures 1 and 2, for example, has its ends received in bearing bushes 31 secured in suitable apertures in the ends of the rotor the said bushes also containing end thrust ball bearings 32 for the ends of the blocks *h*. The rotor may be of the kind comprising a disc c^2 at each end and oil ducts 33 may be bored out through the thickness of these end discs c^2. The bushes 31 may be perforated as shown at 34 to admit the oil from the ducts 33 for lubricating the ends of the blocks *h*. The blocks *h* may be formed with oil grooves or ducts 35 for conveying the oil along the blocks *h* from the end bearings to radial passages through which some of such oil will pass into the recesses in which the thrust members *k* slide for effecting lubrication of such members and also through side ducts to lubricate the surfaces of the blocks *h* and the vanes *j* where they contact. Figure 10 shows the oil ducts 33 aforesaid in connection with a bore in the rotor shaft, through which bore oil from a pump may be conveyed as aforesaid.

Figure 14 illustrates in detail a convenient mode of securing the vanes *j* to the thrust members or tubes *k*. According to this mode of attachment, the tube *k* is formed with a tapering slot from its inner end to near its outer end, the wider end of the slot being at the inner end. The vane *j* is made with a tapering cross-section to correspond with the slot and it is formed with a notch in its outer edge so as to enable such outer edge to come flush with the end of the thrust tube, as will be understood from Figure 14. When the vane *j* has been introduced into the slot, a screw threaded socket 20 is screwed on to the screw threaded inner end of the thrust tube *k* and locks the vane in the tube, the socket being formed with projections 21 for engaging with grooved centric means such as have been hereinbefore described.

Figure 15 illustrates a vane made up of sheet metal plates 22 attached by welding, soldering or other means to a frame 23. In the example illustrated, the outer and side edges of the frame are ribbed at 24 for the purpose of preventing or minimizing side edge and tip leakage of the pressure fluid past the vanes. Thrust members of any of the kinds herein described are applied to vanes of this construction, or members of the framing 23 may be adapted for serving as thrust members as hereinafter described.

Figure 17 shows how a vane can be built up of a plurality of thin metal sheets 25 each separated from its neighbour by wires or rods 26, the sheets being welded to the wires and thereby giving a very light construction possessing great strength and stiffness.

Figure 18 shows a vane consisting of a plate 27 of light metal or alloy such as

aluminium or aluminium alloy cast within a frame 28 of steel or other metal possessing strength. The members of this framing are adapted for serving as thrust members as hereinafter described.

In Figure 16 a vane of sheet metal is formed with horizontal corrugations 29 which not only impart strength but which, in passing through the slot in the trunnion block *h* tend to prevent leakage of pressure fluid through such slot owing to the labyrinth effect produced.

The separate thrust members may be segments of tubes or plates attached to respective surfaces of the vanes as by welding for example. It is not necessary for the thrust members to be cylindrical or of circular or curved cross section but rectangular and other cross sections may be used. For example, in Figure 19 a built up vane is composed of spaced plates 40 inserted into grooves of vertical frame members 41, so that the plates fill the spaces betwen such frame members. The vertical members 41 are connected at the inner ends with a transverse bar or member 42 which serves as the girder or stiffener *p* hereinbefore described with reference to Figure 12. The inner ends of the plates 40 may extend into grooves in the bar 42 and be riveted therein as shown. The trunnion block *h* is formed with a slot for the passage of the plate portions of the vane and this slot is enlarged to form rectangular recesses for the passage of the frame members 41. The latter have a sliding fit in those recesses whereas the plates 40 pass freely through the slot. Thus, in this construction the frame members 41 serve as thrust members to take the stresses due to the reaction between the vanes and the trunnion blocks and the plates 40 are relieved of all such stresses. As indicated in this figure, the trunnion block may be made in halves secured together by screws, in order to simplify the manufacture.

Any of the vanes herein described may be fitted with packing or sealing tongues for making contact with the cylindrical interior of the casing so that the outer edges of the vanes need not make such contact themselves. For this purpose, the outer edges of the vanes would be formed with a groove for receiving a sealing tongue which could be adjustable inwardly and outwardly of such groove, or the said tongue could be inserted in such groove so as to be free to move radially outwards under centrifugal action and thereby make sealing contact with the casing. In Figure 19, the hollow space in the vane between the parallel plates 40 accommodates a sealing tongue 43 whereas a solid vane would require to be formed with a groove or channel along the outer edge portion to receive such tongue. The tongue 43 may be of sheet metal formed with a roll or bead 44. By forming a sort of keyhole slot in the outer ends of the members 41, the tongue 43 can be passed in endwise, as will be understood from Figure 19, and secured by screwing the screw 45 into the counter sunk screw-threaded hole 46. The tongue would be cut accurately as to width so as to have sealing contact with the interior of the casing. If desired, however, the tongue might have a certain freedom for moving outwards under centrifugal action, or it might be engaged by an adjustment for moving it inwardly or outwardly of the vane, as will be readily understood. Figure 20 shows a sealing tongue with a thickened edge portion of triangular cross section in place of the roll or bead 44. If desired, the sealing tongues may be of curved cross section, or may be adapted for taking a curved formation in use so as to produce a wipe contact with the interior of the casing. Figure 21 illustrates a plate 40 formed with ears 47. These plates may be inserted through slots in the bar 42 into the position seen in Figure 18 and the ears 47 may engage recesses at the ends of the slots so as to fix the positions of the plates which are then secured by rivets or screws passed through the bar 42.

According to the modification illustrated in Figure 22, diagonal frame bars 48 are used as thrust members in place of the middle bar 41 in Figure 19 which is parallel with the end bars 41. In this case, the slot in the trunnion block is of proper width all along to give a sliding fit with all the thrust members. Thus, it will be appreciated that the thrust members are capable of taking a number of different forms without departing from this invention.

The modified form of pump shown in Figures 23, 24 and 25 comprises a lay shaft 3 fixedly mounted in one end cover *b* of the pump casing *a*, the shaft being held against rotation by a key 49. The rotor *c* comprises a shaft *e* and a frame consisting of a disc 50 at one end and a ring 51 at the other joined by four bars 52. The shaft *e* and the said frame, may be made from a single piece of steel suitably machined to form the parts mentioned. The bars 52 are recessed for the mounting of segmental plates 53 which complete the rotor body. This construction imparts rigidity to the rotor and renders it of appreciably light weight. The trunnion blocks *h* are received in longitudinal cavities *g* in the bars 52, and their trunnion ends may bear in plain recesses 54 in the end disc and ring of the rotor, or as shown by Figure 26, they may turn in ball bearings 55 disposed in the recesses 54 in the end disc and ring 50 and 51 of the rotor body. The lay shaft 3 is supported at its end remote from the cover *b* by a ball bearing 56 mounted in a circular recess in the

end disc 50 of the rotor and having its inner race formed on an eccentric member 57 which is perforated to receive the end of the lay shaft. The end of the rotor adjacent the end cover *b* of the pump casing is supported by a similar ball bearing 58 on the lay shaft 3. The vanes *j* are of somewhat similar construction to the vane shown in Figure 19 but instead of the plates 40 being mounted in grooves in the vertical and girder members 41 and 42 respectively, these members are merely recessed or rabbeted as at 59 and the plates are let into the recesses and secured by screws or rivets 60 (see particularly Figure 25). The vanes are also furnished with packing or sealing tongues 43 of equivalent construction to those seen in Figures 19 and 20. It is also advantageous, in order to avoid necessity for lubrication between the thrust members 41 and the trunnion blocks *h* to groove the former on opposite sides as at 61, Figures 23 and 25, so that they may move on ball bearings 62 mounted in the trunnion blocks, see Figure 24. The trunnion blocks *h* may be lubricated at their bearings in the parts 50, 51 and 52 by lubricant supplied from an annular groove 63 in the disc 50 and grooves 64 running along the rockers. The groove 63 is supplied by passages 64ª in the disc 50 from a chamber 65 at the centre of the disc, this chamber in turn being fed from an axial duct 66 in the lay shaft 3. This provision for lubrication of the rockers *h*, may, however, be dispensed with if the rockers be mounted in ball bearings 55 as shown in Figure 26; in that case slight clearance would be allowed between the cylindrical surface of the rockers and the corresponding surfaces in the slots *g* in the bars 52 of the rotor body. In order to avoid friction in the revolution of the vanes *j* and to do away with necessity for lubrication at the lay shaft, these vanes may be mounted on centric ring members 67 which rotate on ball bearings 68 on the lay shaft. The centric members have T-shaped slots 69 for the mounting of the vanes *j* and the latter are formed along the inner longitudinal edge with lateral projections or feet portions 70 to engage the slots as will be readily understood from Figure 25. There are four vanes altogether in the machine shown in Figures 23, 24 and 25 and twelve centric members 67 all of the same construction. This allows three centric members to each vane and as successive centric rings are made to support successive vanes, the three centric rings of each vane are spaced apart equidistantly and thus support the vanes evenly. In the above-mentioned constructions in Figures 23 to 26, it is obvious that roller bearings may be substituted for any or all of the ball bearings therein shown. Ball bearings 32 for taking end thrust on the rockers may also be provided as in Figure 9, and these bearings may, if desired, comprise rings of balls, instead of single balls as shown.

Although all the trunnion blocks herein described have been of cylindrical formation, it will be understood that other formations having trunnion ends may be employed provided they are adapted for affording a sliding fit or bearing for the thrust members.

The improved pumps are particularly adapted for use as blowers for the introduction of what are known as supercharges into the cylinders of internal combustion engines. Owing to the fact that the vanes themselves are not subjected to any mechanical wear and tear, they can be run efficiently at high speed and large eccentricity and in view of this the blowers are well adapted for use on aero engines and the like. However, the blowers are also well adapted for use in connection with vacuum cleaners and other apparatus in which air is required to be moved for creating a pressure or a vacuum as the case may be.

Heretofore, it has been customary to use thin steel vanes to secure lightness in this type of machine, but the disadavantage of using thin blades is obvious where high speeds, large eccentricity and substantial pressures are concerned. Vanes of sufficient strength and stiffness for satisfying the working requirements in the presence of such speeds and pressures were calculated to make the machine too heavy and cumbersome and to create undue wear and tear and difficulties in working. By these improvements, the vanes can be composed of light metal of substantial thickness or the thickness may be secured by adopting a light built up vane and such vanes are made wholly satisfactory for the aforesaid working conditions by the provision of the thrust members having the functions hereinbefore described. With vanes of substantial thickness side edge and tip leakage is reduced and such vanes lend themselves more readily than thin blades to the application of auxiliary means for the further prevention of such leakage.

I claim:—

1. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, rockers disposed parallel with the axis of said piston and rockably mounted in slots formed in the periphery of said piston, vanes passing freely through slots in said rockers, centric means mounted in said casing and engaged by said vanes, and thrust members in operative connection with said vanes, said thrust members having sliding engagement with said rockers and being adapted to transmit to said rockers the reactionary

forces developed during the working of said vanes.

2. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, rockers disposed parallel with the axis of said piston and rockably mounted in slots formed in the periphery of said piston, vanes passing freely through slots in said rockers, centric means in said casing and operatively engaged by said vanes, and thrust members connected with and standing proud of the two surfaces of said vanes and having sliding engagement with said rockers, said thrust members being adapted for transmitting to said rockers the reactionary forces developed during the working of said vanes.

3. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, rockers disposed parallel with the axis of said piston and rockably mounted in slots formed in the periphery of said piston, vanes passing freely through slots in said rockers, centric means mounted in said casing, and thrust members constructed to act as holders for said vanes and to be engaged with said centric means, said thrust members having sliding engagement with said rockers and being adapted to transmit to said rockers the reactionary forces developed during the working of said vanes.

4. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, vanes passing through the slots of said rockers, centric guides in said casing and cylindrical stiffeners on said vanes extending from the inner to the outer edges thereof, said stiffeners being adapted for sliding in the slots in said rockers and thereby relieving the vanes of working stresses substantially as set forth.

5. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, vanes passing through the slots of said rockers, centric guides in said casing, cylindrical stiffeners on said vanes extending from the inner to the outer edges thereof, said stiffeners being adapted for sliding in the slots in said rockers and thereby relieving the vanes of working stresses, and means on said stiffeners in engagement with said centric guides substantially as set forth.

6. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes working in and out of said piston body through slots in the latter during a revolution, thrust members on said vanes said members taking a bearing in the said slots and relieving the vanes of working stresses, centric means revolubly mounted within the casing, and operative engaging means between said vanes and said centric means substantially as set forth.

7. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes working in and out of said piston body through slots in the latter during a revolution, thrust members on said vanes said members taking a bearing in the said slots and relieving the vanes of working stresses, centric means revolubly mounted within the casing, and foot devices connected with said vanes and having operative engagement with said centric means substantially as set forth.

8. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes working in and out of said piston body through slots in the latter during a revolution, thrust members on said vanes said members taking a bearing in the said slots and relieving the vanes of working stresses, centric means revolubly mounted within the casing, and foot devices connected with said thrust members and having operative engagement with said centric means substantially as set forth.

9. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes working in and out of said piston body through slots in the latter during a revolution, thrust members on said vanes said members taking a bearing in said slots and relieving the vanes of working stresses, grooved centric means revolubly mounted within the casing, and foot devices connected with said thrust members and with said vanes and having engagement with the grooves in said centric means substantially as set forth.

10. Rotary pump machine comprising in combination a cylindrical casing, an eccentric cylindric piston revoluble therein and with an annular end of said piston running in an eccentric groove formed in an end wall of said casing, slotted cylindrical rockers disposed in slots formed in said piston parallel with the axis thereof, an end ring on said piston said ring being adapted for retaining said rockers in their slots and also for acting as a runner in the eccentric groove in said end wall, reinforced vanes working in the slots in said rockers, and centric means mounted within said casing and having operative engagement with said vanes substantially as set forth.

11. Rotary pump machine comprising in combination a cylindrical casing, an eccentric cylindrical piston revoluble therein, slotted cylindrical rockers disposed in slots in said piston parallel with the axis thereof, vanes

of substantial thickness slidable radially of said casing in the slots of said rockers, cylindrical stiffeners having a diameter which is greater than the thickness of said vanes said stiffeners being attached to said vanes and slidable radially of the casing in enlargements of the slots in said rockers, centric means mounted within said casing, and operative means engaging between said vanes and said centric means substantially as set forth.

12. Rotary pump machine comprising in combination a cylindrical casing, an eccentric cylindric piston revoluble therein, packing means on the ends of said piston adapted for co-operating with the end walls of said casing for preventing end leakage past said piston, slotted cylindrical rockers disposed in slots in said piston parallel with the axis thereof, reinforced vanes working in the slots of said rockers, centric means mounted within said casing, and operative means engaging between said vanes and said centric means substantially as set forth.

13. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes slidably and rockably mounted in slots in said body, a centric shaft mounted in said casing, centric members encircling said shaft and having engagement with said vanes for producing motion of said vanes in said slots, and anti-friction bearings inserted between said centric members and said shaft, substantially as set forth.

14. Rotary pump machine, comprising in combination a cylindrical casing, an eccentric piston body revoluable therein, vanes slidably and rockably mounted in slots in said body, a centric shaft mounted in said casing, centric ring members encircling said shaft and having engagement with said vanes for producing motion of said vanes in said slots, and ball bearings inserted between said centric ring members and said shaft substantially as set forth.

15. Rotary pump machine comprising in combination a cylindrical casing, an eccentric cylindrical piston body revoluble therein, vanes slidably and rockably mounted in slots in said body, a centric lay shaft with fixed bearing at one end in said casing, an eccentric disc on the other end of said lay shaft, anti-frictional bearing means supported by said disc and co-operating with a concentric bearing of said piston body, and centric members encircling said shaft and having engagement with said vanes for producing relative motion thereof in the slots of the piston body substantially as set forth.

16. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, vanes slidably and rockably mounted in slots in said body, reinforcing means on said vanes adapted for relieving the vanes of the working stresses, a centric shaft rigidly mounted in said casing, centric ring members revoluble about said shaft and having engagement with said reinforcing means and ball bearings inserted between said centric ring members and said shaft substantially as set forth.

17. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, vanes slidably mounted in the slots in said rocker, anti-friction bearings inserted in said rocker slots on either side of the vanes, and centric means revolubly mounted in said casing and having engagement with said vanes for producing the motion of said vanes in the slots in said rockers, substantially as set forth.

18. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, vanes passing through the slots in said rockers, reinforcing members for said vanes, ball bearings inserted in said rocker slots on either side of the vanes and in engagement with said reinforcing members, and centric means revolubly mounted in said casing and having engagement with said reinforcing members of the vanes substantially as set forth.

19. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, bearing members in said body for taking end thrust on said rockers, vanes slidably mounted in the slots in said rocker and centric means revolubly mounted in said casing and having engagement with said vanes for producing motion of said vanes in the slots in said rockers substantially as set forth.

20. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers mounted in peripheral slots in said body, thrust ball bearings mounted in said body at the ends of said rockers, vanes slidably mounted in the slots in said rocker, and centric means revolubly mounted in said casing and having engagement with said vanes for producing motion of said vanes in the slots in said rockers substantially as set forth.

21. Rotary pump machine comprising in combination a cylindrical casing, an eccentric piston body revoluble therein, slotted rockers disposed in peripheral slots in said body anti-friction bearings for the rockable mounting of said rockers in said body, vanes slidably mounted in the slots in said rocker, and centric means revolubly mounted

in said casing and having engagement with said vanes for producing motion of the vanes in the slots in said rockers substantially as set forth.

22. Rotary pump machine comprising in combination a cylindrical casing, a piston body eccentrically and revolubly mounted in said casing by a shaft at one end and a ball bearing at the other end, a lay shaft carrying said ball bearing and mounted rigidly by one end in a central position in said casing, a ball bearing adapted for supporting the said shaft eccentrically in said piston body at its other end, vanes slidably and rockably mounted in slots in said piston body, and centric members revolubly mounted on said shaft and having engagement with said vanes substantially as set forth.

23. Rotary pump machine comprising in combination a cylindrical casing, a cylindrical piston body mounted eccentrically and revolubly in said casing by a shaft at one end of said body and a ball bearing at the other end, a lay shaft carrying said ball bearing and mounted rigidly by one end in a central position in said casing, a ball bearing adapted for supporting the said shaft eccentrically in said piston body at its other end, slotted rockers disposed in peripheral slots in said piston body, ball bearings mounted in said body for the rockable mounting of said rockers, vanes passing through the slots in said rockers, reinforcing members for said vanes, ball bearings inserted in said rocker slots on either side of the vanes and in engagement with said reinforcing members, centric ring members mounted on ball bearings on said shaft and projections on said vanes engaging in slots in said centric ring members substantially as set forth.

24. In a rotary pump machine of the character described, and in which the vanes are subject to acceleration and deceleration during a revolution of the piston body at uniform speed, the combination with the vanes which are freely slidable and rockable in slots in the piston body, of thrust members composed of material possessing greater specific strength than the vanes and having a sliding fit in rockable means on said piston body, the stresses due to reaction during operation being thereby localized on the thrust members which are calculated to withstand such stresses to the relief of the vanes.

25. In a rotary pump machine of the character described and in which the vanes are subject to acceleration and deceleration during a revolution of the piston body at uniform speed, the combination with vanes of light construction and substantial thickness of thrust members, possessing relatively great strength and rigidity, said members having a sliding fit in rockable means on said piston body and said vanes being freely slidable and rockable in slots in the piston body, the stresses due to reaction during operation being thereby localized on the thrust members which are adapted for withstanding such stresses.

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