Feb. 28, 1950 E. G. SEASTROM 2,498,715

SLIDING VANE PUMP

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FIG. 1.

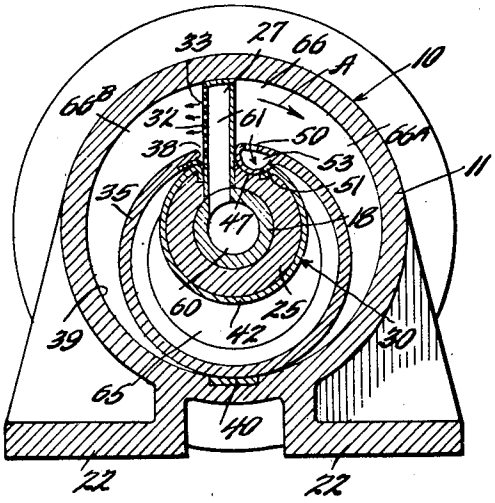


FIG. 2.

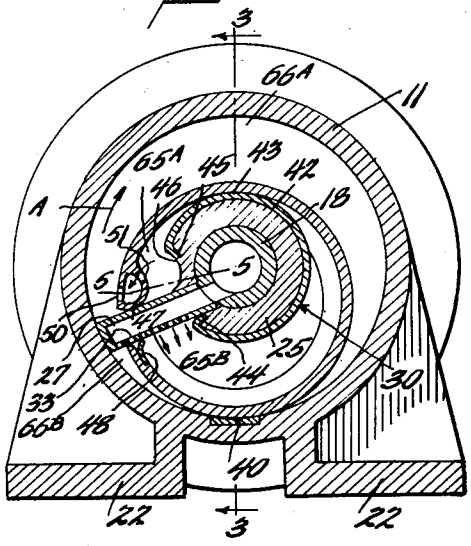
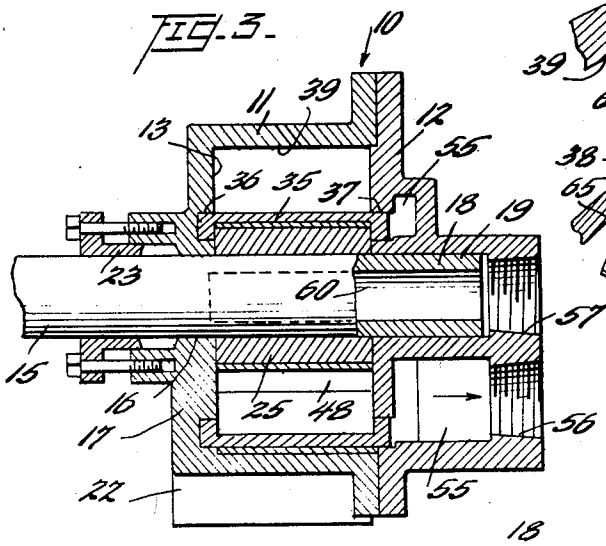


FIG. 3.



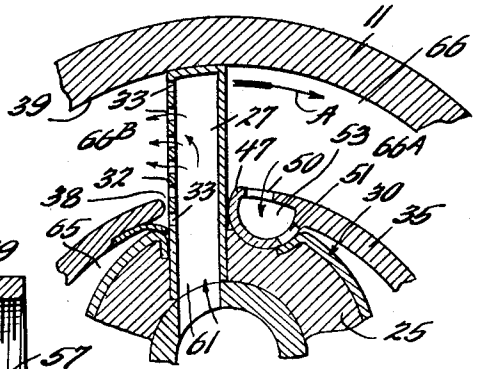
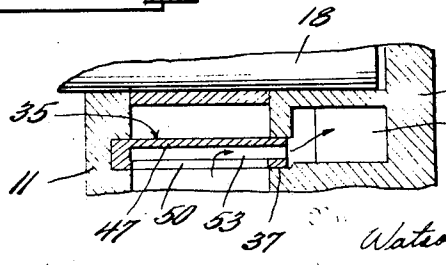


FIG. 4.

FIG. 5.



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FIG. 6.

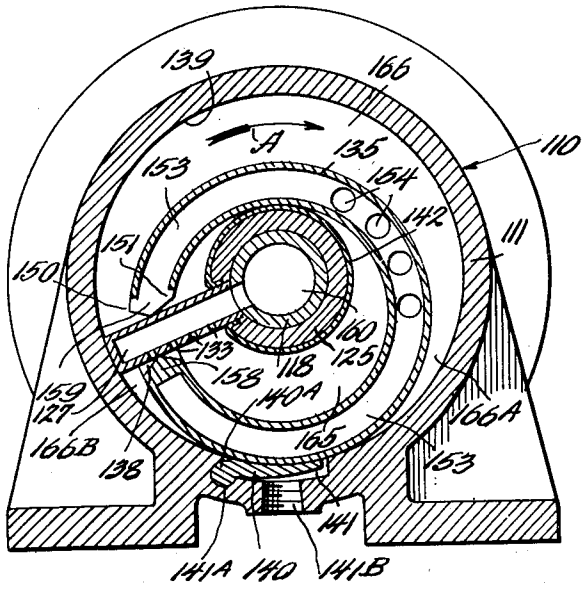


FIG. 7.

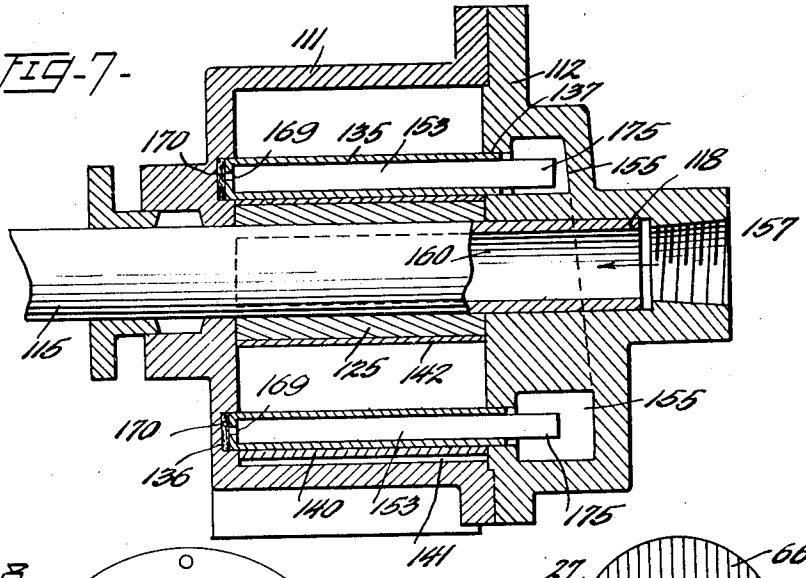


FIG. 8.

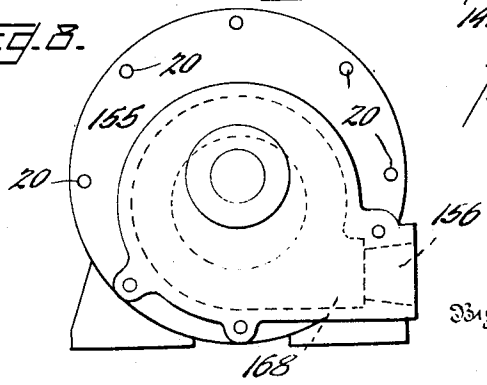
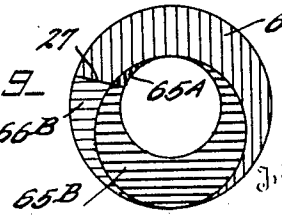


FIG. 9.



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FIG. 10.

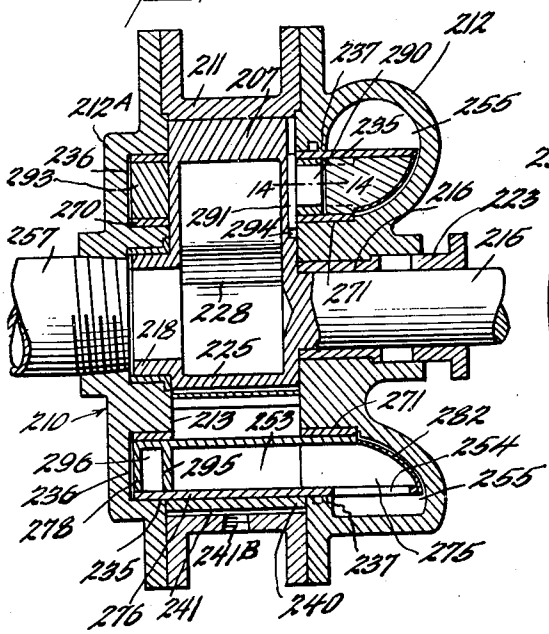


FIG. 11.

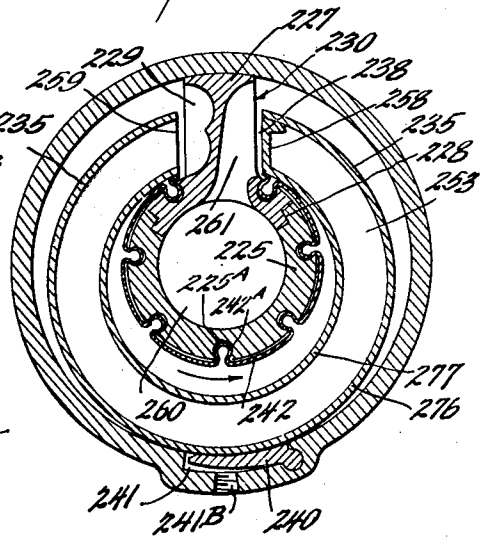


FIG. 12.

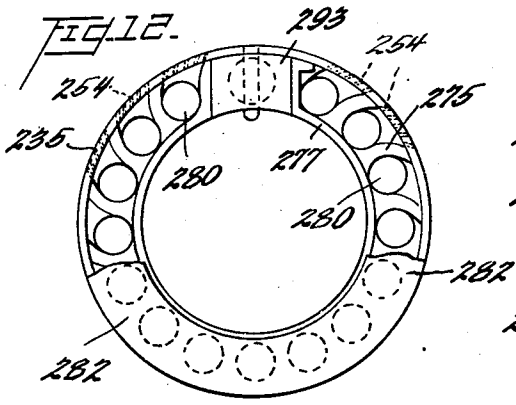


FIG. 13.

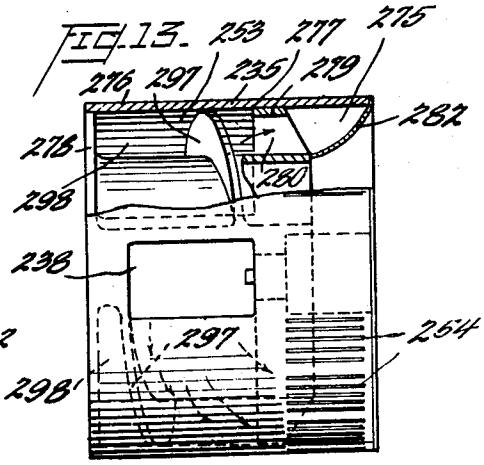


FIG. 14.

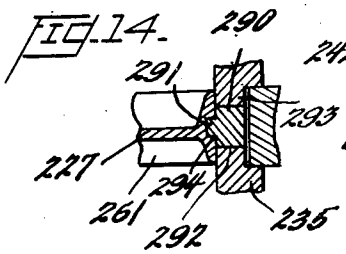
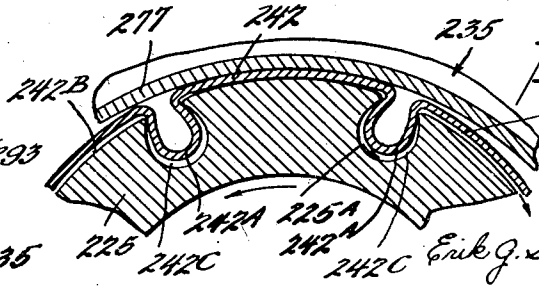


FIG. 15.



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FIG. 17.

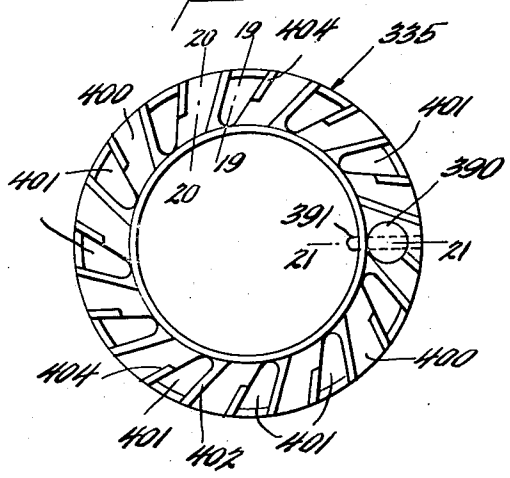


FIG. 18.

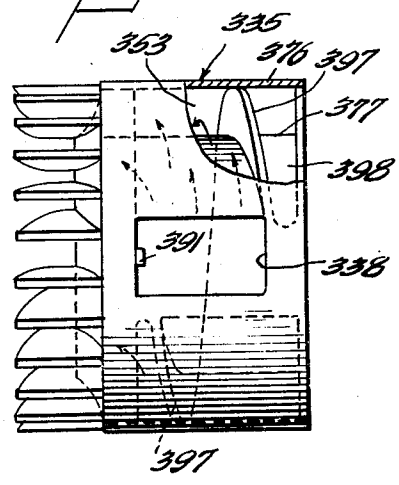


FIG. 19.

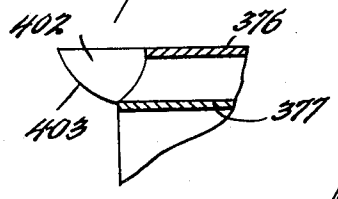


FIG. 20.

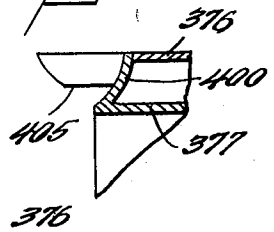


FIG. 21.

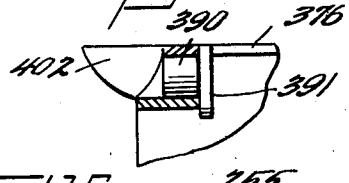
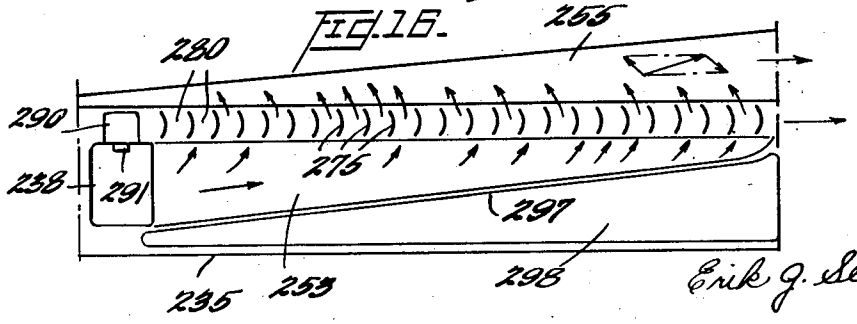


FIG. 16.



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FIG. 22.

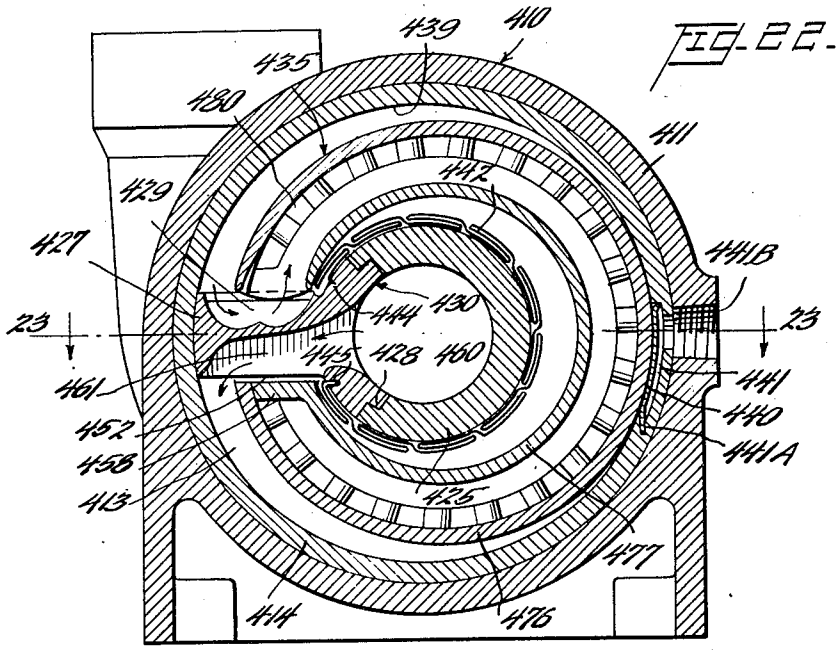
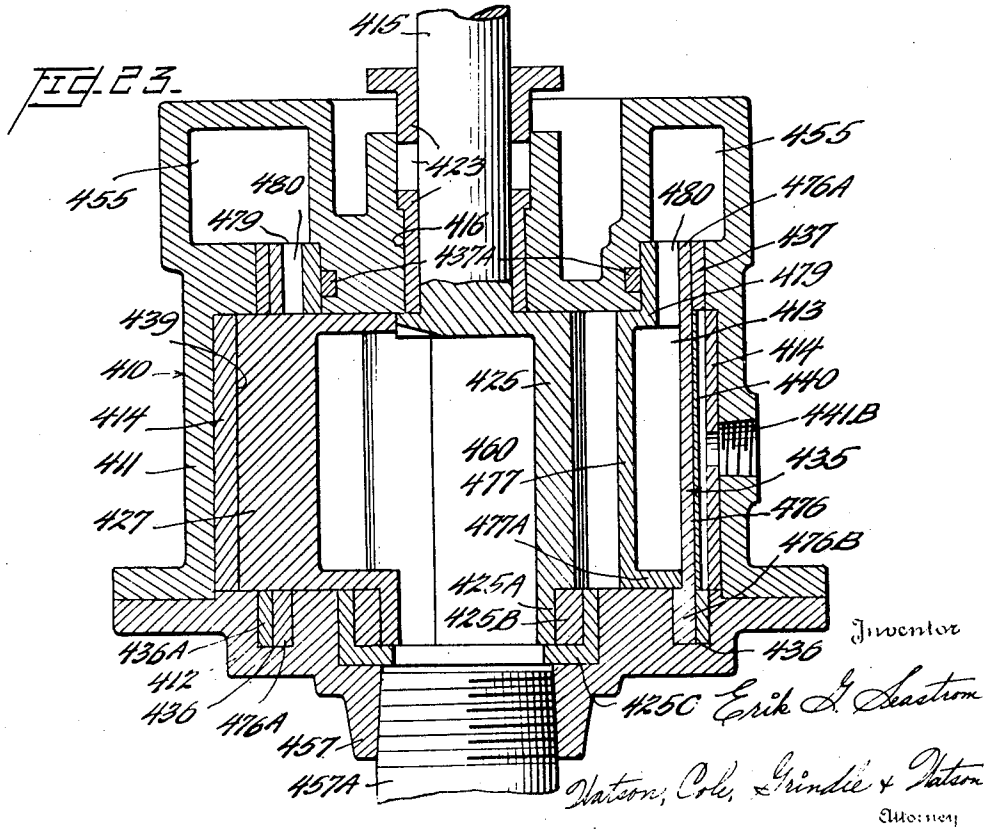


FIG. 23.



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Fig. 24.

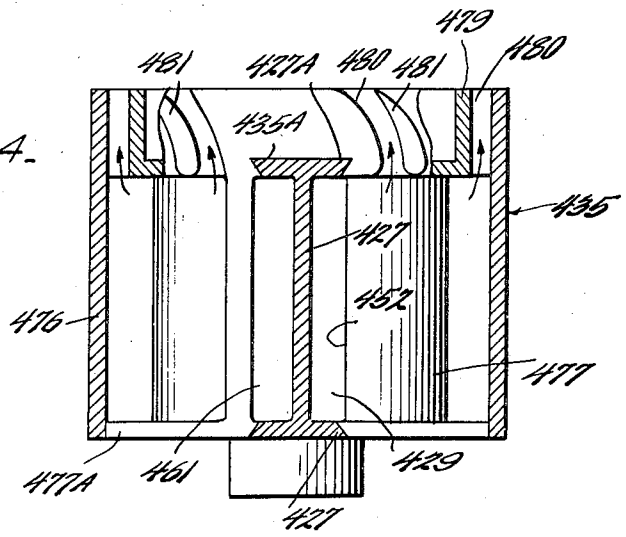


Fig. 25.

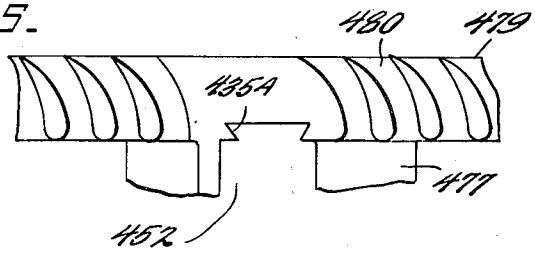
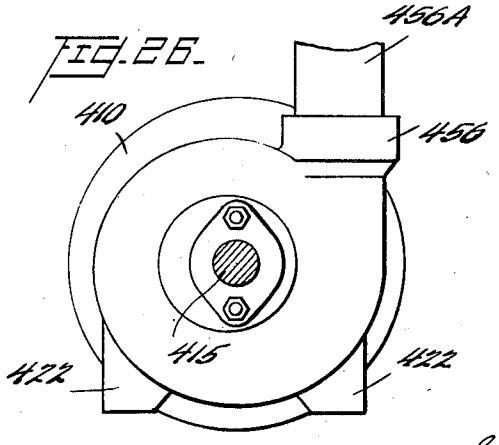


Fig. 26.



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UNITED STATES PATENT OFFICE

2,498,715

SLIDING VANE PUMP

Erik G. Seastrom, Easton, Pa., assignor to Treadwell Engineering Company, Easton, Pa., a corporation of Pennsylvania

Application March 3, 1945, Serial No. 580,871

28 Claims. (Cl. 103—5)

1

This invention relates to pumps and has for its general object the provision of novel and improved pumps of the combined centrifugal and displacement type.

More particularly, it is an object of the invention to provide a novel centrifugal and displacement pump which will afford substantially uniform flow, and which is economical to manufacture and maintain, the construction and arrangement of the parts being such that the pump may be conveniently produced in small sizes for household or domestic use. This application is a continuation-in-part of my copending application, Serial No. 534,306, filed May 5, 1944, now abandoned.

The invention, in its preferred embodiment, contemplates the provision of a rotary having a substantially cylindrical housing within which is disposed an axially arranged impeller member having a radial vane, and an eccentrically disposed cylindrical ring or sleeve through which the vane extends and which is adapted to rotate simultaneously with the impeller. The sleeve is internally tangent to the substantially cylindrical impeller member and externally tangent to the inner wall of the housing. The impeller comprises a hollow axially disposed shaft or hub from which the radial vane or wing extends. The wing or vane member is also hollow and communicates with the interior of the hub which is adapted to receive fluid from the intake openings in the pump casing. The vane is provided with openings in its rear surface considering the direction of movement, and fluid is discharged from these openings into the successively expanding and contracting receiving portions of the lune-shaped chambers provided between the cylindrical sleeve and the respective surfaces of the impeller hub and of the pump casing.

The fluid is constantly discharged from the shrinking or contracting portions of these lune-shaped chambers ahead of the vane, through openings provided in the walls of the sleeve, which openings communicate with passageways within the body of the sleeve and which finally discharge through the outlet connections of the pump. These outlet connections include a centrifugal outlet chamber, preferably of expanding volume, wherein the fluid from the hollow eccentric sleeve is given further impetus toward the final outlet of the pump.

Other objects and features of novelty include the provision of novel sealing means for preventing communication between the several working chambers of the pump as they fluctuate in volume; means for assisting the movement of fluid

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through the passageway in the eccentric sleeve; means for increasing the centrifugal movement of the fluid in the outlet chamber; and means for affording a positive mechanical connection between the impeller and the eccentric sleeve to supplement, when necessary, the hydraulic drive of the sleeve as will be understood as the detailed description proceeds.

Still further novel features will be apparent when the following specification is read in connection with the accompanying drawings in which certain embodiments of the invention are illustrated by way of example.

In the drawings,

Figure 1 is a vertical transverse sectional view of a pump comprising one embodiment of the invention;

Figure 2 is a similar view of the same pump with the impeller displaced from the position shown in Figure 1;

Figure 3 is a vertical axial sectional view of the pump taken on line 3—3 of Figure 2;

Figure 4 is an enlarged detail view in vertical transverse section showing the inlet and outlet provisions for the working chambers of the pump;

Figure 5 is a fragmentary sectional view taken on line 5—5 of Figure 2;

Figure 6 is a transverse vertical sectional view of a pump comprising another embodiment of the invention, in which certain modifications in the outlet means are introduced;

Figure 7 is a fragmentary axial view of the pump shown in Figure 6;

Figure 8 is a view in end elevation of the pump shown in Figure 6, but on a reduced scale;

Figure 9 is a diagram showing very clearly the way in which the lune-shaped chambers are divided into constantly varying intake and discharge portions by the vane;

Figure 10 is a vertical, axial, sectional view of a still further modified form of the invention;

Figure 11 is a partial, transverse, sectional view through the main displacement chamber of the pump shown in Fig. 10;

Figure 12 is an end view of the eccentric, rotating ring or sleeve employed in the pump shown in Figs. 10 and 11; a part of the end cover being broken away;

Figure 13 is a view in side elevation of the same sleeve, parts being broken away for the sake of clearness of illustration;

Figure 14 is a fragmentary, sectional view taken on line 14—14 of Fig. 10 and showing the slot and pivot connection between the impelling vane and the sleeve;

Figure 15 is a fragmentary, sectional view on an enlarged scale of a novel combined fluid pressure and centrifugal sealing arrangement in connection with the rolling contact between the impeller hub and the inner wall of the sleeve;

Figure 16 is a diagrammatic development of the sleeve and the expanding discharge chamber, indicating the relative velocities and forces of the sleeve and liquid;

Figures 17 and 18 are views in end and side elevation respectively of still another form of eccentric sleeve for use in the novel pump installation;

Figures 19, 20, and 21 are fragmentary, axial, sectional views of the vaned portion of the sleeve, taken respectively on lines 19—19, 20—20, and 21—21 of Fig. 17;

Figure 22 is a view in vertical transverse section of a still further modification of the novel pump;

Figure 23 is a horizontal sectional view taken substantially on line 23—23 of Figure 22;

Figure 24 is a view of the rotor member of the pump shown in Figure 22, with parts shown in section and parts in elevation;

Figure 25 is a fragmentary developed view of the discharge orifice portion of the rotor sleeve; and

Figure 26 is a view in elevation of the pump casing.

Referring more particularly to Figures 1 to 5, inclusive, of the drawings, it will be seen that the pump casing designated generally by the reference numeral 10 comprises the body portion 11, and the cover plate 12. The body portion 11 is hollowed out to provide a substantially cylindrical housing 13 for the working members of the pump. A driven rotor shaft 15 extends through an opening 16 in the vertical wall 17 of the housing and this shaft is provided with a hollowed end portion 18 which projects into an axial opening 19 in the cover plate 12. The cover plate is suitably secured to projecting flanges on the body portion 11 as by bolts or other securing means, such as those suggested at 20 in Figure 8, in connection with the second illustrated embodiment. The body portion 11 of the pump casing 10 may be provided with suitable legs or pedestals 22. A conventional stuffing box indicated at 23 surrounds the shaft 15 adjacent the opening 16 in the casing.

The hollow end portion 18 of the shaft 15, which passes through the housing interior 13, is provided with a substantially circular hub member 25 which is rigidly secured thereon by any suitable means. Both the hub 25 and the shaft end 18 are slotted longitudinally to receive the hollow rectangular substantially radally extending vane or wing 27 which constitutes an essential element of the impeller of the pump, and to provide communication between the interiors of the vane and hub. The impeller as a whole may be designated by the reference numeral 30 and will be understood to comprise the hollow end portion 18 of the shaft 15, the hub 25, and the vane 27. The rear wall 32 of the vane 27, considered from the standpoint of the direction of movement of the impeller (indicated by the arrows A), is provided with a plurality of openings 33.

A substantially circular ring or sleeve member 35 is disposed within the interior 13 of the pump casing and is guided within annular grooves 36 and slots 37 provided respectively in the wall 17 of the casing and the cover plate 12. The sleeve 35 is eccentrically disposed with relation to the interior of the housing and also with relation to the hub 25 of the impeller 30, and a longitudinal slot 38 is provided in the sleeve 35 through which the hollow vane 27 of the impeller extends with as close a clearance as practicable considering the relative movement of the parts.

At the line of tangency between the sleeve 35 and the circular wall 39 of the housing, there is provided a strip of sealing material 40. For a similar purpose, the outer surface of the hub 25 which comes in rolling contact with the entire surface of the ring 35 is provided with a covering 42 of sealing material. This material extends nearly all the way around the hub 25 since the line of rolling contact between the hub and the ring is continually changing, although the place of contact 43 is fixed with relation to the pump as a whole (see Figure 2 of the drawings). One end 44 of the sealing strip 42 is turned in and clamped between the vane 27 and the edge of the opening in the hub 25 through which the vane extends. The other end 45 of the strip 42 is embedded and secured to the hub adjacent an arcuate depression 46 which is provided to accommodate the bulb-like enlargement 47 of the ring 35 adjacent the forward face of the vane 27. A cooperating sealing flap 48 may be secured at the edge of the slot 38 in the ring 35 near the rear face 32 of the vane.

The hollow bulb edge 47 of the ring 35 is provided with intaken openings 50 and 51 which open outwardly and inwardly of the ring respectively. The interior of the bulb end 47 provides a longitudinal channel or passageway 53 which opens through the end of the ring 35 which is guided in the circular slot 37 in the cover plate 12, as clearly shown in Figure 5. An annular outlet chamber 55 is provided in the cover 12 and discharge conduits may be applied to the threaded opening 56 of the chamber 55 as shown in Figure 3 of the drawings.

Inlet connections for the pump may be applied to the threaded opening 57 disposed axially of the cover plate 12 and communicating directly with the central opening 60 within the shaft end 18, from which the fluid passes into the hollow interior 61 of the vane 27.

During operation of the pump, the impeller 30 and the ring 35 are continually rotating, for example, in a clockwise direction as indicated by the arrows A. It will be observed that there is provided a lune-shaped chamber between the outer surface of the impeller hub 25 and the interior surface of the ring 35 as indicated at 65 in Figure 1 of the drawings. In this figure, the lune-shaped chamber is undivided and full of fluid. Between the outer surface of the ring 35 and the inner wall 39 of the casing, a second lune-shaped chamber 66 is provided. In Figure 1 it will be seen that this chamber is substantially bisected by the vane 27. However, as the impeller moves in the direction of the arrow A, the right hand portion or segment 66A of the chamber 66 will be diminishing in volume while the left hand segment 66B will be increasing. The liquid within the portion 66A is being forced through the opening 50 and into the passageway 53 of the bulb-like end 47 of the edge of the ring 35. At the same time, the liquid being thrown centrifugally from the axial inlet chamber 60 through the hollow interior 61 of the vane 27 passes through the openings 33 in the wall 32 of the vane and serves to fill the chamber portion 66B of the outer lune 66

At the point shown in Figure 1, the entire lune 65 is at a "neutral" position in which it is completely filled with liquid and is about to discharge it. It will be understood that as the vane rotates from this positions, the lowermost openings 33 in the vane 27 will being to discharge into the inner lune-shaped chamber 65 while the outlet opening 51 will being to receive the fluid from the other side of the lune 65. As the vane 27 reaches the lower vertical position, 180° displaced from the position shown in Figure 1, the chamber 65 will be substantially equally divided into intake and discharge portions. At this point the outer lune-shaped chamber 66 will be undivided and will be filled with fluid.

In Figure 2 of the drawings the vane 27 has advanced beyond the lower vertical position, fluid is being discharged through the majority of the openings 33 into the portion 65B of the lune 65 and the opposite portion 65A is discharging liquid through the opening 51. A few of the outermost openings 33 in the vane are beginning to discharge liquid into the portion 66B of the lune 66 and the greater part 66A of this lune is discharging through the opening 50 in the ring 35. From this, the general operation of the pump will be clearly understood. The vane 27 is continually and alternately discharging fluid through its rear wall into the successively enlarging portions 65B and 66B in the inner and outer lune-like chambers and the front wall of the vane is continually pushing fluid ahead of it as the forward chamber portions 65A and 66A diminish due to the eccentricity of ring 35. The fluid is thus being transferred by a combination of centrifugal action and displacement from the shrinking chambers. During this rotative movement the respective chambers are sealed off by means of the sealing material 40, the end of the impeller 27 which has a close fit with the wall 39 of the casing, and the material 42. This latter strip of material is increased in effectiveness by the centrifugal expansion thereof during operation.

The entire construction and operation of the displacement portion of the pump may be further clarified by an inspection of the diagram shown in Fig. 9 of the drawings.

In Figures 6, 7, and 8 of the drawings, there is illustrated a modification of the pump shown in the earlier figures and constituting a second embodiment of the invention. Many of the parts of this embodiment are quite similar to corresponding parts of the first embodiment and will be designated by the same reference numerals with 100 added. For example, the pump casing is indicated at 110 and comprises the body portion 111 and the cover plate 112. A shaft 115 is connected with suitable driving means and has a hollow end 118 through which the fluid is received into the central chamber 160. A hub 125 is fixed upon the hollow end 118 of the shaft and an impeller vane 127 is received within registering openings in the shaft end 118 and the hub 125. Discharge openings 133 are provided in the rear face of the vane through which fluid may flow from the hollow interior 161 of the vane. The end of the vane, of course, has a sliding fit with the inner wall of the housing 111, and hub 125 is covered with sealing material 142 just as in the case of the first embodiment.

An eccentric ring 135 has one end fitted within the groove 136 of the casing portion 111 and its outer end is guided within the circular slot 137 in the cover portion 112. The eccentric ring 135 differs somewhat from the ring 35 of the embodiment first described in that it is hollow, being provided substantially throughout its circumference with an approximately annular chamber 153. This chamber 153 opens axially through a plurality of orifices 154 into the annular outlet chamber 155 of the pump, which is contained within the cover plate or head 112. Any desired or appropriate number of these openings 154 may be provided. The chamber 155 tapers somewhat and is of greatest cross-section near the bottom of the pump where it discharges through tangential passageway 168 into the discharge conduit which may be applied in the connection 156. The discharge of the fluid thus has some centrifugal effect.

A longitudinal slot 138 is provided in the hollow ring or sleeve 135, for the accommodation of the vane or impeller element 127. The edges of the slot 138 are preferably curved to provide for the relative movement of the vane and ring during rotation around their different centers. Adjacent the rearward face of the vane 127 the slot 138 has a solid wall 158 but adjacent the forward wall of the vane the edge of the slot has its wall cut away as at 159. Portions of the side wall of the ring are also cut away as at 150 and 151, so as to receive fluid within the chamber 153 from the shrinking portions of the lune-shaped pump chambers 165 and 166. The operation of this embodiment of the pump will be readily understood. The chambers 165 and 166 are successively divided by the vane 127 into forward portions of diminishing capacity and rearward portions of increasing capacity, the former being vented through the openings 150 and 151 to the interior of the ring and thence to the outlet chamber of the casing, the latter being supplied with fluid through the openings 133 in the vane.

In order to equalize the pressure in the hollow ring 135 and the annular groove 136, a series of openings 169 may be provided in the circular end wall of the ring. An anti-friction or wear strip 170 may also be provided in the bottom of the groove if desired.

Instead of the simple sealing strip 40 suggested in the first embodiment of the invention, there is shown in Figs. 6 and 7 of the drawings a pressure seal which utilizes the differences in pressure between the section 166A and 166B of the outer lune 166. The lune section 166A ahead of the vane 127 is under somewhat higher pressure than the section 166B adjacent the trailing face of the vane. To take advantage of this condition, a hinged packing or sealing member 140 is disposed within a recess 141 provided within the lower portion of the casing. The member 40 has a circular pintle portion 140A situated within the similarly shaped portion 141A of the recess 141. Thus, any pressure liquid from the working chamber portion 166A which makes its way into the recess 141 will cause the hinged sealing member 140 to press firmly against the outer periphery of the sleeve 135. It will be noted that the left-hand and inner part of the seal 140 is in communication with the chamber 166B of lower pressure. Thus, the difference in pressure in these two working chambers is employed to make the seal 140 more effective.

A clean-out opening 141B is provided at the lowest point of the recess 141 and may be stopped by a suitable closure element (not shown).

Adjacent the openings 154, there are formed upon the end surface of the ring or sleeve 135, a series of vanes 175 which project into the ex-

panding centrifugal chamber 155 and aid in swirling the liquid within this chamber and effecting the centrifugal action. Thus, it will be noted that the fluid passes centrifugally through the hollow vane of the impeller; the action in the lunes is mainly displacement; and the final discharge through the outlet chamber 155 to the orifice 156 again has a centrifugal component.

The embodiment of the invention illustrated in Figs. 10–15 inclusive of the drawings will now be described. The pump casing or housing 210 in this example is made in three parts, a central section 211 and two end cover plates or castings 212 and 212A. These casing portions provide a substantially cylindrical chamber 213 for the moving parts of the displacement portion of the pump. In this embodiment the drive shaft 215 is driven by a motor or other source of power, passes through the stuffing box 223, and through the opening 216 in the end casting 212 of the housing 210. The end portion of the shaft 215 is enlarged to form the integral hollow hub portion 225, a substantially cylindrical chamber 260 being provided within the hub and communicating through the end portion 218 of the shaft with the inlet connection 257. The inlet connection 257 is preferably co-axially disposed with relation to the drive shaft 215 and is secured to the end plate or casting 212A.

Interlocked with the hub 225 is the radially-extending impeller vane 227, the vane being interlocked as indicated at 228.

As clearly shown in Figs. 11 and 14 of the drawings, the vane 227 is provided with an outlet passageway 261 through which fluid from the central chamber 260 is centrifugally thrown radially outwardly into the lune-shaped displacement portions of the working chamber 213. Upon the opposite face of the vane 227, facing in the direction of rotation of the impeller, there are provided the recesses 229 which provide a sort of scoop which serves to aid in the withdrawal of liquid from the lune-shaped sections of the displacement chambers, and in directing the fluid into the mouth of the hollow eccentric which will be described. The impeller as a whole comprises the enlarged hollow hub 225 of the shaft 215, together with the interfitted vane 227, and this assembly in its entirety may be designated by the reference numeral 230.

The circular, eccentrically disposed hollow ring, in this embodiment, is indicated generally by the reference numeral 235 that is shown detached from the pump housing in Figs. 12 and 13 of the drawings. An eccentric, circular groove 236 is formed in the cover plate 212A and in corresponding portions of the cover plate or casting 212 there are provided openings 237. Within the inner portions of the groove 236 and the annular opening 237 are inserted the bushing rings 270 and 271, forming bearing means for the ring 235.

As in the case of the embodiment previously described, ring or sleeve 235 is provided with a rectangular, longitudinally extending, radial slot or opening 238, to accommodate the radial vane 227. The sleeve 235 is provided with a hollow interior chamber 253 which is longitudinally closed at one side of the opening 238 by means of the wall 258, but is open for the admission of fluid at its opposite end as at 259 adjacent the forward face of the vane 227 which is provided with the scoop-like recesses 229. The sleeve 235 is preferably made in two principal parts, the outer part consisting of the cylindrical wall 276, and the other part comprising the inner wall portion 277 together with the end wall 278 which fits into the groove 236.

As best shown in Figs. 12 and 13 of the drawings, the inner member of the ring 235 is provided with an annular projection 279 having a circular series of openings 280 therein. Beyond the openings 280 this inner member of the sleeve 235 is provided with curved vanes 275. The wall 276 of the sleeve 235 where it projects into the outlet chamber 255 in the head casting 212 is provided with an annular series of slots 254, through which the liquid is radially discharged to obtain a centrifugal action within the outlet chamber 255. This centrifugal outlet chamber is similar in most respects with the outlet chambers 55 and 155 of the embodiments previously described, and is provided with outlet connections (not shown) similar to those indicated at 56 and 156 in the earlier figures of the drawing. At the outlet end of the sleeve 235, there is disposed an annular cover plate 282, preferably made of sheet metal and of an arcuate section. This plate is applied to the curved edges of the blades 275 and serves to smoothly direct the liquid between the blades and through the slots 254.

The lower portion of the chamber 213 is provided with a recess 241 within which there is disposed a hinged sealing element 240, pivotally mounted as at 240A and constructed and arranged to operate in the same manner as the seal 140 in the embodiment previously described. A clean-out opening is provided at 241B.

Where the hub 225 comes in rolling contact with the surface of the inner wall 277 of the sleeve 253, there is provided the novel pressure differential and centrifugal sealing installation 242. As best seen in Figs. 11 and 15, the sealing element 242 comprises a flexible and somewhat resilient strip formed with crimped or undulating portions 242A at intervals around the structure, each adapted to be received within one of the narrow-mouthed recesses 225A in the hub 225. As shown in Fig. 15, at all points around the hub 225 remote from the ever-changing lines of contact at 243, the sealing strip 242 stands somewhat away from the surface of the hub, leaving a space 242B between these elements. Similarly, a space 242C occurs between the looped or crimped portions 242A of the sealing element and the surfaces of the recesses 225A. However, adjacent the point of rolling contact 243, the ring 235 presses the sealing element 242 closer to the surface of the hub. Thus, any fluid beneath the strip 242 within the spaces 242B and 242C is squeezed or pressed along from one pocket or recess to the other, thus supplying a sealing pressure passing into the low pressure region. By this means, sealing under pressure is assured, as well as the natural centrifugal sealing effect resulting from the rotation of the impeller.

In order to prevent wearing and the possibility of noisy contact between the forward and rear faces of the vane 227 and the walls of the opening 238 adjacent the opposite ends 258 and 259 of the sleeve chamber 253, a mechanical connection is provided between the vane 227 and the sleeve 235. This connection is best shown in Figs. 10, 12, and 14 of the drawings, and comprises a circular stud or plug 290 at one end of which is formed a longitudinal key portion 291. The circular part 290 is received within a similarly shaped recess 292 formed in a solid portion 293 of the sleeve 235 where one or more of the

outlet openings 280 are omitted, and of course adjacent the opening 258 through which the vane 227 passes.

A longitudinal groove 294 is formed in one edge of the vane 227 to receive the key portion 291 of the connecting element. This groove or slot 294 is necessarily of greater length than the key 291 in order to provide for reciprocating movement due to the eccentricity of the sleeve 235 with respect to the impeller 230 and its vane 229.

Although the mechanical driving means just described are featured in the embodiments of the invention disclosed in the present specification, these means are complementary to and serve to augment the fluid pressure driving force asserted on the sleeve by virtue of the hydraulic phenomenon more fully set forth and claimed in my copending application Serial No. 758,871, filed July 3, 1947. Due to the construction of the pump and the relationship of its operating parts, the velocity of the fluid passing through the displacement portion of the pump is somewhat greater than that of the sleeve; thus, there is an absorption of energy, under most conditions of operation, sufficient to carry the sleeve around its orbit without continually being forced by the vane through the key member 290, 291. Thus, even when the mechanical drive means are employed, excessive wear on those parts is prevented.

At 295 in Fig. 10 there is shown a partition which separates the active space 253 of the interior of the sleeve 235 from a dead space 296 beyond the partition. The sleeve is not made solid at this point since this would unnecessarily add to the weight of the pump. The liquid moves laterally through the space 253 due to differences in pressure at the several points along its course through the outlet chamber and the central displacement chamber. However, in the embodiment of the sleeve illustrated in Figs. 12 and 13, a helical partition 297 is formed upon the inner section 277 of the sleeve and this partition, together with the inner wall 277 and the outer wall 276, forms a gradually narrowing chamber from which the liquid is "squeezed" through the openings 280 by means of the helical wall 297. Rearwardly of the wall or partition 297 there is an expanding dead space 298. By means of this helical partition there is provided in effect a screw conveyor for the fluid which acts further to displace the fluid toward the delivery point.

In Fig. 16 there is shown a development of the sleeve chamber, the delivery openings with their blades, and the expanding outlet chamber. It will be seen from this diagram that the contraction of the sleeve chamber 253 is substantially comparable to the expansion of the centrifugal outlet chamber 255. During the transfer of the fluid through this portion of the pump, energy is absorbed which may be sufficient to carry the sleeve through its orbit. Thus, the load on the pivot key 290, 291 may be partially or wholly relieved.

In Figs. 17–21 inclusive there is illustrated another embodiment of eccentric sleeve which is designated generally by the reference numeral 335. For the most part, this sleeve is constructed similarly to the sleeve 235 and similar reference characters will be employed. For example, the outer annular wall is shown at 376, the inner casting of the sleeve is indicated at 377, the helical blade or partition is designated 397, the opening for the impeller vane is shown at 338, the delivery passageway through the sleeve at 353, the dead space at 398, and the pivot key element at 390 391. The outlet end of the sleeve, however, is constructed differently from the previous embodiment and the new arrangement is probably best shown in Fig. 17. The sleeve, at this end, is provided with an end wall 400 which is relieved at intervals by the radially outwardly flared openings 401. Upon one side of each of these openings there are provided axially extending blades, fins, or vanes 402 which extend for the full width of the opening and are arcuately curved upon their inner sides as at 403. A sheet metal cover (not shown) may be provided in this case similar to the one indicated at 282 in Figs. 12 and 13 of the drawings. Upon the opposite side of each of the openings 401 there are provided the narrower blades or vanes 404 which are curved at their ends to conform to the cover plate and the configuration of the outlet chamber, but are cut off as at 405 at about half the width of the other blades 402. At one point around the end of the sleeve, the opening 401 is omitted to make room for the pivot key element 390, 391, as clearly shown in Figs. 17 and 21.

A still further modification of the invention is illustrated in Figures 22–26 of the drawings, the chief differences in this arrangement over the others previously described being a variation in the form of the sealing devices, changes in the discharge means of the rotary sleeve, and novel interlocking arrangements between the driving vane of the impeller and the eccentric rotating hollow ring or sleeve. These and other changes in the construction and arrangement of the pump will be described in detail.

As indicated in Figure 26 of the drawings, this form of the pump comprises a pump casing 410 provided with the feet or pedestals 422 and a vertically disposed outlet connection 456 to which a discharge pipe 456A is attached. The inlet connection 457, as in the case of the earlier described embodiments, is disposed axially of the driving shaft 415, as will be readily perceived by inspection of Figures 22 and 23 of the drawings.

In these two figures it will be seen that the casing designated generally by the numeral 410 comprises a main body portion 411 and a cover plate 412, these members enclosing a substantially cylindrical working chamber 413 and a discharge chamber 455. A lining ring 414 is disposed within the chamber 413, this ring providing a smooth interior surface or inner wall 439 against which the rotating impeller is adapted to slide, and also enabling the provision of an enlarged housing facilitating the boring of the bushing seats or grooves in the casing member 411, between the chambers 413 and 455.

The drive shaft 415 enters the pump casing through an opening 416 in the body portion 411, which opening is provided with a bushing and stuffing box assembly 423.

The drive shaft 415 is provided with an enlarged hollow hub portion 425, the interior 460 of which opens endwise toward the axial intake connection 457 to which the inlet pipe 457A is fitted. The outer end of the hub 425 is narrowed as at 425A and is surrounded by a crimp ring 425B which is enclosed within the flanged ring 425C, which arrangement provides a journal bearing for the hub at the cover plate end of the casing.

The impeller vane is designated by the numeral 427 and is generally similar to the vane 327 of the embodiment illustrated in Figures 10 and 11 of the drawings, being formed with a hollowed

out discharge portion 461 which extends approximately radially of the vane and opens outwardly through the rearward surface of the vane. The forward surface, according to the direction of rotation of the impeller, is provided with the scoop portions 429 similar to the arrangement shown in Figures 10 and 11. The base of the vane 427 is provided with shouldered portions providing an inter-lock 428 with similar shouldered portions cut in the hollow hub 425. The vane and the hub thus are rigidly connected together to form an impeller unit assembly designated generally by the numeral 430.

The eccentric hollow ring or sleeve is denoted generally by the reference numeral 435, and is shown in some detail in Figure 24 of the drawings as well as in Figures 22 and 23. The inner portion of the sleeve comprises a substantially annular member 477 having lateral flanges 477A and a shouldered outlet portion 479 providing a restricted series of outlet orifices 480. The inner portion 477 of the sleeve is enclosed by an outer ring 476, one margin 476A of which covers the orifice portion 480 of the sleeve and the opposite edge 476B projects axially beyond the inner portion 477 and is journaled within the annular groove 436 of the cover plate 412. A bushing or bearing ring 436A surrounds this portion of the sleeve. The opposite end of the sleeve bears in a bushing 437 and a sealing ring 437A is disposed within a groove in the casing upon the inner side of the rotating sleeve at this end of the device.

The lining ring 414 within the housing 413 is provided with a sealing flap 440 which seats in a recess 441 formed in the inner surface of the ring 414. The seal element 440 is of resilient construction and one edge is received within a slit 441A formed in the ring 414. The seal 440 forms a similar function, and in substantially the same manner, as the hinged sealing member 240 shown in Figure 11 of the drawings. A clean-out opening 441B is also provided at this point in the casing 411.

The rolling contact seal element 442 is wrapped around the outer surface of the hub 425 and is designed to perform the same function as the seal 242 shown in Figure 11.

The seal 442 comprises a sheet of metal, plastic, or other suitable material, and is of a crimped construction having overlapping folds provided by a zig-zag formation of the sheet around the surface of the hub, the ends 444 and 445 of the seal are inserted in slits formed in the side walls of the vane 427 as clearly shown in Figure 22 of the drawings. The superposed folds or laminations of the sealing member when rotating in rolling contact with the inner wall 477 of the sleeve 435 will pass through alternating high and low pressure regions and the circumferential spaces behind the seal and under the overlapping folds will absorb some of the pressure of the fluid substantially greater than the minimum. It is evident, therefore, that this pressure differential will tend to pull portions of the seal into the low pressure chamber. This condition is similar to that produced in the embodiment shown in Figures 11 and 15 of the drawings, and it will be readily seen how the seal produces the described cushioning and sealing effect.

The vane 427, as in the earlier embodiments, passes through an elongated opening 452 in the sleeve 435, and although the back pressure of the fluid will transmit the driving force from the vane to the sleeve under most conditions, the vane and sleeve are interfitted so that the sleeve may be driven by contact with the forward edge of the vane. As shown in Figure 24 of the drawings the side portions of the vane 427 are of dove-tail formation as indicated at 427A, and fit within the similarly formed undercut portions 435A of the sleeve.

The end portion 479 of the inner part of the sleeve which cooperates with the edge 476A of the outer part to form the restricted discharge openings 480 are provided with streamlined partitions 481 which are curved so as to discharge the fluid through the outlet passageways 480 between these partitions in a generally tangential direction within the exhaust or outlet chamber 455 formed in the casing 411 and communicating with the outlet connection 456. This gives a centrifugal effect comparable to that attained by the discharge structure shown at the right hand side of Figure 10 and in Figure 12 of the previous embodiment. It will be noted that the curvature of the discharge slots or orifices 480 is in a direction away from the direction of rotation of the rotor so that the reaction of the discharged fluid aids the rotary effort.

Reviewing the construction and operation of this pump, it will be seen that first of all, the liquid is thrown centrifugally through the hollow vane 27—427 to the outer portions of the working chamber. Then the liquid is moved through the casing mainly by displacement until it reaches the outlet or exhaust chamber 55—455, whereupon a final centrifugal stage is effected.

It is well known that practically every rotary pump can be converted into a liquid motor by reversing the action thereof and thus the liquid may be supplied under pressure and the power taken off the rotor shaft instead of applying driving power thereto. An important feature of the present arrangement lies in that a compressible medium such as air or steam can be used as the driving means in converting the present pump to a motor. In the case of steam the supply enters the primary stage, namely the displacement chamber, and may be allowed to expand into the secondary stage, namely the turbine section. In this way, several units may be hooked up in pairs with the steam finally entering the condenser.

Various changes and modifications may be made in the embodiments illustrated and described herein without departing from the scope of the invention as defined in the following claims.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. A rotary pump for transferring substantially incompressible liquids, comprising, in combination, a stationary casing having a smooth, uninterrupted, inner cylindrical wall enclosing a working chamber, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried

by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a continuous sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, means for venting fluid from said discharging portions, and means for driving the impeller member, said annular sleeve being hollow, and one among the fluid supplying and fluid venting means comprising a passageway through said vane and the other among said fluid venting and fluid supplying means compressing a passageway through said hollow sleeve.

2. A rotary pump for transferring substantially incompressible liquids, comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for supplying fluid to said respective receiving portions of the chamber, means on said sleeve for venting said fluid from both of said discharge portions, a fluid outlet passageway for receiving the fluid from said last named means, and means for driving said impeller member, the said means on said sleeve being so constructed and arranged as to have unobstructed access to said portions at all times except momentarily at instants when one of said portions of a lune-shaped chamber is at maximum capacity and the other at zero capacity.

3. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing, and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for supplying fluid to said respective receiving portions of the chambers, said annular sleeve being provided with a longitudinal passageway open to both chambers on the forward side of said vane, an outlet chamber in said casing continually in communication with said passageway, and means for driving said impeller.

4. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for supplying fluid to said respective receiving portions of the chambers, said annular sleeve being hollow and having openings leading into the interior thereof from both chambers adjacent the forward face of said vane, an outlet chamber in said casing, means providing continuous communication between the interior of said sleeve and said outlet chamber, and means for driving said impeller member.

5. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of

uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, both the hub and vane of the impeller member being hollow and the latter part thereof provided with openings in its trailing wall which faces the receiving chambers, thus providing means for delivering fluid centrifugally to the respective receiving portions of the chamber, said annular sleeve also being hollow and having openings leading into the interior thereof from both chambers adjacent the forward face of said vane, an outlet chamber in said casing, means providing continuous communication between the interior of said sleeve and said outlet chamber, and means for driving said impeller member.

6. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentricallly disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for supplying fluid to said respective receiving portions of the chambers, said annular sleeve being provided with a longitudinal passageway open to both chambers on the forward side of said vane, an expanding outlet chamber in said casing continually in communication with said passageway, the construction and arrangement being such that the fluid is given a rotary motion in the outlet chamber and discharged tangentially therefrom, and means for driving said impeller member.

7. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, sealing means at the point of sliding contact between the sleeve and the casing wall at one of said fixed points of tangency, a sealing annulus on one of the contacting elements at the point of combined sliding and rolling contact at the other fixed point of tangency, means for supplying fluid to and venting it from said respective portions of the chambers, and means for driving said impeller member.

8. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and

the receiving portions rearward thereof considering the direction of rotation, sealing means at the point of sliding contact between the sleeve and the casing wall at one of said fixed points of tangency, an annulus of sealing composition wrapped around said hub and providing sealing means at the point of combined sliding and rolling contact at the other fixed point of tangency, means for supplying fluid to and venting it from said respective portions of the chambers, and means for driving said impeller member.

9. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, said annular sleeve being hollow providing an annular chamber, said chamber opening toward the forward face of the vane to receive fluid from said discharge portions, and an opening in one end of said sleeve for discharging fluid from said annular chamber axially outwardly of the working chamber, and means for driving said impeller member.

10. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, said annular sleeve being hollow providing an annular chamber, said chamber opening toward the forward face of the vane to receive fluid from said discharge portions, an exhaust chamber disposed at one end of said working chamber, one end of said sleeve projecting through a slot in the casing communicating with said exhaust chamber, and a plurality of openings in said end of the sleeve for discharging fluid into said exhaust chamber, and means for driving said impeller.

11. The pump according to claim 9 in which there is provided a radially projecting helically formed blade in said annular chamber functioning as a screw conveyor for transferring the fluid endwise thereof and through said discharge openings.

12. The pump according to claim 10 in which a series of vanes are provided on said end of the sleeve for swirling the fluid as it is discharged into said exhaust chamber.

13. The pump according to claim 10 in which said exhaust chamber is of expanding volume toward a tangential outlet, and a series of vanes are provided on said end of said sleeve for swirling the fluid as it is discharged into said exhaust chamber and attaining a final centrifugal pumping effect.

14. The pump according to claim 10 in which there is provided a radially projecting helically formed blade in said annular chamber functioning as a screw conveyor for transferring the fluid endwise thereof and through said discharge opening, and wherein said exhaust chamber is of expanding volume toward a tangential outlet, and a series of vanes is provided on said end of the sleeve for swirling the fluid as it is discharged into said exhaust chamber and attaining a final centrifugal pumping effect.

15. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the

receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, said annular sleeve being hollow providing an annular chamber, said chamber opening toward the forward face of the vane to receive fluid from said discharge portions, an exhaust chamber disposed at one end of said working chamber, one end of said sleeve projecting through a slot in the casing communicating with said exhaust chamber, and a plurality of orifices opening radially outwardly at said end of the sleeve for discharging fluid into said exhaust chamber and setting up a swirl therein, a tangential outlet for said exhaust chamber, and means for driving said impeller.

16. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, a pin and slot pivotal connection between said vane and said sleeve, means for venting fluid from said discharging portions, and means for driving the impeller member.

17. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve cause a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, a groove in the end wall of said vane, a circular opening in the wall of the slot in the sleeve through which the vane passes, a key having a circular part rotatably received within said opening and a squared part slidably received in said groove, said key adapted to take any stresses between the vane and the sleeve thus relieving the portions of said members adjacent said slot from wear.

18. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve cause a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, means for venting fluid from said discharging portions, and means for driving the impeller member, a sealing element extending axially of said working chamber at the point of external tangency of the sleeve with the outer wall of the chamber, and a sealing member between said hub and the internal surface of said sleeve to seal off the successive points of tangency of the hub with said sleeve during their rolling contact.

19. A rotary pump of the class described comprising a casing having a working chamber therein, a cylindrical wall surface therein and an impeller portion having a cylindrical surface, the wall and impeller portion being of different diameters, mounted eccentrically with respect to each other, and said surfaces being tangent to each other and in rolling contact, the line of tangency bounding two fluid chambers under different pressures, a sealing member covering one of said surfaces, and means admitting high pressure fluid behind said sealing member to aid in maintaining the seal.

20. A rotary pump of the class described comprising a casing having a working chamber therein, a cylindrical wall surface therein and an impeller portion having a cylindrical surface, the wall and impeller portion being of different diam-

eters, mounted eccentrically with respect to each other, and said surfaces being tangent to each other and in rolling contact, the line of tangency bounding two fluid chambers under different pressures, a sealing member covering one of said surfaces, and means admitting high pressure fluid behind said sealing member to aid in maintaining the seal, a series of circumferentially spaced axially extending slots in the surface to which the sealing member is applied, the sealing member being crimped to form folds inserted in said slots to retain the member in position.

21. A rotary pump of the class described comprising a casing having a working chamber therein, a cylindrical wall surface therein and an impeller portion having a cylindrical surface, the wall and impeller portion being of different diameters, mounted eccentrically with respect to each other, and said surfaces being tangent to each other and in rolling contact, the line of tangency bounding two fluid chambers under different pressures, a sealing member covering one of said surfaces, the sealing member comprising sheet material crimped to form a series of overlapping folds, the construction and arrangement permitting admission of high pressure fluid within and behind said folds, whereby said sealing member is cushioned to better perform its function during the rolling contact of the tangent surfaces.

22. A rotary pump of the class described comprising a casing having a working chamber therein, a cylindrical wall surface therein and an impeller portion having a cylindrical surface, the wall and impeller portion being of different diameters, mounted eccentrically with respect to each other, and said surfaces being tangent to each other and in rolling contact, the line of tangency bounding two fluid chambers under different pressures, a sealing member covering one of said surfaces, and means admitting high pressure fluid behind said sealing member to aid in maintaining the seal, a series of circumferentially spaced axially extending pockets in the surface to which the sealing member is applied, the pockets having restricted mouths, and bights formed in said sealing member and loosely retained in the slots.

23. A rotary pump comprising, in combination, a substantially cylindrical casing, an annular liner ring fixed within said casing and providing a peripheral inner wall for the casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub and rotatably received within annular grooves provided in the end walls of the casing, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, a sealing member carried by said liner ring at the point of sliding contact between the sleeve and the casing wall at one of said fixed points of tangency, means for supplying fluid to and venting it from said respective portions of the chambers, and means for driving said impeller member.

24. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective moving part of the impeller member, said vane passing through a slot in said sleeve, said slot and said vane being provided with interlocking shoulder portions providing a driving connection between them, the outer end of said vane having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, said annular sleeve being hollow providing an annular chamber, said chamber opening toward the forward face of the vane to receive fluid from said discharge portions, and an opening in one end of said sleeve for discharging fluid from said annular chamber axially outwardly of the working chamber, and means for driving said impeller member.

25. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and co-axially therewith, said impeller member comprising a central substantially cylindrical hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, an eccentrically disposed annular sleeve surrounding said impeller hub, said sleeve being internally tangent to said hub and externally tangent to said inner wall of the casing and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axis of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, a radially extending vane carried by said hub and constituting the effective

moving part of the impeller member, said vane passing through a slot in said sleeve with its outer end having a sliding fit with the inner peripheral wall of the casing, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, means for independently supplying fluid to the fluid receiving portions, said annular sleeve being hollow providing an annular chamber, said chamber opening toward the forward face of the vane to receive fluid from said discharge portions, an exhaust chamber disposed at one end of said working chamber, one end of said sleeve projecting through a slot in the casing communicating with said exhaust chamber, and a plurality of openings in said end of the sleeve for discharging fluid into said exhaust chamber, said openings being provided by intervening streamlined curved partitions so constructed and arranged that said openings are directed tangentially and are of an expanding cross section and serve to direct the fluid into said exhaust chamber to create a centrifugal swirl therein, and means for driving said impeller.

26. A rotary pump of the class described, comprising, in combination, a casing containing a substantially cylindrical working chamber, a hollow hub rotatable concentrically of said casing, a hollow cylindrical ring mounted for rotation in said chamber in bearings eccentric to said chamber and said hub, a longitudinally extending slot in said ring, a radially extending vane carried by said hub, projecting through said slot in said ring, and adapted to sweep the inner wall of said chamber during such operation, an opening in the edge of the slot adjacent the forward face of the vane for admitting fluid from the chamber to the interior of said ring, outlet connections leading from said ring, the opposite edge of said slot being imperforate, a concavity in said forward face of the vane, a delivery passageway through said vane leading from said hub and opening through the rearward face of said vane, and means for supplying the hub with a fluid medium.

27. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and coaxially therewith, said impeller member comprising a central substantially cylindrical hollow hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, the hollow interior of said hub providing a fluid transfer chamber, an annular hollow double-walled rotatable sleeve of substantially rectangular longitudinal cross section surrounding said impeller hub and providing a fluid transfer chamber within the hollow interior of the sleeve, longitudinally spaced end walls also bounding said last named fluid transfer chamber, an axially extending rectangular slot in one side of said sleeve, said slot being longitudinally coextensive with the said working space of the pump, a radially extending vane carried by said hub for rotation therewith, said vane being substantially rectangular in cross section, passing through said slot, and of dimensions to have an easy working fit therein, the edges of the outer portion of said vane having a sliding substantially fluid-tight fit with the inner walls of the casing bounding said working space, a radial wall provided on said sleeve at one side of said slot confining the hollow interior at that point, while at the opposite side of the slot a longitudinally elongated opening faces the adjacent side of the vane providing free communication with the hollow interior of said sleeve, the intermediate portion of said last named side of the vane being radially concave for an extent greater than the thickness of said sleeve, thus permitting flow between said sleeve opening and the working space upon either side of the sleeve, the opposite side wall of said vane facing the adjacent confining wall of the sleeve being radially concave for an extent greater than the thickness of said sleeve, and an opening through the radially inward portion of said vane providing communication between the last mentioned concave portion and the interior of the hollow hub from which the vane extends, thereby permitting flow between the interior of said hollow hub and the working space on either side of the sleeve, means for furnishing fluid to and receiving it from said fluid transfer chambers.

28. A rotary pump comprising, in combination, a substantially cylindrical casing, an impeller member rotatably mounted within said casing and coaxially therewith, said impeller member comprising a central substantially cylindrical hollow hub forming a substantially annular working space of uniform radius between the hub and the inner circumferential wall of said casing, the hollow interior of said hub providing a fluid transfer chamber, an annular hollow double-walled rotatable sleeve of substantially rectangular longitudinal cross section eccentrically surrounding said impeller hub and providing a fluid transfer chamber within the hollow interior of the sleeve, longitudinally spaced end walls also bounding said last named fluid transfer chamber, means rotatably mounting said sleeve so that it is internally tangent to said hub and externally tangent to said inner wall of the casing, and free to rotate about its own center with the points of tangency substantially fixed at diametrically opposite sides of the axes of the casing, whereby said working space is divided into two chambers the cross sections of which comprise complementary oppositely facing interlocking lunes, an axially extending rectangular slot in one side of said sleeve, said slot being longitudinally coextensive with the said working space of the pump, a radially extending vane carried by said hub for rotation therewith, said vane being substantially rectangular in cross section, passing through said slot, and of dimensions to have an easy working fit therein, the edges of the outer portion of said vane having a sliding substantially fluid-tight fit with the inner walls of the casing bounding said working space, whereby the rotation of the impeller member and the sleeve causes a progressive and alternate division of the respective lune-shaped chambers into successively waxing and waning fluid receiving and fluid discharging portions, the discharging portions in the case of both chambers being in advance of said vane and the receiving portions rearward thereof considering the direction of rotation, a radial wall provided on said sleeve at one side of said slot confining the hollow interior at said point, while at the opposite side of the slot a longitudinally elongated opening faces the adjacent side of the vane providing free communication with the hollow interior of said sleeve, the intermediate portion of said last named side of the vane being radially concave for an extent greater than the thickness of said sleeve, thus permitting flow be-

tween said sleeve opening and the fluid receiving and discharging sections of the lune-shaped chambers upon either side of the sleeve, the opposite side wall of said vane facing the adjacent confining wall of the sleeve being radially concave for an extent greater than the thickness of said sleeve, and an opening through the radially inward portion of said vane providing communication between the last named concavity and the interior of the hollow hub from which the vane extends, thereby permitting flow between the interior of said hollow hub and the fluid receiving and discharging sections of the lune-shaped chambers on either side of the sleeve, means for furnishing fluid to and receiving it from said fluid transfer chambers.

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