

Jan. 8, 1963

H. R. BELLER
ROTARY PUMP

3,072,067

Filed Dec. 22, 1959

3 Sheets-Sheet 1

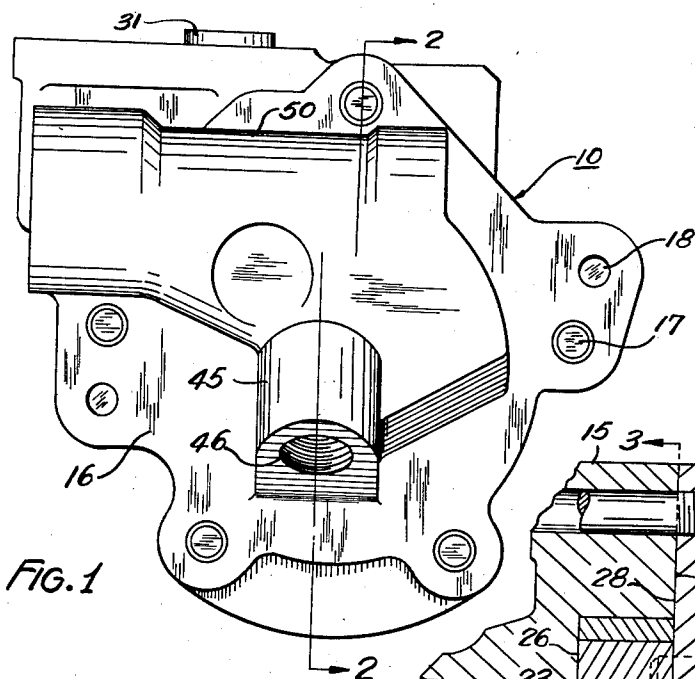


FIG. 1

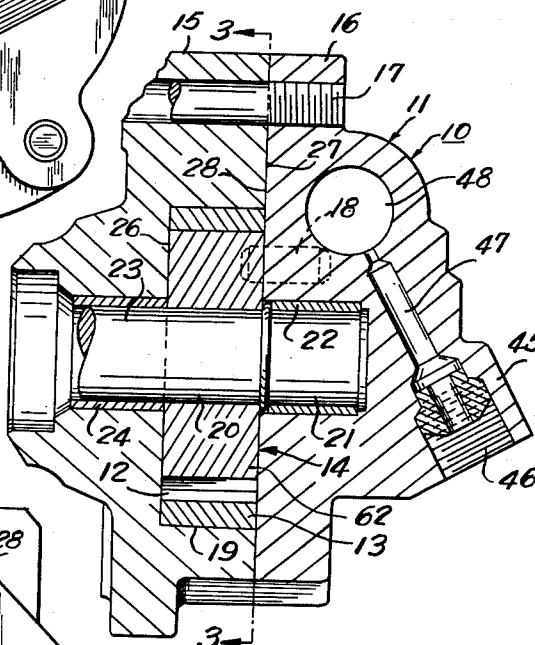


FIG. 2

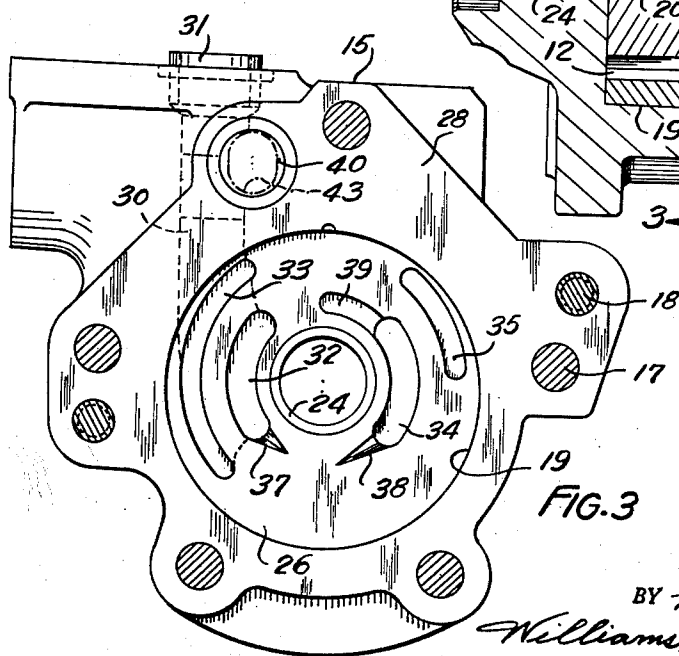


FIG. 3

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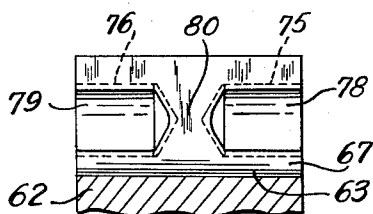
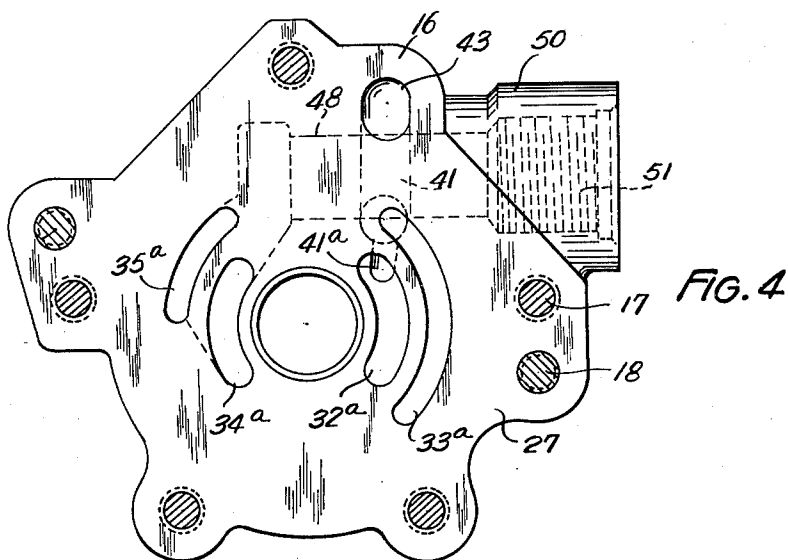


FIG. 8

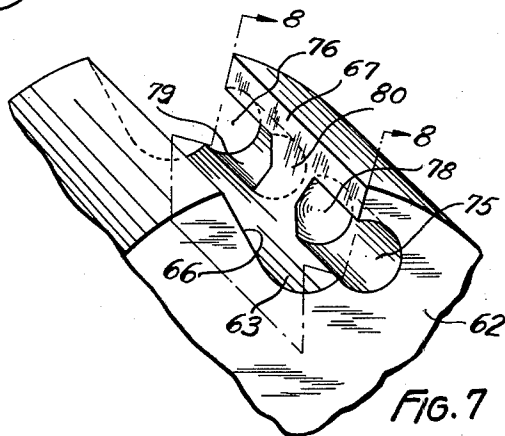


FIG. 7

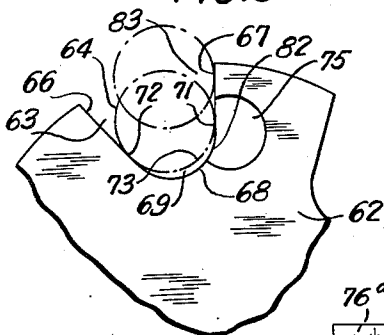


FIG. 9

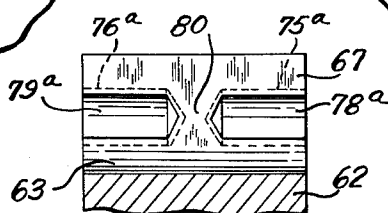


FIG. 10

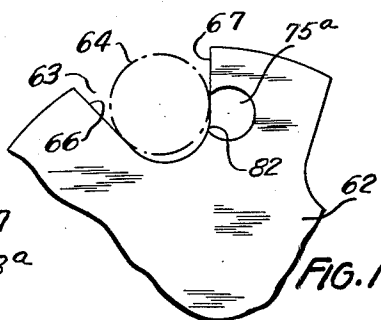


FIG. 11

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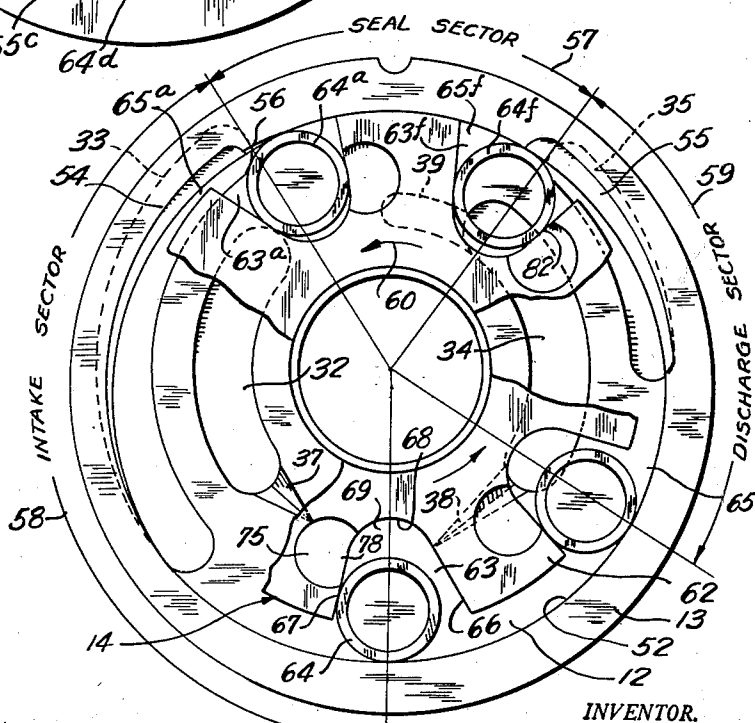
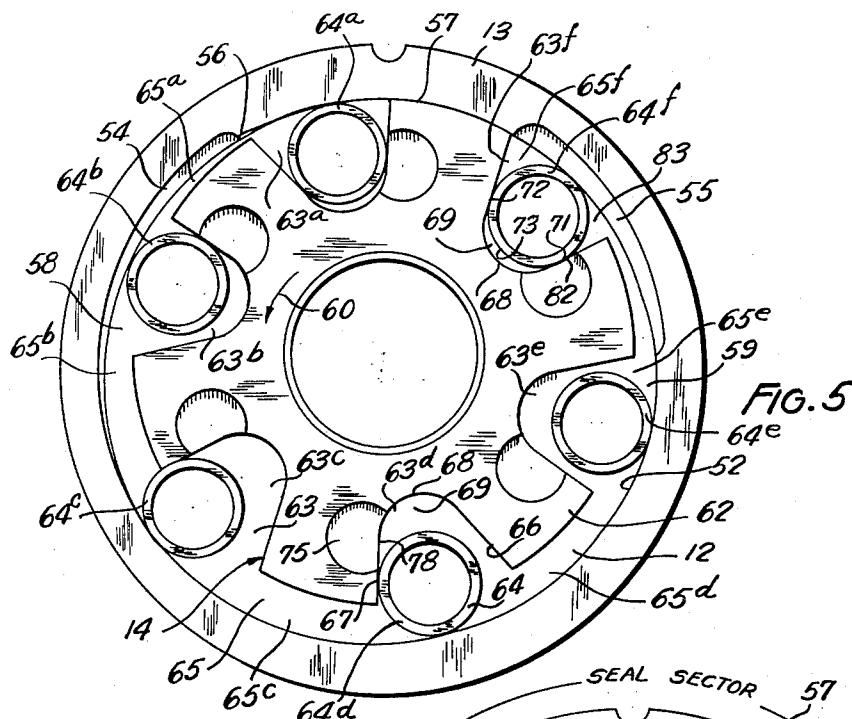


FIG. 6

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3,072,067

ROTARY PUMP

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4 Claims. (Cl. 103-136)

This invention relates to rotary pumps of the kind comprising a rotor operable in a work chamber and provided with annularly spaced slots and with pumping elements shiftable in the slots and co-operable with the peripheral wall of the chamber.

In rotary pumps of this kind, and particularly in such pumps where the shiftable pumping elements are rollers, various problems have been encountered including the problem of noise resulting from fluid sounds and from mechanical bumping of the rollers against adjacent portions of the pump structure, as well as the problem of fluid flow within the pump when the fluid being handled is a viscous one. The present invention provides a novel rotary pump construction in which these problems have been successfully overcome and by which a quiet and efficient pumping action, with good operating characteristics and stability for the rollers, is achieved and renders the pump highly satisfactory and practical for operation at both high and low speeds and for delivering fluid at both high and low discharge pressures, throughout the expected viscosity range for the fluid being handled.

An object of the invention is to provide a novel rotary pump having the characteristics and purposes indicated above and wherein passage means located in trailing wall portions of the rotor body and continuously in communication with the bottom portions of the slots facilitate flow of fluid internally of the pump by which the quieter pumping operation and better stability of the pumping elements or rollers are achieved.

Another object is to provide a novel rotary pump of the character referred to above wherein the passage means located in the trailing wall portions comprises recess means in the form of recesses extending into the rotor body from at least one end thereof and connected with the respective slots by openings or interruptions in such trailing wall portions.

Still another object is to provide such a novel rotary pump wherein the recess means of the rotor body comprise a pair of recesses adjacent each slot and extending into the associated trailing wall portion from opposite ends of the rotor body and the adjacent ends of which recesses are in a spaced relation for engagement of the pumping element or roller of the slot with the wall portion located between such adjacent ends.

Additionally, this invention provides such a novel rotary pump wherein said recess means and the opening means connecting the same with the slots are located in the rotor so as to form passage means which facilitates flow of fluid, particularly viscous fluid, into the pumping chambers in the intake portion of the pumping cycle and also form passage means extending past the pumping elements or rollers in the discharge portion of the pumping cycle.

Other objects and advantages of this invention will be apparent in the following detailed description and in the accompanying drawings forming a part of this specification and in which,

FIG. 1 is an outside elevation of a rotary pump embodying this invention, the pump being viewed from the cover side of the housing thereof;

FIG. 2 is a vertical axial section taken through the pump on section line 2—2 of FIG. 1;

FIG. 3 is an inside elevation of the body member of the pump housing when viewed as indicated by the direc-

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tional line 3—3 of FIG. 2 and with the rotor means and cam ring omitted;

FIG. 4 is an elevation of the inner side of the cover member of the housing;

FIG. 5 is an end elevation of the rotor means and cam ring and showing the same apart from the pump housing;

FIG. 6 is an end elevation similar to that of FIG. 5 but of a diagrammatic form and illustrating the operation of the rotor means in relation to the intake and discharge ports of the housing;

FIG. 7 is a fragmentary perspective view of the rotor body at the location of one of the slots thereof;

FIG. 8 is mainly an elevational view of one of the trailing wall portions of the rotor body, the view being taken as indicated by the directional line 8—8 of FIG. 7;

FIG. 9 is a diagrammatic view showing the location of certain passage means relative to the adjacent rotor slot;

FIG. 10 is a view similar to that of FIG. 8 but showing the recess means of the trailing wall portion as having a different size relation; and

FIG. 11 is an illustrative diagram similar to that of FIG. 9 but applying to the recess means of FIG. 10.

As representing a practical and preferred embodiment of this invention the accompanying drawings show the rotary pump 10 as comprising, in general, a housing 11 containing a work chamber 12 surrounded by a cam ring 13, and a rotor means 14 operable in the work chamber for performing a desired cycle of pumping operation.

The housing 11 is of a suitable construction and is here shown as consisting of connected housing sections comprising a housing body or body member 15 and a cover member 16 connected therewith as by means of bolts or screws 17 and locating dowels 18. The body member 15 is provided with a cylindrical recess 19 extending thereto from a flat clamping surface 28 and in which the cam ring 13 is disposed so as to provide the above-mentioned work chamber 12. The rotor means 14 is supported and rotatably driven by a suitable shaft 20 having its inner end portion 21 journaled in a bushing 22 of the cover member 16, and its other end portion 23 projecting from the body member 15 and journaled in a bushing 24 of the latter. As shown in FIG. 2, the inner end wall 26 of the recess 19 forms one side wall of the work chamber 12 and a portion of the flat face 27 of the cover member 16 forms the other side wall of the work chamber.

As is best illustrated in FIG. 3, the body member 15 has an intake passage 30 extending thereto and which is adapted to be connected with a fluid supply conduit or the like by means of a tubular fitting or bushing 31 projecting from this housing member. The inner end of the intake passage 30 communicates with a pair of arcuately extending inner and outer intake ports 32 and 33 formed in the wall 26 of this housing member. The body member 15 is also provided with a pair of arcuately extending inner and outer discharge ports 34 and 35 located on the opposite side of the rotation axis and likewise formed in the wall 26.

The wall 26 of the housing member 15 also has intake and discharge grooves 37 and 38 formed therein and an extension groove 39. The intake groove 37 forms an extension of tapering cross-sectional area of the intake port 32 and is located at the tail or departure end of the latter. The discharge groove 38 is likewise a groove of tapering cross-sectional area and is located at the approach end of the discharge port 34. The extension groove 39 is formed as a recess in the wall 26 and is located at the tail or departure end of the discharge port 34. The functions of all of the ports and grooves described just above will be explained hereinafter.

The housing member 15 is also provided with an axial intake passage extension or transfer passage 40 which communicates with the intake passage 30 and opens through the flat clamping surface 28, as shown in FIG. 3. The passage 40 connects the intake passage 30 with passages and ports of the cover member 16 which will be described next.

The cover member 16, as shown in FIG. 4, is provided with a pair of arcuately extending inner and outer intake ports 32^a and 33^a which correspond in size and location with the intake ports 32 and 33 of the body member 15 and lie in an axially opposed relation to the latter ports. The cover member 16 is also provided with a pair of inner and outer discharge ports 34^a and 35^a of a size and shape similar to the intake ports 34 and 35 and which lie in an axially opposed relation to the latter ports. The intake ports 32^a and 33^a are connected with an intake passage 41 which is provided in the cover member 16 in such location that its inlet end 43 is formed by an opening in the clamping surface 27 and lies opposite to and communicates with the passage 40 of the housing member 15 when the cover member is clamped against the latter. The portion of the passage 41 with which the intake port 32^a is connected is here shown as being an extension portion 41^a.

The cover member 16 is also provided with a boss 45 containing a discharge passage 46 with which a delivery conduit or the like can be connected. The discharge passage 46 is connected with the discharge ports 34^a and 35^a through a connecting passage 47 and through a portion of a valve chamber 48. The intake ports 32^a and 33^a also communicate with the valve chamber 48 through a portion of the intake passage 41.

As shown in FIGS. 1 and 4, the valve chamber 48 is formed in a projection 50 of the cover member 16 and connects the pair of discharge ports 34^a, 35^a with the pair of intake ports 32^a and 33^a for bypassing pumped fluid from the former ports or discharge side of the pump to the latter ports or intake side of the pump. Suitable valve means (not shown) is provided in the valve chamber for controlling such bypassing of pumped fluid. The valve chamber 48 is closed at its outer end by a suitable plug or closure means 51.

The cam ring 13 has a cylindrical exterior shape for seating in the recess 19 of the body member 15 and the inner periphery thereof forms the peripheral wall 52 of the work chamber 12. The peripheral wall 52 can be of a circular shape or if desired can have a generated shape, depending upon the functional performance desired for the pump 10 during the cycle of operation thereof.

The cam ring 13 is also provided with arcuate grooves 54 and 55 in the peripheral wall 52 thereof and which lie respectively adjacent the groups of intake and discharge ports. The groove 54 forms an intake transfer groove and the groove 55 forms a discharge transfer groove. The functions of the grooves 54 and 55 will be explained hereinafter. The cam ring 13 additionally has a tapered seal groove 56 therein at the approach end of the transfer groove 54.

The shaft 20 supports the rotor means 14 in an eccentric position in the work chamber 12, as shown in FIG. 5, with the periphery of the rotor means in a sealing tangential engagement with the peripheral wall 52 along a sealing sector portion 57 thereof. The rotor means accordingly divides the work chamber 12 into an intake sector portion 58 lying on one side of the sealing sector 57 and containing the pairs of intake ports 32, 33 and 32^a, 33^a, and a discharge sector portion 59 lying on the opposite side of the sealing sector 57 and containing the pairs of discharge ports 34, 35 and 34^a, 35^a. The direction of rotation of the rotor means 14 is counterclockwise as indicated by the directional arrows 60 of FIGS. 5 and 6.

The rotor means 14 comprises a cylindrical rotor body

62 having a group of annularly spaced axially transverse slots 63 in the periphery thereof and pumping elements 64 shiftably received in such slots. The pumping elements 64 are here shown as being rollers, preferably hollow rollers, of an axial length substantially equal to the axial width of the rotor body 62 and are rollably engageable with the peripheral wall 52 of the cam ring 13 during the rotation of the rotor means 14.

The rollers 64 divide the crescent-shaped space of the work chamber 12 into pumping chambers 65 each of which lies in an advance position ahead of its associated roller and includes the associated slot 63. During the rotation of the rotor means 14 in the work chamber 12 the pumping chambers 65 move in a counterclockwise direction away from the sealing sector 57 and, as they traverse the intake sector portion 58, they are in communication with the pairs of intake ports 32, 33 and 32^a and 33^a and receive fluid from the latter. As the pumping chambers 65 move toward the sealing sector 57 and traverse the discharge sector portion 59, they communicate with the pairs of discharge ports 34, 35 and 34^a and 35^a for the delivery of pumped fluid through the discharge passage 46.

The slots 63 of the rotor body 62 are so formed that they have leading wall portions and trailing wall portions 66 and 67 on the leading and trailing sides thereof and which wall portions are connected at the bottom of the slot by a bottom wall portion 68. The portion of each slot lying adjacent the bottom wall portion 68 thereof can be referred to as a pocket portion 69 of the associated pumping chamber 65. The leading and trailing wall portions 66 and 67 are flat wall portions having a radially outward diverging relation and one of these wall portions, in this case the trailing wall portion 67, is shown as lying in a radial plane passing through the rotation axis of the rotor means.

The pump 10 is here shown as being provided with six of the rotor slots 63 and with an equal number of rollers 64 and pumping chambers 65. For purposes of identification and convenience of description, the pumping chambers are designated in the counterclockwise order in which they appear in FIG. 5 by the reference numerals 65^a, 65^b, 65^c, 65^d, 65^e and 65^f. The slots are designated in a similar order by the reference numerals 63^a, 63^b, 63^c, 63^d, 63^e and 63^f. The rollers of the respective slots are designated by the reference numerals 64^a, 64^b, 64^c, 64^d, 64^e and 64^f.

The rollers 64 are of a size in relation to the slot 63 that they will be freely shiftable therein and will rollably engage the peripheral wall 52 under the influence of centrifugal force and of the pressure of the fluid in the pumping chambers. The rollers 64 are also movable to a retracted position in their respective slots as they reach and traverse the sealing sector portion 57, and in which retracted position the rollers 64^a and 64^f are shown in FIG. 5.

During the rotation of the rotor means 14, the rollers 64 are also in engagement with and pushed by the trailing wall portions 67 of the slots 63 although at times during the cycle of pumping operation the rollers may, in succession, separate from their associated trailing wall portions under the influence of fluid pressure and fluid flow in the pumping chambers, as is represented for the roller 64^e in FIG. 5.

When the rollers 64 are in the retracted position in their respective slots 63 as represented by the positions of the rollers 64^f and 64^a in FIG. 5, opposed peripheral portions 71 and 72 of these rollers are then in engagement with the leading and trailing wall portions 66 and 67 respectively and the bottom portion 73 of the retracted roller is spaced from the bottom wall portion 68 of the slot to define therebetween the above-mentioned pocket portion 69.

As an important feature of the pump 10, the rotor body 62 is provided with recess means and opening means,

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located adjacent the slots 63 and having an important purpose in the operation of the pump and which recess means and opening means will be described next. This recess means comprises a pair of recesses 75 and 76 for each slot 63, and the opening means comprises a pair of openings 78 and 79 for each slot and which openings are communication openings connecting the recesses with their associated slot. The recesses 75 and 76 of the associated communication openings 78 and 79 have the same form and location for each of the slots 63, and consequently, the recesses and communication openings need be described in detail for only one slot.

The recesses 75 and 76 are formed in the trailing wall portion 67 of the slot 63 and extend axially into the rotor body 62 from the opposite ends thereof and lie in a substantially axially aligned relation. The recesses 75 and 76 are here shown as being cylindrical openings or bores formed in the rotor body and have their adjacent inner ends in a spaced-apart relation so that a portion of the trailing wall portion 67 remaining therebetween forms an abutment portion 80 engageable by the associated roller 64.

The recesses 75 and 76 are so formed that they intersect the trailing wall portion 67 and the interruptions thus formed in the latter constitute the communication openings 78 and 79. The recesses 75 and 76 are of a cross-sectional size or diameter, and are located at a radial distance from the rotation axis of the rotor means 14, so that they are continuously in communication with the associated slots 63 at or adjacent the pocket portions 69 thereof throughout the operating cycle of the pump. The location of the recesses 75 and 76 is also such that, when the rollers are in their retracted position explained above with reference to the rollers 64^f and 64^a, these recesses and their associated communication openings 78 and 79 will form fluid passages extending past the associated roller and connecting the pocket portion 69 with the portion of the slot lying adjacent the opposite or outer side of the roller. The recesses and the associated communication openings for the slots 65^f and 65^a are shown in FIG. 5 as forming such connecting passages 82 extending past or partially around the rollers 64 and 64^a, that is, in a bypass relation to these rollers on the trailing side thereof and on axially opposite sides of the abutment portion 80.

The cycle of operation of the pump 10 will now be described by referring particularly to FIGS. 5 and 6 of the drawings. During the counterclockwise rotation of the rotor means 14 from the position thereof shown in FIG. 5 and as indicated by the arrow 60, the pumping chambers 65^a and 65^b travel along the intake sector portion 58 of their rotational path and since they are then in communication with the pairs of intake ports 32, 32^a and 33, 33^a, they will be supplied with fluid through these ports. The transfer groove 54 and the seal groove 56 will assist in distributing the fluid to these pumping chambers during the enlargement and filling thereof.

As the slots 63 move along the past the tapered intake groove 37 in succession, the communication between the pumping chambers and the intake port 32 will be gradually cut off. During the subsequent forward movement of the pumping chambers, they will arrive in succession at the discharge groove 38 by which they will be gradually placed in communication with the discharge port 34. As the pumping chambers 65 advance through the discharge sector portion 59 of their travel, the peripheral wall 52 of the cam ring 13 will force the rollers 64 inwardly of their slots 63 thereby displacing fluid, under discharge pressure and as pumped fluid, through the discharge ports 34, 35 and 34^a, 35^a for delivery through the discharge passage 46. The transfer port 55 of the cam ring 13 facilitates the flow of pressure fluid from the pumping chambers into the discharge ports 35 and 35^a. As the pumping chambers move beyond the discharge ports 34, 35 and 34^a and 35^a they will remain in communication with the

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port 34 through the extension portion 39 thereof so that pumped fluid will continue to be discharged from the slots 63 moving into the sealing sector 57.

The operation of the pump 10 will now be described further and with reference to the recesses 75, 76 and the communication openings 78, 79 of the rotor body 62. As mentioned above, the recesses 75 and 76 are continuously in communication with the associated slot 63 through the openings 78 and 79 of the trailing wall portion 67, and consequently, when the pumping chambers are traversing the intake sector portion 58 of their path of travel, the outer ends of the recesses 75 and 76 will be in communication with the intake ports 32 and 32^a so that intake fluid can pass freely through these recesses and the associated communication openings into the inner or pocket portions 69 of the slots 63.

The auxiliary fluid passages thus provided by the recesses 75, 76 and their communication openings 78, 79 and leading directly into the pocket portions 69 will facilitate filling of these pocket portions with intake fluid, and consequently, there will be less likelihood of inadequate filling or the formation of void spaces in the pocket portions 69 and which would tend to permit the rollers 64 to separate from the peripheral wall 52 of the cam ring 13. This greater facility for the entry of intake fluid into the pocket portions 69 therefore results in more prompt and complete filling of the pump chambers 63, particularly when the fluid being handled is a viscous fluid, and in greater stability for the rollers 64 by which they are better maintained in a co-operative rollable engagement with the peripheral wall 52. Because of these advantages for the auxiliary fluid passages formed by the recesses 75, 76 and the communication openings 78, 79 in facilitating the filling of the pumping chambers 65 and in achieving a greater operating stability for the rollers 64, they accomplish an extremely important purpose in producing a quieter and smoother operation of the pump.

As the outer ends of the recesses 75 and 76 move out of communication with the intake ports 32, 32^a and the intake groove 37, the intake function of these auxiliary fluid passages is terminated but as the slots 63 traverse the discharge sector portion 59 of their travel, the outer ends of the recesses 75 and 76 are in communication with the discharge ports 34 and 34^a, and assist in discharging pumped fluid from the pumping chambers then traversing such discharge sector. Since the outer ends of the recesses 76 will also come into communication in succession with the extension slot 39, they will continue to assist in the delivery of pumped fluid from the pumping chambers and particularly from the pocket portions 69 thereof as the slots advance into the sealing sector 57.

As the slots 63 arrive in succession at the position illustrated in FIG. 5 for the slot 65^f in which the associated roller 64 will be in its retracted position described above, the passages 82 formed by the recesses 75, 76 and their associated communication openings 78, 79 will extend around this retracted roller 64^f as somewhat of a bypass passage and will connect the pocket portion 69 with the outer slot portion 83, and consequently, will place the pocket portion 69 in better communication with the discharge means and will tend to cause equalization of fluid pressures on the inner and outer opposite sides of the retracted roller.

Because of the provision of such connecting or bypass passages by the recesses 75, 76 and the communication openings 78, 79 for the retracted roller, a greater operating stability for the roller will again be achieved as well as a greater facility for the escape of fluid from the pocket portion 69 of the slot as each slot moves into the sealing sector 57. Because of these functions there will be little or no tendency for the roller to pump or chatter against the cam ring 13 or for the occurrence of fluid noises, and consequently, a smoother and quieter functioning of the pump will be achieved.

When a roller is in the retracted position shown for

the rollers 64¹ and 64^a, it will be in tangential engagement with the abutment wall portion 80 of the trailing wall portion 67 and will be prevented by such abutment portion from dropping into, and unduly restricting, the communication openings 78 and 79. The engagement of the roller with the abutment portion 80 also enables the roller to always move along a flat surface portion of the trailing wall portion 67 during the radial shifting of the roller in its slot.

The recesses 75, 76 and the communication openings 78, 79 can be of any appropriate size and shape for accomplishing the purposes explained above and, in FIGS. 7, 8 and 9 of the drawings, the recesses are shown as being cylindrical and of a diameter which does not exceed the radius of the roller 64. In FIGS. 10 and 11 of the drawings the recesses 75^a and 76^a are shown as being of a smaller diameter but a greater axial length than the recesses 75 and 76. Again the diameter of the recesses 75^a and 76^a does not exceed the radius of the roller 64.

From the accompanying drawings and the foregoing detailed description it will now be readily understood that this invention provides a novel rotary pump in which auxiliary passage means employed in the rotor means accomplishes important advantages in the greater facility with which intake and pumped fluids can be handled, and particularly viscous fluids, and by which greater operating stability is achieved for the shiftable pumping elements of the rotor means, and particularly for pumping elements of the roller form, by which a smoother and quieter pumping operation is consistently obtained.

Although the novel rotary pump of this invention has been illustrated and described herein to a somewhat detailed extent, it will be understood, of course, that the invention is not to be regarded as being limited correspondingly in scope but includes all changes and modifications coming within the terms of the claims hereof.

Having described my invention, I claim:

1. In a rotary pump; housing means having end walls and containing a work chamber having a surrounding annular concave peripheral wall; rotor means operable in said work chamber comprising a rotor body having an annular convex peripheral wall and transverse slots extending axially across and interrupting said convex peripheral wall at circumferentially spaced points; pumping elements comprising rollers disposed in said slots and radially shiftable therein; said housing means having a sealing sector and intake and discharge sectors on opposite sides of said sealing sector; said elements having sealing engagement with said concave peripheral wall during rotational operation of said rotor means in said work chamber and dividing said intake sector into intake pumping chambers and said discharge sector into discharge pumping chambers; said rotor body having leading and trailing

wall portions forming walls of said slots on the leading and trailing sides thereof; inlet port means located to communicate with and supply fluid to said intake pumping chambers; discharge port means in the discharge sector for receiving pumped fluid under pressure from said discharge pumping chambers; said trailing wall portions having recesses therein movable past said inlet port means and communicating with the bottom portion of said slots and top trailing portion of said slots for facilitating entry of fluid into the bottom of said slots and intake pumping chambers; said recesses also providing for an exposed area on the trailing sides of said pumping elements for pressure action of the discharge pumping chamber fluid against said elements for producing a forced sealing engagement of said elements against said concave peripheral wall and against the leading wall portions of said slots during movement of said elements through said discharge sector; the forced sealing engagements of said elements with said concave peripheral wall and said leading wall portions being movable into said sealing sector in advance of said recesses for minimizing fluid leakage flow from said discharge sector to said intake sector through said sealing sector.

2. A rotary pump as defined in claim 1 wherein the trailing wall portions of said slots include a flat wall portion associated with each slot, and wherein said rollers are tangentially engageable by their associated flat wall portion.

3. A rotary pump as defined in claim 1 wherein said recesses comprise a pair of substantially axially aligned cylindrical bores extending into the rotor body from opposite ends thereof and whose adjacent ends are spaced apart; the bores adjacent each slot intersecting the associated trailing wall portion to provide communication openings in the latter through which said bores are in communication with the associated slot.

4. A rotary pump as defined in claim 1 wherein said inlet port means are provided in said end walls and lie in said intake sector.

References Cited in the file of this patent

UNITED STATES PATENTS

1,245,691	Deysner	Nov. 6, 1917
1,466,904	Jackson	Sept. 4, 1923
1,580,162	Peterson	Apr. 13, 1926
2,520,724	Jessop	Aug. 29, 1950

FOREIGN PATENTS

220,600	Great Britain	Feb. 26, 1925
121,563	Australia	June 20, 1946
451,747	Canada	Oct. 12, 1948
1,198,698	France	June 15, 1959