Feb. 26, 1963 T. F. THOMPSON 3,078,807

DUAL-ACTION DISPLACEMENT PUMP

Filed Oct. 16, 1958 3 Sheets-Sheet 1

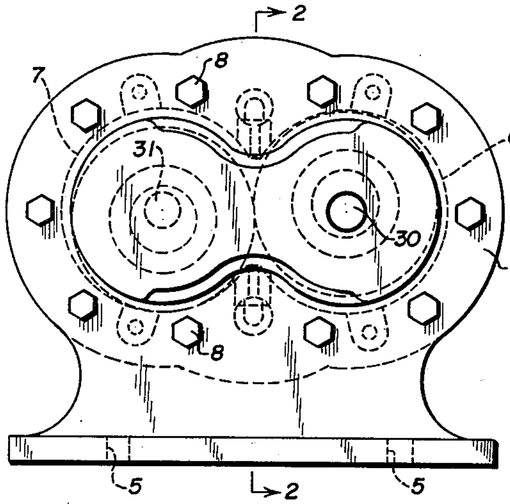

Fig. - 1

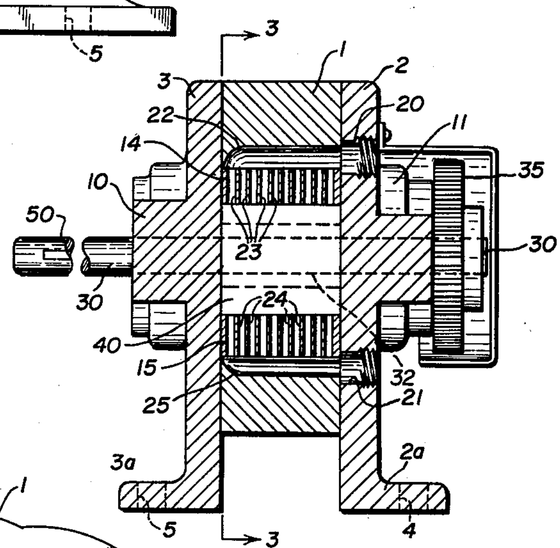

Fig. - 2

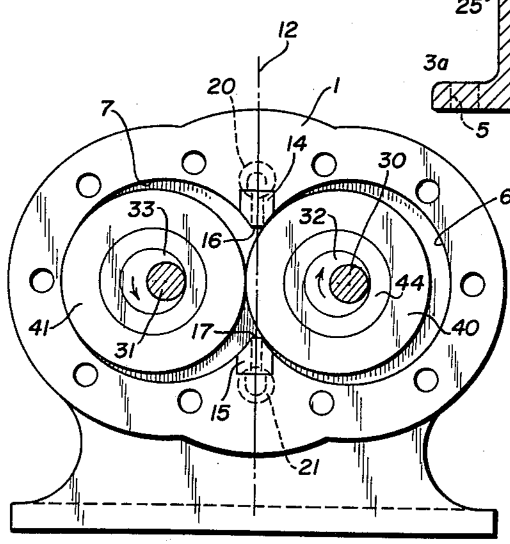

Fig. - 3

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DUAL-ACTION DISPLACEMENT PUMP

Filed Oct. 16, 1958 3 Sheets-Sheet 2

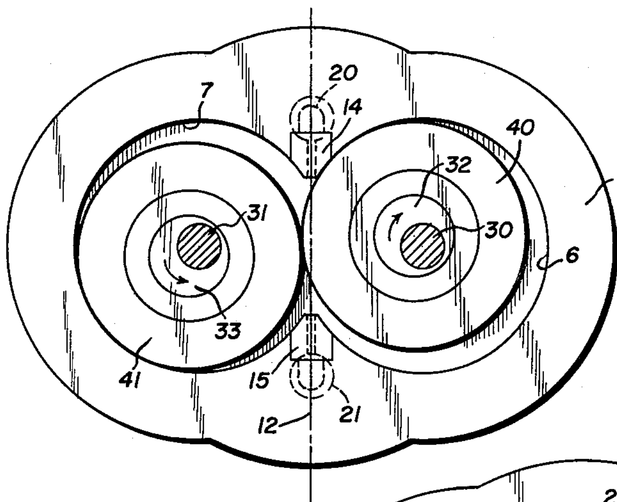
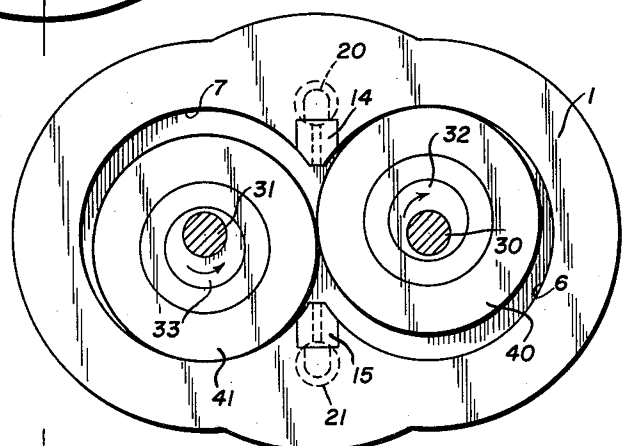


Fig. - 4

Fig. - 5



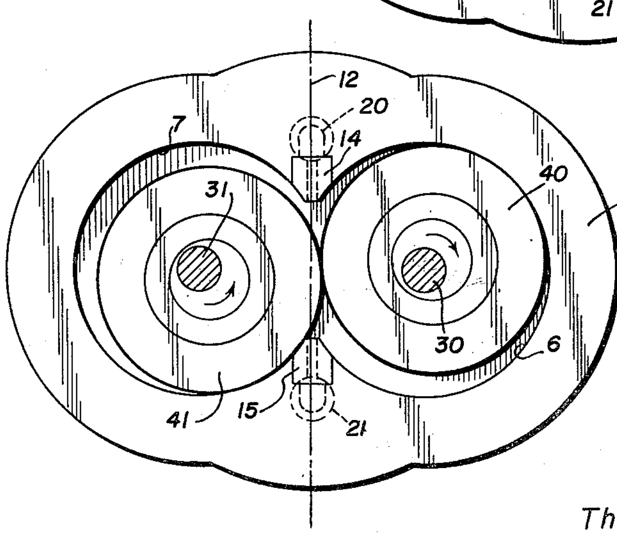


Fig. - 6

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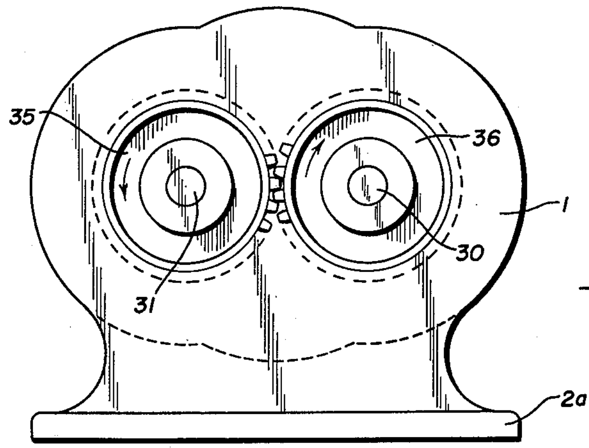

Fig.-7

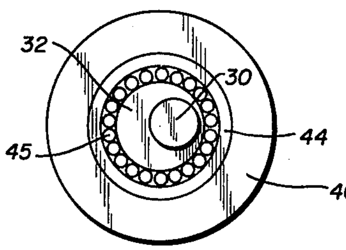

Fig.-8

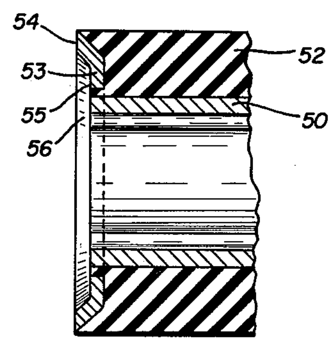

Fig.-9

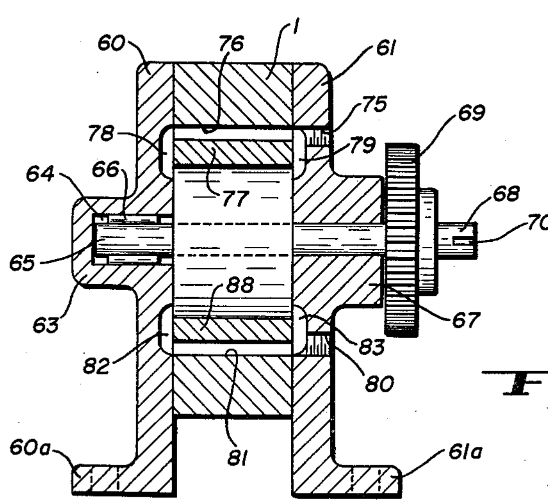

Fig.-10

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DUAL-ACTION DISPLACEMENT PUMP

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2 Claims. (Cl. 103—126)

This invention relates to pumps and more particularly it relates to rotary positive displacement pumps of high capacity and high pressure.

It is an important object of the invention to provide a simplified rotary double displacement pump having a minimum of wear surfaces and a minimum of moving parts.

It is a further object of the invention to provide a double displacement rotary pump of high capacity and capable of producing high pressures with a minimum expenditure of power.

It is a further object of the invention to provide a rotary displacement pump in which two interconnected rotors alternately increase and decrease the pumping volume of interconnected chambers in which they operate, with a minimum of back flow and with a positive fluid displacement so as to provide an essentially non-pulsating pump.

It is another object of the invention to provide a rotary pump in which at least two rotors mounted in the pump operate conjointly, rolling on each other and each rolling on the surface of its enclosing pump chambers with a minimum of slippage.

Another object of the invention is to provide a double rotor, a rotary pump in which the rotors are mounted on eccentric shafts so that once in each revolution each rotor provides a complete seal from the inlet and outlet for its enclosing chamber, and the inlet is sealed from the outlet.

A still further object of the invention is to provide a rotary pump which includes a double rotor arrangement mounted in a housing so that one rotor provides a seal for the opposite roller while both simultaneously displace liquid from the inlet to the outlet in an overlapping discharge whereby to provide a double non-pulsating displacement of fluids through the pump.

These and other objects and advantages of the invention may be readily ascertained by referring to the following description and appended drawings in which:

FIG. 1 is an end elevational view of a pump according to the invention;

FIG. 2 is a cross-sectional view of the pump illustrated in FIG. 1 taken along section line 2—2;

FIG. 3 is a partial sectional view of the pump of the invention illustrating one position of the pump rotors;

FIGS. 4, 5 and 6 are essentially schematic drawings illustrating sequential steps of operation of the pump;

FIG. 7 is an end elevation of a pump of the invention illustrating the gear mounting of dual rotors of the invention;

FIG. 8 is a cross-sectional view of one form of rotor for use in one form of the pump of the invention;

FIG. 9 is a cross-sectional, lengthwise view through a modified roller of the invention; and

FIG. 10 is a cross-sectional view of a pump of the invention illustrating a further modification thereof.

In general, the displacement pump of the invention includes a hollow housing having two essentially cylindrical chambers of equal diameter, overlapped and interconnected in the general shape of a figure eight, with an upper and lower bight on the plane of symmetry. A roller is provided in each chamber, with the diameter of the roller slightly smaller than the diameter of the chamber. The rollers are mounted on eccentric shafts which are positioned and so interconnected that rotation of the shafts maintains the two rollers in continuous engagement with each other and each roller in continuous engagement

with the wall of its enclosing chamber. Each roller is so proportioned as to bridge the gap at the intersection of the two chambers, and the bridging occurs alternately at 180 degrees apart. The rollers are freely rotatably mounted on the eccentric shafts so that each roller, being in contact with the housing, merely rolls on the inner surface of the housing and rolls on each other. This rolling is essentially without slipping due to the fact that each roller is freely rotatable on the shaft and is not rotatably driven. A perfectly smooth housing and roller surface is not essential, the criterion being that the surface of each roller meshes or aligns with and seals against the surface of its chamber and the surface of the opposite roller throughout each revolution. The rollers mounted on the eccentric shafts must be of such a size and the eccentricity must be great enough to move the rollers into and out of the area of chamber overlap to alternately increase and decrease the volume of the space in each chamber. This increase of volume occurs alternately at the inlet and the outlet at essentially 180 degrees of rotation whereby each roller provides suction intake and pressure outlet on a 180 degrees cycle with the cycles of the rollers substantially overlapped to produce a non-pulsating pumping action. Since each roller is of a smaller diameter than the chamber in which it operates, a volume or space remains between the roller and the surface of the chamber. The operation of the eccentric shafts is such as to move the tangential contact of the rollers alternately into and out of the confines of the chambers so that there is an alternate increasing and decreasing volume in the opposite chambers at 180 degrees apart which produces the effective pumping action.

In the pump illustrated in FIGS. 1 through 3 for purposes of detailed description, a hollow housing **1** is provided with end plates **2** and **3** for enclosing intersecting cylindrical chambers **6** and **7**. A foot *2a* mounted on the end plate **2** and the foot *3a* mounted on end plate **3** are arranged to be attached to a base member by means of bolts or the like through holes **4** and **5** in the feet. This arrangement provides means for anchoring the pump in operation position. The end plates are secured to the housing **1** by means of bolts **8** or other suitable means for securing the parts together. The joints between the housing **1** and the end plates **2** and **3** must be tight to provide an essentially fluid tight connection, and for this purpose various sealing mechanisms well known in the art may be used. Also, since this is a high pressure pump, a plurality of bolts are preferably provided around the periphery of the chambers to provide a tight enclosure capable of withstanding the fluid pressures which the pump is capable of producing.

A boss **10** mounted on the end plate **3** and a boss **11** mounted on the end plate **2** provide means for journaling shafts in the pump. The bosses are substantially of figure 8 shape extending across both chambers for supporting the shafts. Each shaft must include a seal, and since this is a common feature for pump shafts, no specific illustration is deemed necessary.

The cylindrical chambers **6** and **7** illustrated in the pump intersect in such a manner as to provide an overlapped area, for example as illustrated in FIGURE 3, the area on either side of a plane **12** passing through the intersection of the two cylindrical chambers. A sealing member **14** is mounted in the upper intersection and extends the length of the chambers, and a sealing member **15** is mounted at the lower intersection and, also, extends the length of the two cylindrical chambers. Each of the sealing members includes a flattened surface at about the intersection which is a predetermined distance between the intersections and in effect cuts off the point of the bight of each intersection. The seal member **14** includes a flattened area **16** while the sealing member **15** includes the flattened area **17** facing the area **16**. An upper port **20** extends through the end plate **2** above and adjacent the intersection of the cylindrical chambers and a passage **22** in the housing body communicates therewith. A plurality of small bores **23** extend through the sealing member **14** through the flattened area **16** and interconnect the passageway **22** with the interior of the pump housing. In a similar manner a passageway **25** in the lower portion of the housing interconnects with the port **21** through the end plate **2** and with a plurality of bores **24** through the sealing member **15** and the area **17**. One of these passages provides an inlet for the pump while the opposite passageway provides an outlet, depending on the rotation of the rotors in the pump.

A shaft **30** is journaled for rotation concentrically with the chamber **6**, and a shaft **31** is journaled concentrically in chamber **7**. An eccentric member **32** is mounted on the shaft **30** for conjoint rotation therewith, and an eccentric member **33** is rigidly mounted on the shaft **31** for conjoint rotation therewith. The shafts **30** and **31** are geared together, by means of gears **35** and **36** mounted on the ends of the shafts which extend through the boss **11**. The shafts rotate in opposite directions and must be so geared together with a minimum of play and the eccentrics must be securely fastened to the shafts so that the zenith of each of the eccentrics is exactly 180 degrees of rotation apart. Furthermore, the shafts are so geared together by spur gears **35** and **36**, FIG. 7, that they rotate in opposite directions at substantially the same speed. A cylindrical rotor **40** is freely, rotatably mounted on the eccentric **32**, and a cylindrical rotor **41** is freely, rotatably mounted on the eccentric **33**. Each rotor is essentially the same length as the housing **1** so that the ends of the rotors seal against the end plates **2** and **3** of the pump.

One form of the rotor is illustrated in FIG. 8 wherein the cylindrical rotor body **44**, which is normally made of a rigid material such as steel or the like, is mounted on roller bearings **45** on the eccentric **32**. This mounting permits the member **44** to freely rotate on the eccentric. The resilient covering **46** is bonded or otherwise secured to the exterior surface of the cylindrical member **44** forming a covering or sheath on the roller. The parts are dimensioned so that the exterior surface of the resilient material **46** is in contact and slightly compressed on the inner surface of the cylindrical chamber **6**. The free rotation of the rotor on the eccentric permits it to roll on the surface essentially without slipping. In a similar manner, the opposite rotor is in contact with the surface of the chamber **7**. The two rotors are in contact and they are compressed so that the two cylinders ride on one another also essentially without slipping and without slippage on the chamber walls. The resilient material covering the roller is slightly compressible at its contact points, and under normal operating conditions there is only an insignificant leakage at such contact points. The compression, also, provides a right frictional engagement between the rotor members which prevents back-leaking from outlet to inlet.

The shaft **30** extends through the boss **11** and provides means for mounting a pulley for driving the pump, including a key way **50** cut in the shaft. Suitable packing and bearings must, of course, be provided to prevent fluid leaking and to provide efficient rotation. Such packing and bearing assemblies may be essentially known types.

The diameter of each rotor is slightly less than the diameter of the chamber in which it is mounted so that there is a space or a volume between the exterior surface of the rotor and the surface of the chamber. This volume represents the volume of displaced liquid moved from the inlet to the outlet of the pump. As explained below, the operation of the pump provides a positive displacement of the fluid from the inlet to the outlet. Both rotors provide the pumping action so the pump, as illustrated, has a dual displacement of fluid for each revolution.

In one very effective size, a pump is provided in which the chambers have 3.89 inch diameter, and the axes of the cylinders are mounted 3.4687 inches apart. This provides an overlap area between the cylinders so that there is in effect a figure 8 chamber in the pump. The cylindrical chambers are provided with parallel axes. The bight at the intersection of the cylinders is fitted with a seal member, as explained above, and bores through the sealing members provide the inlet and the outlet openings for the pump. The housing is 2.27 inches in width, however, the length or the width of the housing may be varied as this measurement determines the capacity of the same diameter pumps. A 0.669 inch shaft is journaled for concentric rotation in each chamber and a one and a quarter inch diameter member is mounted 0.215 inch off center or concentricity forming the eccentric member on the shaft. This provides a throw of 0.215 inch for each rotor. A 3.520 inch external diameter roller or rotor is mounted on roller bearings mounted on each eccentric. The roller is covered with a soft durometer rubber sheath which permits the rollers to be squeezed against the surfaces and against each other. The compression of the rubber sheath is about one-thirty-second of an inch on each side. With the pumps of this dimension and with the shafts operating at about 600 r.p.m. the pump delivers five gallons per minute at about 900 lbs. pressure. Higher pressure and capacity may be achieved by increasing the pump speed.

The operation of the pump is more readily understood by referring to FIGS. 3 through 6 which illustrate various positions of the rollers during movement. It is essential in the consideration of the operation of the pump to note that each eccentric rotates freely in the rollers, and the rollers merely roll around the inner surfaces of the chambers and roll against each other essentially without lost motion between the rollers or between the housing or casing. In FIG. 3 the rollers are shown in the extreme left position or nine o'clock position where the roller **41** is contacting the housing. In this position the roller **40** is also in the nine o'clock position tangentially contacting roller **41**. This leaves a maximum space between the housing and the roller **40**. Also, in this position the roller **40** contacts both sealing member **15** and sealing member **14** completely sealing chamber **6** from the inlet and outlet ports. Rotor **41** on the other hand is not in contact with either sealing member. According to the rotation of the shafts as indicated by the arrows, sealing member **14** is the inlet and the other sealing member **15** is the outlet. In this position the space in chamber **7** adjacent to inlet is increasing in size while the space adjacent to the outlet **15** in the chamber **7** is decreasing.

In the position illustrated in FIG. 4, the shafts have turned 45 degrees in the indicated direction and the rollers also have moved essentially 45 degrees. In this position the roller **40** is still substantially in contact with the inlet sealing member **14**, but it is no longer in contact with sealing member **15**. The volume between the roller **40** and the casing chamber **6** has been opened to the outlet **15**. As the roller **41** has moved 45 degrees downwardly the volume in this chamber adjacent to the outlet has been decreased, thus forcing the liquid out the outlet. Simultaneously, the roller **40** has moved up providing communication for the space in chamber **6** with the outlet. Since that roller **40** has moved around 45 degrees, the space in chamber **6** has been decreased and the pressure created by decreasing volume is now released through the outlet **15**. It is to be noted that the roller **41** was discharging continuously while at some point in the 45 degrees rotation, the movement of roller **40** opened the outlet to the volume of roller **40** providing in effect a continuous discharge without pulsation. Simultaneously with the action at the discharge, the inlet volume of chamber **7** has increased due to the movement of the roller **41**, thereby increasing the suction on the inlet and drawing in more fluid. Since the roller **40** is essentially still in contact with the sealing member **14** during this rotation. The movement of the roller is essentially all discharge.

Further rotation of the shafts, to the position illustated in FIG. 5, where the zenith of the eccentric **33** is vertically downward and the zenith of the eccentric **32** is vertically upward, moves the rollers to a position where the inlet volume of roller **41** and minor inlet volume of **40** substantially equals the outlet volume of roller **40** and the small outlet volume of roller **41**. In this position the tangential contact between the two rollers is substantially along the plane of symmetry **12** through the chambers. Also, in this position the roller **40** is now out of contact with the sealing member **14** and the inlet volume of roller **40** is increasing thereby causing a suction while the inlet volume of roller **41** is approaching maximum due to the movement of the roller **41** upwardly towards the sealing member **14**. The roller **40** is displacing liquid from the space in the chamber toward the outlet **15**, and the roller **41** is completing its discharge.

Further movement of the shafts causes a displacement movement of the rollers to the position indicated in FIG. 6, where the rotor **41** is now in sealing contact with the outlet sealing member **15** and the inlet volume of the chamber **7** is approaching maximum volume. Simultaneously the discharge volume of chamber **6** is decreasing, displacing the fluid through the outlet sealing member **15**. It is to be noted in this position that the rotor **41** has extended to right past the plane of symmetry **12** so that the volume in chamber **6** is approaching its minimum while the volume in chamber **7** is approaching a maximum. Continued rotation of the shafts will move the rotor **41** to the position where it contacts both the sealing members **14** and **15**, completely sealing the chamber **7** from both the inlet and the outlet opening, which is exactly 180 degrees from position as illustrated in FIG. 3. In this position the volume in chamber **7** is at a maximum while the volume in chamber **6** is at a minimum. Further rotation of the shafts continues the displacement of the fluid at the outlet volume from chamber **6** and before it is completely discharged the space of chamber **7** opens up to the outlet forming a continuous discharge. Simultaneously, the inlet volume of chamber **6** opens up prior to the closing of the inlet of **7** forming a continuous inlet.

A modified roller is illustrated in FIG. 9 wherein a roller body **50** is arranged for mounting on the bearing set mounted on the eccentric of the shafts, and the body of the roller **50** is slightly smaller than the width of the housing so that the roller body does not contact the end plates of the pump. A resilient sheath **52** is sealed to the exterior surface of the body **50** and the diameter of the resilient body is slightly larger than the theoretical diameter of the rollers if they exactly fit the housing. This is essentially the same arrangement as the rollers described in FIG. 8 to provide the compression between each roller and its housing and roller on roller to prevent back-leaking of fluid. A metal disc insert **53** is sealed in the rubber with a bearing surface **54** in position to contact the end plates of the pump. The disc **53** may be a steel member having a hardened face **54** or it may be a hardened steel member providing a wearing surface for the roller against the end plates. The wearing face **54** of the disc **53** extends slightly beyond the disc surface **55** forming a shallow recess **56** which may act as a grease ring for holding a body of lubricating grease. The grease also acts as a seal against the end plates of the pump. With the use of the seal ring **53** the distance between the bearing face **54** on the one end and the opposite bearing face on the other seal ring on the other end of the roller may be made slightly larger than the distance between the end plates of the pump, thereby causing the resilient covering to exert a spring like pressure on the disc against the end plate forming a tight seal to prevent leaking and back flow of fluid from the pressure side of the pump.

In the modification illustrated in FIG. 10, a housing **1** is provided with end plates **60** and **61**. The end plate **60** is provided with a foot **60***a*, and the end plate **61** is provided with its foot **61***a* for securing the pump to a base member. In this instance the end plate **60** includes an enclosed boss **63** having a bearing cavity **64** therein for journaling a shaft **65** therein by means of roller bearings **66**. The end plate **60** includes two such bosses, one for each shaft, providing a sealed bearing for each shaft and thereby reducing the possibility of leakage. A boss is provided for the opposite ends of the shafts in end plate **61** to provide a gear mount for both shafts and a drive end **68** on the shaft **65**. Gears **69** are mounted on the shafts to provide conjoint rotation and the shafts, as explained above. The shaft **68** may be provided with a key way **70** for keying a drive pulley thereto.

An additional modification is provided in that the inlet **75** is interconnected with a passage **76** which extends through the housing **1** essentially in the bight between the two chambers. Instead of communicating with bores (as shown in FIG. 2) through the sealing projections **77** and **88** of housing **1**, a bypass or passage way around each of the sealing members is provided. Thus a passage **78** in end plate **60** and a similar passage **79** in end plate **61** provides an inlet. The passages **78** and **79** communicate with the pump interior adjacent to the sealing member **77** and when either roller is in sealing position against the sealing member **77** either or both of the inlet or outlet passages are completely closed from the space in the chamber. In a similar manner an outlet **80** communicates with a passage way **81** in the housing **1**. A passage **82** in the end plate **60** and a passage **83** in end plate **61** provide communication with the interior of the pump around a sealing member **88**. In this manner the inlet end outlet is provided for the pump without requiring the small bores through the sealing members as illustrated for the sealing members **14** and **15**. Such passage ways around the sealing members are satisfactory for short length cylindrical pumps, but as the cylindrical rollers and chambers are elongated it is preferable to have the communication through the sealing member. This provides for a uniform pressure along the length of the rotor, and a greater volume may be passed.

While the invention has been illustrated by reference to specific embodiments, there is no intent to limit the scope or concept to the precise details so set forth, except as defined in the following claims.

I claim:

1. In a positive displacement pump having a housing including a pair of hollow cylindrical chambers of the same diameter partially overlapping along a chord which is substantially less than the maximum diameter of said chambers, and a pair of end walls enclosing the chambers, the improvement which comprises, a rigid cylindrical roller substantially smaller in diameter than its enclosing chamber mounted in each chamber, a shaft concentrically mounted through each chamber, a cylindrical member eccentrically and rigidly secured to each said shaft, a bearing set mounted on each said cylindrical member, one of said rollers mounted on each bearing set so as to be freely rotatable thereon, a resilient material covering of substantial thickness secured to the periphery of each roller, the peripheral diameter of each resilient covering being less than the diameter of the chambers but great enough for one covering to contact both wall ends at the intersection of the chambers and bear against the other roller which is bearing against its chamber's wall at a point of intersection of a line through both shafts and the chamber wall, a sealing member mounted at each intersection of the chambers walls and positioned to seal the resilient covering when the covering is bearing against it, each sealing member including a planar surface perpendicular to a plane through the

intersection of the chambers and the edges of said surfaces providing the seal for each roller, inlet means including a plurality of small bores extending from end wall to end wall across one said surface, outlet means including a plurality of small bores extending from end wall to end wall across the other said surface, a circular gear mounted on each shaft protruding beyond the side wall of the chamber and intermeshed together for conjoint rotation of said shafts, and means for rotating at least one of said shafts.

2. A positive displacement pump according to claim 1, in which each of said small bores of each of said inlet and outlet extends through the seal means and communicates with an inlet and outlet passageway in the pump housing respectively.

References Cited in the file of this patent

UNITED STATES PATENTS

20,796	Holly	July 6, 1858
1,771,863	Schmidt	July 29, 1930
1,837,714	Jaworowski	Dec. 22, 1931
2,103,474	Lindberg	Dec. 28, 1937
2,308,742	Brown	Jan. 19, 1943
2,451,603	Barker	Oct. 19, 1948

FOREIGN PATENTS

333,210	Germany	Feb. 19, 1921
536,786	Germany	Oct. 28, 1930
625,405	Germany	Feb. 8, 1936
696,469	Germany	Sept. 21, 1940