Sept. 24, 1968 E. E. COOK 3,402,672

ROLLER PUMP ASSEMBLY

Filed April 21, 1966 2 Sheets-Sheet 1

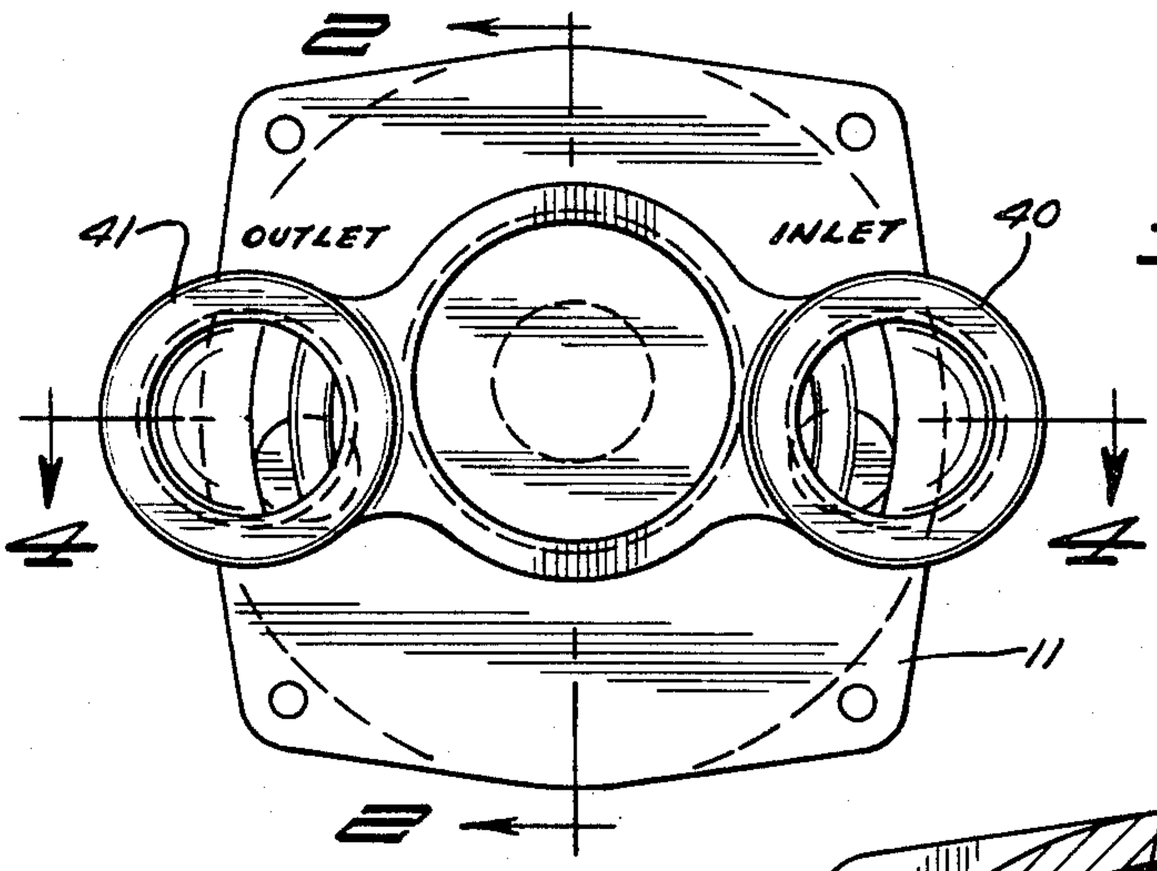


FIG. 1

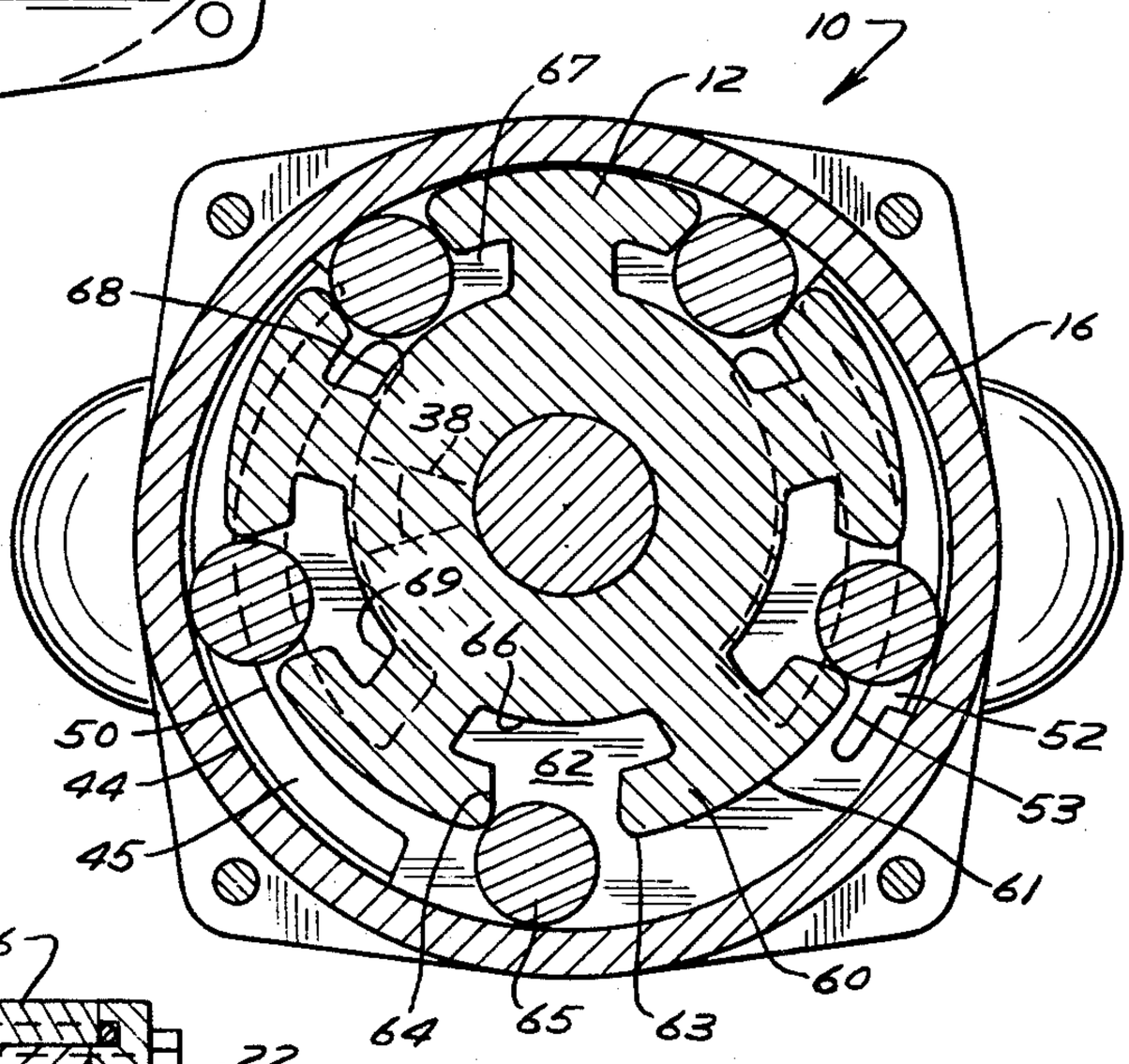


FIG. 3

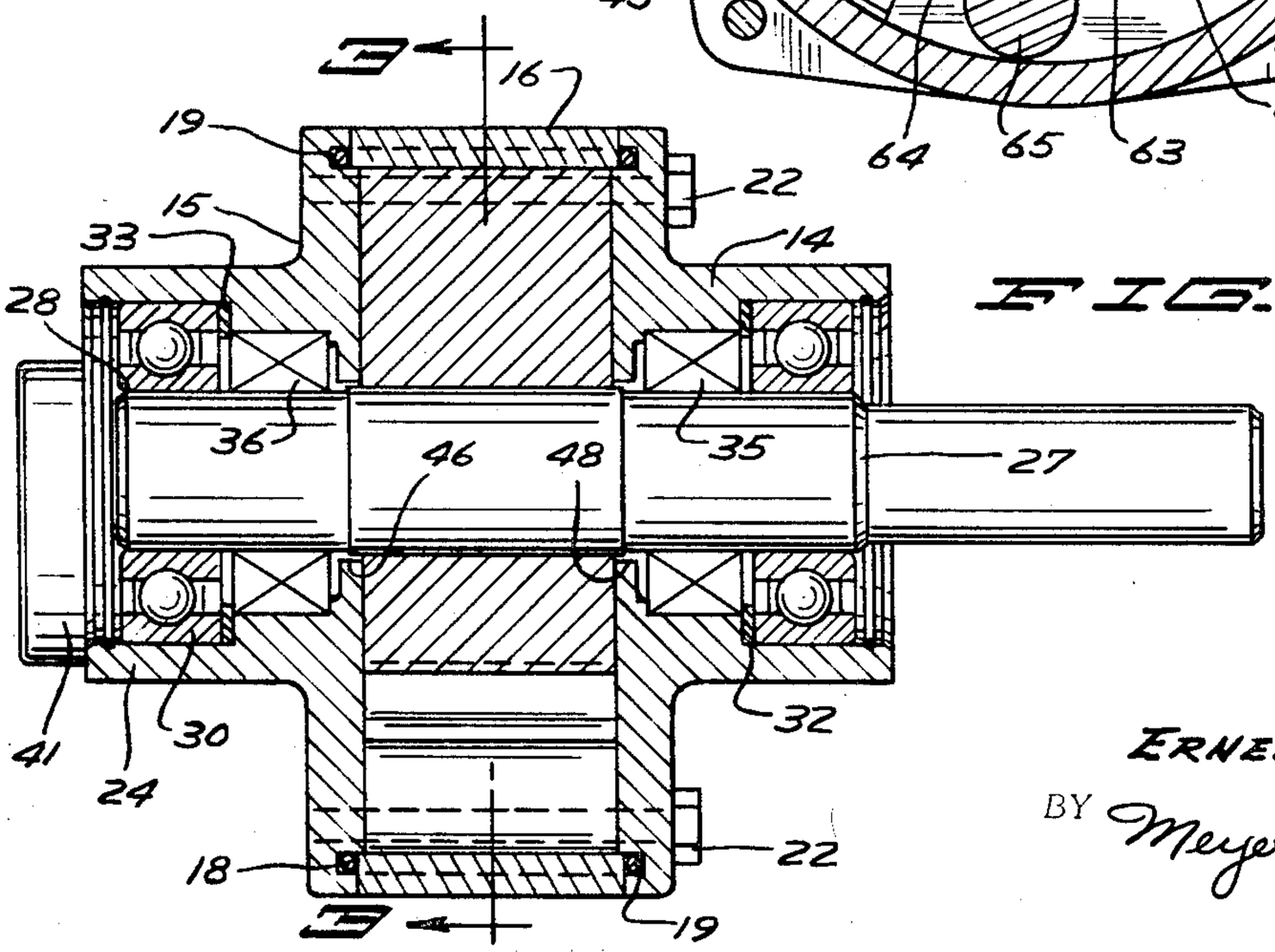


FIG. 2

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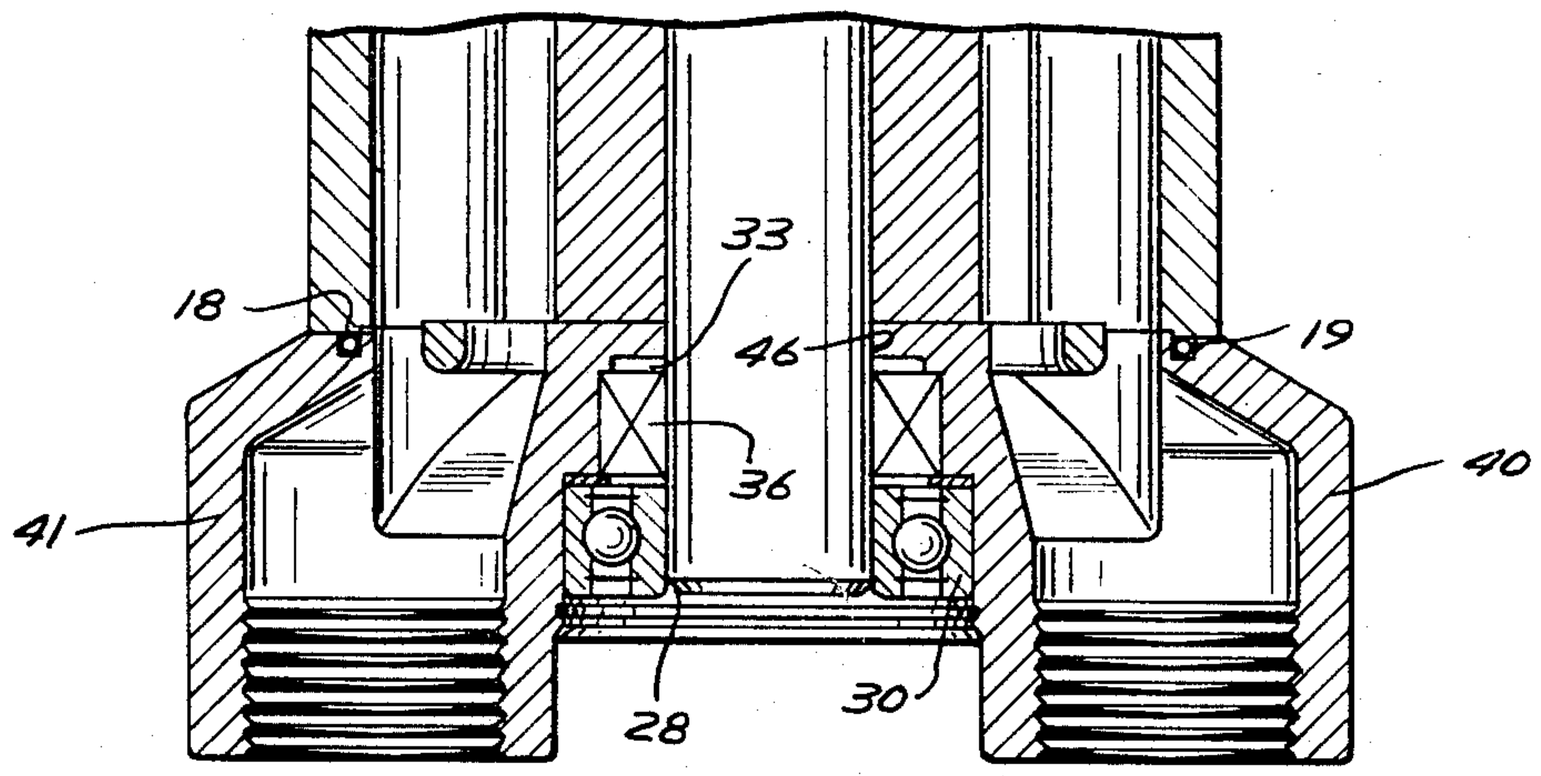


FIG. 4

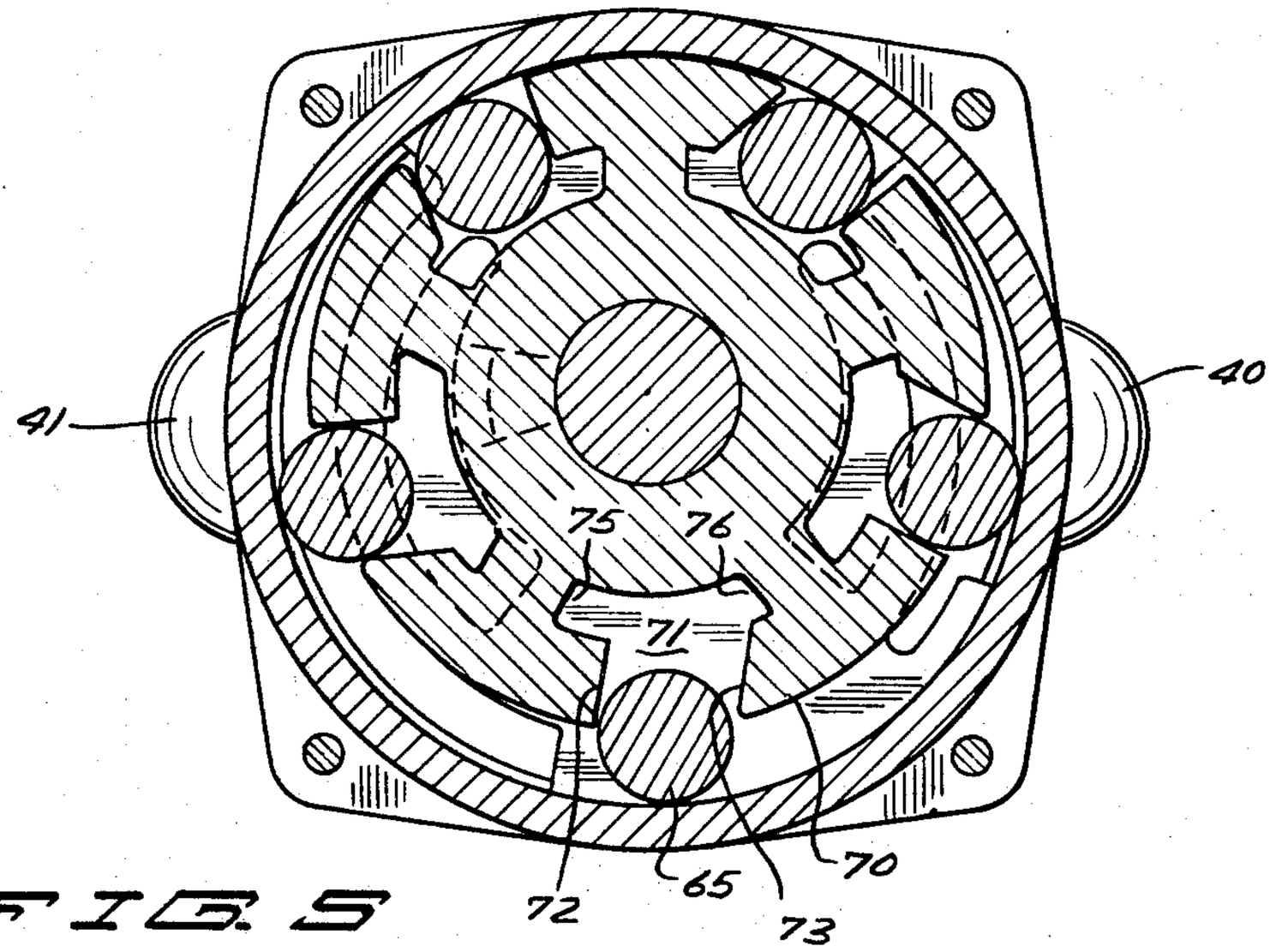


FIG. 5

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ROLLER PUMP ASSEMBLY

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ABSTRACT OF THE DISCLOSURE

A roller pump comprising a cylindrical pumping chamber having a rotor rotatably mounted therewithin, and being provided with a plurality of roller receiving slots, each slot being generally radially disposed within said rotor and having leading and trailing surfaces for controlling the disposition of the roller, each of said slots having an arcuate extension cavity extending across the width of the rotor and defining a fluid reservoir chamber within the slot, the arcuate extension cavity having an arcuate length which substantially exceeds the arcuate width of the individual roller receiving slot.

This invention relates to rotary pumps and more particularly to rotary pumps of the type which employ free-floating roller elements held captive within slots formed in a rotor assembly.

It is an important object of the invention to provide a pump of the class described which has an extremely high capacity for its size, and which is efficient and economical, both in manufacture and in its operation.

It is a further object of this present invention to provide a rotor and roller assemblage which maintains a fluid piston in connection with each of the rollers so as to increase the efficiency of the fluid flow under high speed operating conditions, and which also reduces the noise and wear within the various elements or components of the pump.

Yet a further object of the present invention is to provide a pump assembly which has an enhanced sealing arrangement between the suction side and the pressure side of the pump, so as to increase the efficiency of its operation.

Yet a further object of the present invention is to provide a pump having an operating characteristic such that the individual rollers are maintained in reasonably parallel relationship with the axis of the rotor.

These and other objects and advantages of this invention will more fully appear from the following description, made in accordance with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is an end elevational view of one end of the pump, and showing the inlet and outlet thereof;

FIGURE 2 is a vertical sectional view of the pump shown in FIGURE 1, and taken along the line and in the direction of the arrows **2—2** of FIGURE 1;

FIGURE 3 is a vertical sectional view taken along the line and in the direction of the arrows **3—3** of FIGURE 2;

FIGURE 4 is a view of the inside of the end plate shown in FIGURE 1, and illustrating the arrangement of the inlet and outlet parts of the pump assembly, and taken along the line and in the direction of the arrows **4—4** of FIGURE 1; and

FIGURE 5 is a view similar to FIGURE 3, and showing a rotor of a somewhat modified design.

In accordance with the preferred modification of the present invention, and with particular reference to FIGURES 1–4 of the drawings, it will be seen that the pump generally designated **10** includes a housing portion **11** together with a rotor assemblage **12** journaled therein. The elements are so arranged that the pump is driven from

the right as shown in FIGURE 2, and all of the fluid flow is substantially axial of the rotor and occurs through the porting disclosed to the left as shown in the same view, this flow including both the inlet and outlet. It will be recognized, of course, that the porting may be arranged on opposite end faces of the pump assembly, if desired.

The housing **11** may be conveniently formed from an assembly including a pair of end plates **14** and **15** together with a cylindrical sleeve portion **16** disposed there between. Each of the end plates **14** and **15** is provided with a circumferential groove as indicated at **18**, in order to provide for a reception area for the O-rings designated **19—19**. A cylindrical pumping chamber **20** is defined by the inner circumferential walls of the end plates **14** and **15**, along with the inner surface of the cylindrical sleeve **16**. In order to retain the assembly in proper pre-assembled form, through bolts **22—22** are provided for reception in thru-bores formed in the end plate **14**, and for further reception in the tapped bores in the end plate **15**. The end plates **14** and **15** are further provided with substantially identical boss areas **24** and **25**, each of these bosses having openings there through for receiving the driveshaft and the appropriate bearing members therein. A shaft opening **27** is formed in the end plate **14**, and a complementary shaft receiving area **28** is formed in the end plate **15**, with appropriate bearing assemblies **29** and **30** being disposed in each of these boss areas, respectively. These bearings **29** and **30** are preferably roller-bearing assemblies and lie against an appropriate shouldered area **32** and **33** in each of the boss areas. Shaft seals **35** and **36** are diposed between the pumping chamber **20** and the individual bearings **29** and **30**. If desired, a weep hole may be provided in the area of the bearings to permit any fluid which may have passed the seals **35** or **36** to drip outwardly from between the bearing assemblies and the shaft seals. Thus, the shaft is arranged for free rotation within the confines of the pump asembly **10**. As shown in phantom in FIGURE 3, the end wall **15** is provided with a shallow cavity as at **38**, and this cavity communicates with a small passageway, not shown, which leads to the space existing between the shaft seals **35** and **36** and the bearing assemblies **29** and **30**. Thus, any fluid which may escape beyond the seals and into the space occupied by the bearings will be subjected to a reduced pressure resulting from this communication with the suction or inlet side of the pump which has been designated **40**, the outlet side being designated **41**.

It will be observed from FIGURES 2 and 3 that, while the cylindrical pumping chamber is generally circular in configuration, the shaft opening formed in the end plates **14** and **15** is somewhat above the true center axis of the pumping chamber **20**.

The outer edge of the individual end plates **14** and **15** have a plurality of openings formed therein, as previously indicated, these openings being adapted to accommodate the cap screws or other devices for arranging the assembly together. If desired, one or more of the individual cap screws **22—22** may be used as a locating screw or the like to assist in orienting the individual end-plates relative to the central sleeve **16**. Also, of desired, the individual screws may be utilized to retain a suitable external mounting structure (not shown). If desired, marginal relief areas may be provided along the outer portion of the end plate **15** such as is shown at **44** in order to permit complete operability of the individual rollers out to the circumference of the sleeve **16**, and thereby guard against entrapment of any portion of the fluid being pumped.

As previously indicated, the inlet port **40** and the outlet port **41** are formed in the end plate **15**. The inlet port cavity **45** is formed arcuately about the axis of the shaft

opening **46**, this shaft opening being adapted to receive the shaft **47** there through. This shaft opening **46** is in alignment with the corresponding shaft opening **48** formed in the end plate **14**, as illustrated in FIGURE 2. These shaft openings **46** and **48** are in axial alignment, each line vertically above the true axial center of the pumping chamber **20** when the end plates are in place. Inlet port **45** communicates with the inlet **40**, which, as previously indicated, is formed as an integral fixture of the pump. An elongated rib **50** runs arcuately for the length of the inlet port **45** and lies in the same plane as the remainder of the inner surface of the plate **15**.

Substantially diametrically opposite from the inlet port **45** is an outlet port **52** which in turn communicates with the outlet **41** formed in the end plate **15**. This outlet port is, as is the case with the inlet port **45**, integrally formed with the end plate **15**. An elongated rib **53** extends arcuately for the length of the outlet port **52**, substantially similar to its counterpart rib **50**. As was the case with the rib **50**, rib **53** lies in the same plane with the remainder of the end wall formed at the inner surface of the end plate **15**.

The rotor assembly **12** has a rotor body **60** of substantially circular shape which in turn is mounted upon the shaft **47** and secured thereto by means of a set-screw, keyway or the like. The shaft **47** is, as indicated, journaled through the bearings **29** and **30** for free rotation therein, and is further journaled through the seals **35** and **36**. The shaft **47** extends outwardly of the pump housing to the right as shown in FIGURE 2, in order to permit coupling to a suitable power source. The outer peripheral surface **61** of the rotor **60** is substantially concentric with the axis of the shaft **47**, however is eccentric with respect to the inner surface of the sleeve **16** and consequently with respect to the pumping chamber **20**. The upper portion of the peripheral surface **61** is substantially in contact with the inner surface of the sleeve **16** as shown in FIGURE 3, while the lower portion is substantially spaced therefrom and defines positive pumping spaces, the volume of which changes as the rotor body **60** rotates within the pumping chamber.

Formed across the rotor body **60** and extending radially inwardly are a plurality of roller receiving slots **62**. Each of these slots has a leading face **63**, a trailing face **64**, which confront one another in spaced, substantially parallel relationship. A cylindrical roller **65** is disposed within each of the slots **62** and is radially movable inwardly and outwardly within each slot. An important feature of the invention resides in the arrangement of the cavity area shown at **66**, which is generally inwardly of the slot area **62**. The depth of the slot area **62** is substantially equal to the diameter of the roller elements **62**, however the arcuate extension zones **67** and **68** of the slot **62** provide a reservoir chamber for retaining a quantity of the fluid beind pumped. Thus, the roller elements **65** may be depressed substantially the entire depth of the slots **62**, without having to force the fluid outwardly of the slot area. It is important that the arcuate extension zones **67** and **68** do not come in close contact, one to another, in order to provide a substantial web **69** of material between adjacent slots.

In the use and operation of the pump of the present invention, the rotor **12** is disposed in sliding contact with the inner surfaces of the end plates **14** and **15**, as best shown in FIGURE 2, and the shaft **47** together with the rotor body **60** rotates in a counter-clockwise direction as viewed in FIGURE 3. The individual rollers **65** are thrown outwardly by centrifugal force so as to substantially ride against the inner circumferenital surface of the sleeve **16**, and also to slide against the trailing surface **64** of each of the slots **62**. The clearance between each roller **65** and the leading surface **63** is generally small in order to prevent undesired passage of fluid from the area generally beneath the roller **65**. As each roller moves with the rotor **60**, it maintains contact with the

inner circumferential surface of the sleeve **16** at the inside of the sleeve **16**, and begins to move outwardly in its slot **62** as the outer circumference of the rotor leaves the inner housing surface. The rollers **65** also, generally, lightly contact the end wall surfaces of the end plates **14** and **15**, and as the rollers continue over the inlet port **40**, the expanding space **66** beneath the roller causes fluid to be pulled in from the inlet **40** to occupy the space beneath each roller **65**. Also, it will be noted that the space outwardly of the rotor body **60** and between consecutive rotors begins to increase and likewise exerts a pulling force on the fluid in the inlet port **45**. Since the rib **50** is arcuate and continuous for the length of the inlet port **45**, each roller **65** is maintained in proper lateral position as it passes thereover.

As previously noted, the small passageway **38** which connects the inlet port to the space between the bearing **30** and the seal **36** permits a suction force upon this space. Therefore, any liquid which may be trapped in the space is pulled back into the rotor and is inter-mixed with the fluid being pumped. The inlet port **45** terminates short of the area of maximum outer travel of each of the rollers **65** and hence there is no further intake of fluid from the inlet **45** through inlet port **40**. However, as the rotor **60** continues its travel in a counter-clockwise direction as shown in FIGURE 3, the space between the rotor body **60** and the inner circumference of the sleeve **16** begins to diminish. Shortly thereafter, it reaches the lower end of the outlet port **52** and again the roller members **65** ride upon the rib area **53** in order to eliminate axial displacement of the rollers **65**. The liquid which has previously been pulled into the slot **62** in the space beneath the roller **65** is now caused to move laterally outwardly of the rotor **60** and accordingly be discharged through the outlet port **41**. In a similar manner, the liquid forwardly of the roller **65** is caused to be squeezed into the outlet port area **52**. The ports are thus self-valving in character and the consecutive increasing and diminishing volumes associated with each roller causes a continuous flow of liquid into the inlet **45** and out of the outlet **52**. Continuing on in its counter-clockwise movement, the roller **65** arrives at the upper-most portion of travel along the inner circumference of the sleeve **16**, and there is depressed substantially the entire radial length inwardly into the slot **62**. At this point, a seal is effected between the inlet side and outlet side of the pump, and as the rotor **60** continues to rotate, it again brings the individual roller designated **65** into proximity with the extreme end of the inlet port **45**.

Each of the arcuate extensions **67** and **68** of the slots **62** create a reservoir area which is constantly maintained within the apparatus. This reservoir diminishes the radial velocity of fluid moving outwardly of the slot area, and further provides a cushioning affect for the rollers **65** within the individual slot areas **62**. In this manner, cavitation may be reduced due to the velocity of fluid moving between the rollers and the trailing and leading surfaces **64** and **63** of the slots respectively.

The arrangement as described makes it possible for the inlet and outlet to be located on either the same or opposite end plates of the pump assembly. While the arrangement disclosed herein shows the inlet and outlet to be disposed on the same end plate, it will be appreciated that the assembly will work equally well with the inlet and outlet arranged on oppositely disposed end plates. The radial disposition of these ports will, of course, necessarily be as shown in FIGURE 1.

Special attention is now directed to FIGURE 5 of the drawings which a modified form of rotor assembly is shown. In this arrangement, the rotor **70** employs a slot area **71** which has a trailing surface **72** and a leading surface **73**, the roller **65** being arranged therebetween. Arcuate extensions **75** and **76** are shown on opposite sides of the inward extremity of the slot **71**, and they are for the same purpose of providing an inwardly dis-

posed reservoir chamber as previously described in the apparatus shown in FIGURES 1–4. With particular attention being directed to the trailing surface **72** and the leading surface **73**, it will be observed that these surfaces are in generally mutually parallel relationship, one with another. In addition, it will be observed that the trailing surface **72** is disposed along the radius line of the rotor body **70**. This arrangement enables the roller **65** to be moved generally outwardly a distance greater than would otherwise be possible if the center line of the slot **71** were generally along a radius line of the rotor **70**. The remaining operating features of this assembly are essentially the same as those shown in the modification of FIGURES 1–4, the only distinction being in the arrangement of the trailing and leading surfaces **72** and **73** of the slot areas **71.**

It will be appreciated that those specific modifications given herein are for purposes of illustration only, and that those skilled in the art may depart from these specific embodiments or illustrations without necessarily departing from the spirit and scope of the present invention.

What is claimed is:

1. A fluid pump comprising:

(a) a housing having a cylindrical pumping chamber therein,

(b) said pumping chamber being defined by an inner circumferential wall and a pair of spaced circular end walls,

(c) a rotor rotatably mounted within said pumping chamber and having its axis in offset parallel relation to that of said pumping chamber and having a width such as to extend from one of said circular end walls to the other,

(d) said rotor having a plurality of roller receiving slots formed into and across the circumferential surface thereof,

(e) a roller disposed for free rotation in each of said slots in close clearance with the sides thereof adjacent to the radially outwardly disposed portions of the sides thereof and extending from one of said circular end walls to the other,

(f) inlet port means formed through one of said walls,

(g) outlet port means formed through one of said walls and arcuately spaced from said inlet port, and

(h) said roller receiving slots having leading and trailing surfaces adjacent the outer opening extending across the axial length of said rotor, and defining an access opening to said slot and having a radial depth, the breadth of said access opening being substantially equal to the diameter of said roller, and arcuate extension cavities disposed radially inwardly of said access openings and in communication therewith and being formed within the body of said rotor, each of said extension cavities extending across the width of said rotor and defining a fluid reservoir chamber within said slot, and having an arcuate length which substantially exceeds the arcuate width of said roller receiving slots.

2. The fluid pump as defined in claim **1** being particularly characterized in that said arcuate extension cavities extend arcuately a substantially equal distance from each of said leading and trailing surfaces.

3. The fluid pump as defined in claim **1** being particularly characterized in that the outer circumferential surface of said rotor is in close running clearance with the inner circumferential surface of said chamber along one radial portion thereof.

4. The fluid pump as defined in claim **1** being particularly characterized in that said trailing surface is disposed generally along a radius line of said rotor.

5. A fluid pump comprising:

(a) a housing having a cylindrical pumping chamber therein,

(b) said pumping chamber being defined by an inner circumferential wall and a pair of spaced circular end walls,

(c) a rotor rotatably mounted within said pumping chamber and having its axis in offset parallel relation to that of said pumping chamber and having a width such as to extend from one of said circular end walls to the other,

(d) said rotor having a plurality of roller receiving slots formed into and across the circumferential surface thereof,

(e) a roller disposed for free rotation in each of said slots in close clearance with the sides thereof adjacent to the radially outwardly disposed portions of the sides thereof and extending from one of said circular end walls to the other,

(f) inlet port means formed through one of said walls,

(g) outlet port means formed through one of said walls and arcuately spaced from said inlet port, and

(h) said roller receiving slots having leading and trailing surfaces adjacent the outer opening and extending across the axial length of said rotor, and defining an access opening to said slot and having a radial depth, the radial depth of said roller receiving slots being substantially equal to the diameter of said rollers, and arcuate extension cavities disposed radially inwardly of said access openings and in communication therewith, and being formed within the body of said rotor, each of said extension cavities extending across the width of said rotor and defining a fluid reservoir chamber within said slot, and having an arcuate length which substantially exceeds the arcuate width of said roller receiving slots.

6. The fluid pump as defined in claim **5** being particularly characterized in that the arcuate width of said access opening is substantially equal to the diameter of said roller.

7. The fluid pump as defined in claim **5** being particularly characterized in that the outer circumferential surface of said rotor is disposed in close running clearance with the inner circumferential surface of said chamber along one radial portion thereof.

8. The fluid pump as defined in claim **5** being particularly characterized in that the trailing surface of said slots is disposed generally along a radius line of said rotor.

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