

[54] REVERSIBLE FLUID UNIT
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[22] Filed: Dec. 2, 1971
[21] Appl. No.: 204,154
[52] U.S. Cl. 418/45, 417/474
[51] Int. Cl. F01c 5/00
[58] Field of Search..... 418/45; 417/474,
417/475, 476

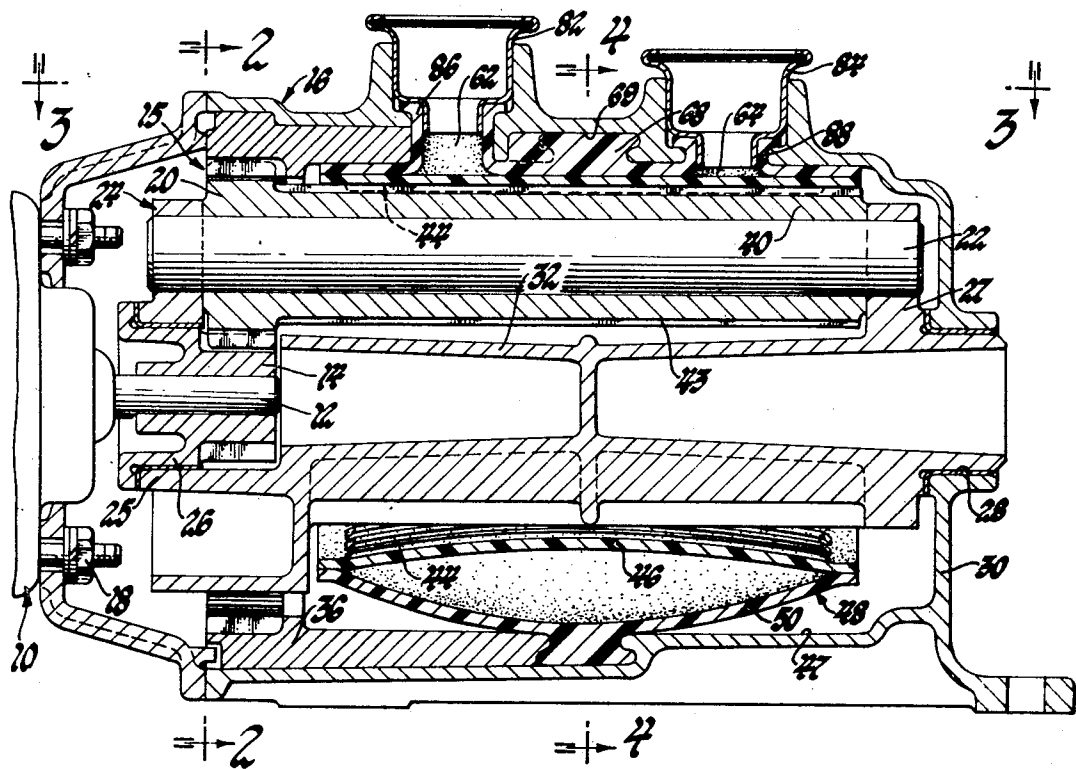
[56] References Cited

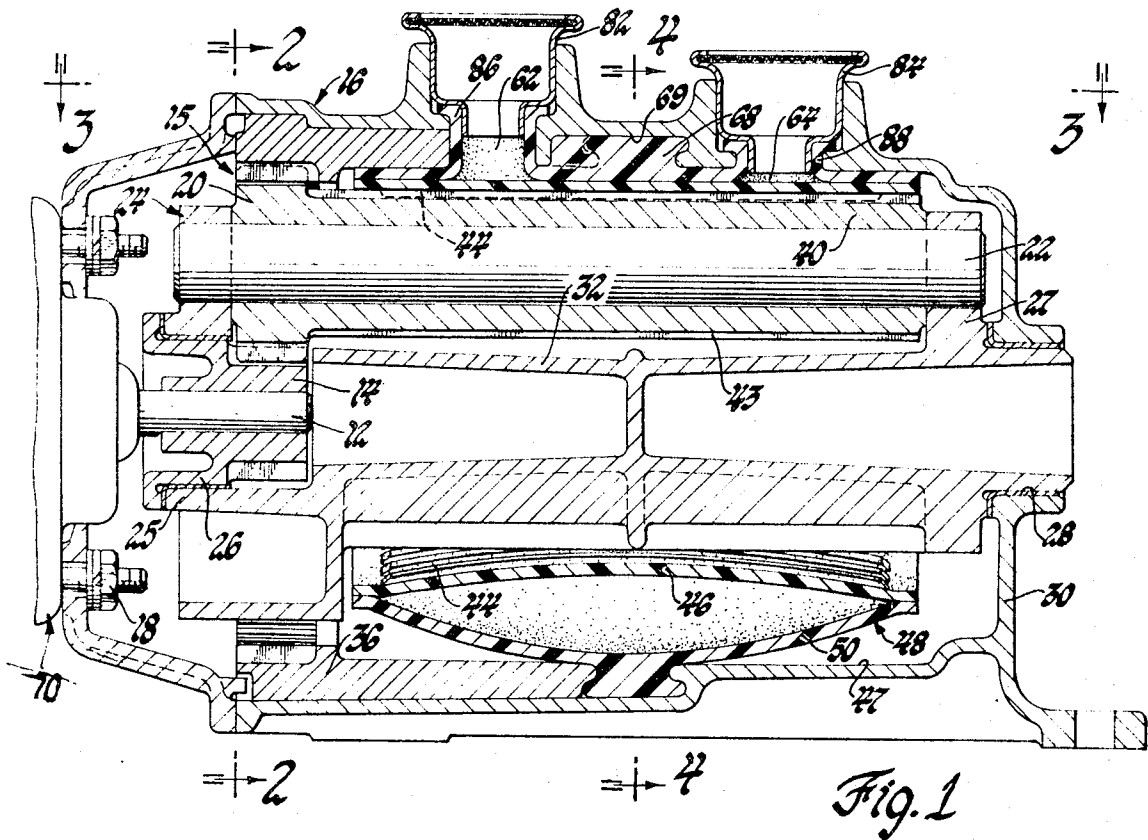
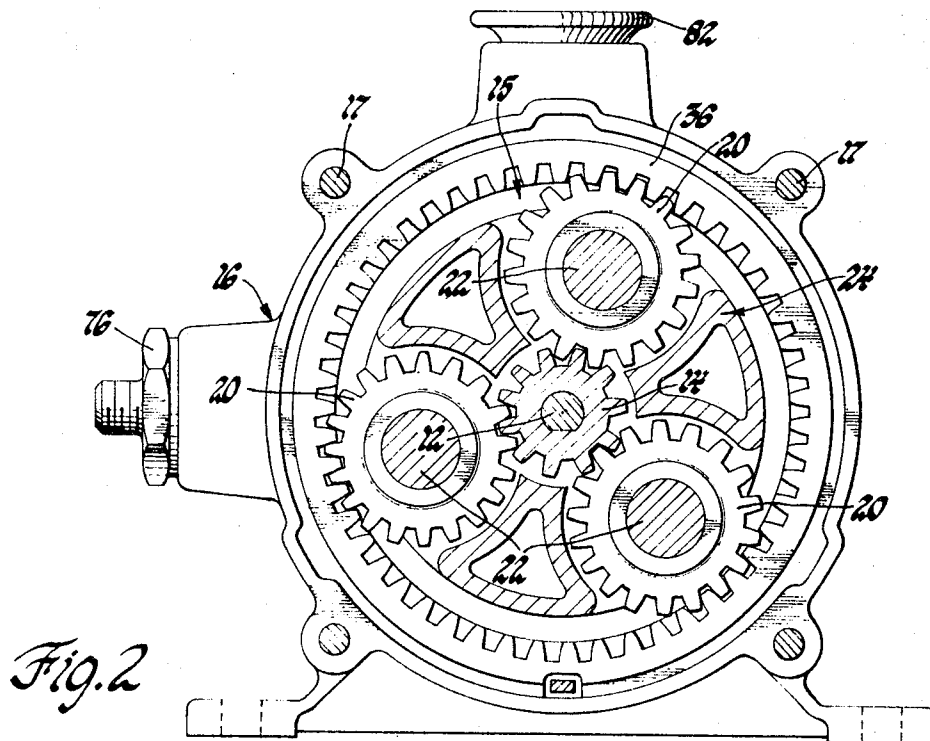
UNITED STATES PATENTS			
2,428,619	10/1947	Douglas	418/45
2,414,355	11/1947	Bogoslowsky.....	418/45
2,617,362	11/1952	Parsons.....	418/45
2,970,748	2/1961	Bendall.....	417/475

3,216,362 11/1965 Hewko..... 418/45
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[57] ABSTRACT
This unit may be employed as a reversible fluid pump
or motor and has a housing for an orbiting rotor opera-
tively disposed within the inner diameter of an annular
fluid conducting bladder assembly formed with arcu-
ately spaced fluid inlet and outlet passages. The pump
disclosed has a motor driven rotor that carries a plural-
ity of arcuately spaced roller members which contact
and squeeze inner and outer walls of the bladder as-
sembly together so that sealed pockets are formed between
the adjacent roller members that carry fluid in the or-
bital direction of the rotor. When the rotor is driven,
fluid is drawn into the bladder assembly as the pockets
form at the inlet port and is exhausted as they reach the
outlet port.

11 Claims, 5 Drawing Figures





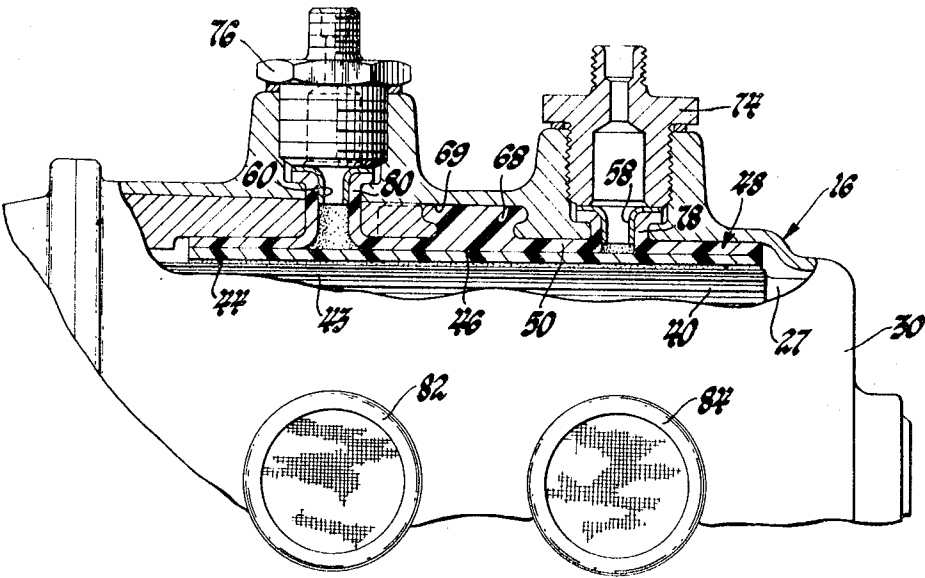


Fig. 3

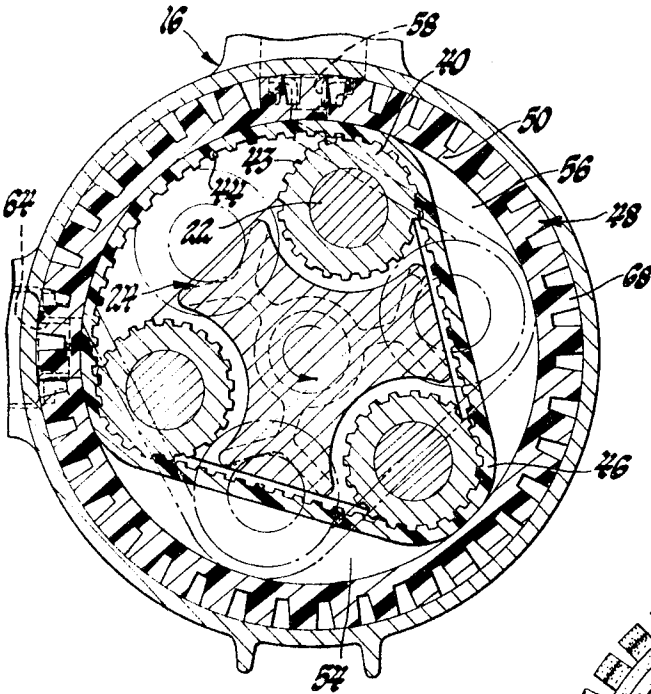


Fig. 4

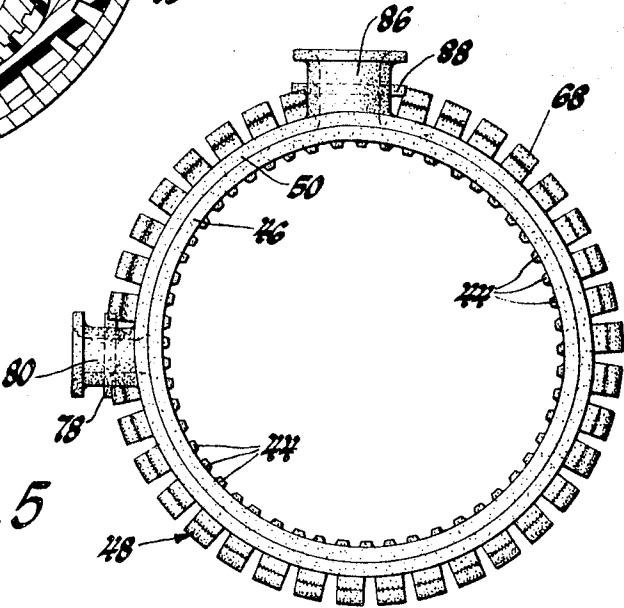


Fig. 5

REVERSIBLE FLUID UNIT

This invention relates to a reversible fluid unit in which there is a new and improved fluid conducting bladder assembly and cooperating roller means operatively disposed in a housing which function as a fluid pump or motor without creep and undue wear of the bladder assembly.

Prior to the present invention some fluid pump units have been made with fluid-conducting flexible tubes circular in cross section. These tubes form arcs of about 180° in passing through the body of the unit. In such prior art construction the inlet of each tube is supplied with a fluid and is then subjected to an arcuately progressing squeezing action by a set of motor driven rotating rollers. As the rollers are orbited in the housing, the liquid or gas which is supplied to the inlet side of the pump is forced ahead of the rollers through the tube to the outlet side. This prior art construction permits the handling of a wide variety of materials with minimized adverse effect on the pump's mechanical parts since the fluid is moved entirely through the tube and does not normally contact the internal mechanical part of the pump.

While these prior pumps are ideally suited for numerous applications, particularly where the special handling of corrosives, abrasive solutions, gasses or other fluid is needed, they often cannot be operated for extended time periods since the service life of the tube is greatly diminished by the constant flexing action imposed thereon by the orbiting rollers. Also there is a tendency for the tube to creep during operation which stretches and strains the tubing detracting from its durability. This adds to maintenance burden and costs and limits the use of such units to environments readily accessible for maintenance.

In this invention there is provided a new and improved reversible fluid pump or motor unit. In the preferred embodiment this unit now described as a pump has a planetary gear set which serves as a speed reducing drive from a standard high-speed, low-torque driving motor to a set of rollers which cooperate with an annular bladder disposed about the rollers to form fluid receiving pockets therebetween. These pockets move in an arcuate path as the rollers orbit about a central axis. The pockets carry fluid in the orbital direction of motion of the rollers with fluid being drawn into the pump as the pockets form serially at the inlet port in the bladder. These pockets are exhausted as they reach an outlet port in the bladder. Teeth are provided on the inner wall of the bladder which mesh with those on the outside diameter of the rollers aligning the bladder with the stationary ring gear of the gear unit to prevent creep of the bladder as the rollers orbit. The bladder preferably is formed from inner and outer annular elastomeric members arcuate in cross-section with a height which diminishes from a maximum at its center toward the side edges where they are joined together by an adhesive, by seam welding, or other suitable means. When installed in the pump the pockets formed by the bladder have a "duck bill" cross section to provide for low stress during constant flexing to improve service life. The sealed pockets provide a positive displacement feature that permits the pump to be used as its own valve sealing against back flow when rotation is stopped. Reversing of the driving motor causes the fluid to flow in the opposite direction. The fluid being pumped contacts only the bladder making the pump

useful for many fluids including those which are highly corrosive.

In this invention the revolving planet gears provide for speed reduction from the input, the actuation of the bladder assembly as well as preventing creep of the bladder.

It is an object of this invention to provide a new and improved fluid pump or motor unit having a flexible fluid conducting bladder therein cooperating with special roller means operatively connected to a speed changing planetary gear unit for providing fluid receiving pockets in the bladder assembly movable between inlet and outlet passages and for maintaining the bladder in a fixed position in the unit.

Another object of this invention is to provide a fluid pump or motor unit having a new and improved bladder assembly of a low profile design that is subjected to low stress when contacted by orbiting rotor means to provide for the long service life of the bladder assembly.

Another object of this invention is to provide a new and improved positive displacement fluid unit, which may be employed as a pump or motor, that has an annular flexible bladder assembly which cooperates with a rotor to provide a plurality of fluid receiving pockets therein for conducting fluid from an inlet to an outlet.

Another object of this invention is to provide a new and improved positive displacement fluid unit having a flexible, curved, fluid-conducting bladder therein which cooperates with a set of arcuately spaced rollers operatively connected to the planet gears of a speed changing planetary gear set to provide a plurality of fluid receiving pockets that carry fluid from an inlet port to an outlet port of the unit.

These and other features, objects and advantages of this invention will be more apparent from the following detailed description and drawings in which:

FIG. 1 is a cross-sectional view of the fluid unit of this invention;

FIG. 2 is a view taken along lines 2—2 of FIG. 1; FIG. 3 is a top view taken along lines 3—3 of FIG. 1; FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 1; and

FIG. 5 is a plan view showing the free position of the bladder assembly of this invention.

Turning now to the drawings of a preferred embodiment of the invention there is shown in FIG. 1 a motor 10 which may be a conventional high-speed, low-torque electric motor that has an output shaft 12 which is keyed to drive a sun gear 14 of a planetary gear set 15 disposed within a housing 16. This housing has two parts connected together by bolts 17 and is secured to the housing of the motor by nut and bolt fasteners 18. The sun gear 14 of the planetary gear set meshes with three planet gears 20 which are evenly spaced from each other being rotatably mounted on separate elongated spindles 22 of a carrier 24. One side 25 of the carrier is rotatably mounted by sleeve bearings on a shoulder 26 of the sun gear while the opposite side 27 is rotatably mounted by a sleeve bearing in an opening 28 formed in an end wall 30 of the housing 16. The sides 25 and 27 of the carrier 24 are joined by a central tubular connection 32 that is coaxial with the sun gear 14.

Each of the planet gears 20 mesh with a reaction ring gear 36 which is securely fixed to the interior of the pump housing 16. This construction provides a speed

reduction of the planet gears and carrier as they orbit about the rotational axis of the sun gear in response to the drive of the sun gear by the motor 10. Each of the three planet gears 20 has an integral and coaxial extension forming a roller 40, disposed between the sides 25 and 27 of the carrier. The rollers are provided with teeth 43 which mesh with the internal teeth 44 of the inner wall 46 of an elastomeric annular bladder assembly 48 disposed adjacent to the smooth annular interior surface 47 of the housing 16.

The bladder assembly has an elastomeric outer wall 50 that is joined at its outer edges to the outer edges of the elastomeric inner wall 46 by an adhesive or by seam welding. When installed around the rollers 40, fluid receiving pockets such as the pockets 54 and 56 shown in full lines in FIG. 4 are formed. The pockets formed between the rollers move clockwise about 270° from side-by-side inlet ports 62 and 64 of the bladder assembly to side-by-side outlet ports 58 and 60. This occurs when the rollers orbit around the rotational axis of sun gear 14 in response to the drive of sun gear 14 by the motor 10. The 90 degree segment formed by the inner and outer walls of the bladder assembly from the outlet ports to the inlet ports are fastened together in a fluid-tight relationship to block the clockwise flow of fluid from the inlet ports to the outlet ports. When the rollers reach their phantom line position shown in FIG. 4 a total of three pockets are formed. These pockets progressively formed between the inner and outer walls of the bladder have a "duckbill" cross-section as shown best in FIG. 1 which provides for low stress of the bladder assembly when flexed during operation to materially lengthen service life of the bladder assembly.

The outer wall 50 of the bladder assembly is formed with an annular castellated central rib 68 that projects radially outwardly which facilitates the forming of bladder assembly into a circle as shown in FIG. 5 from a linear unit. This rib is fitted into an annular internal groove 69 formed in housing 16 to secure the bladder assembly therein.

Housing 16 has projecting socket portions in which are secured outlet hose fittings 74 and 76 each having a fluid passage therein which communicates with the associated outlet port 58 or 60. The ends of these fittings contact the flanged ends of respective retainer sleeves that have tubular portions that closely fit inside of the flanged necks 78 and 80 which form the outlet ports 58 and 60 of the bladder assembly. Also, there are projecting inlet sockets for hose fittings 82 and 84. Each of these is formed with a reduced diameter sleeve portion that is mechanically fitted inside of the flanged necks 86 and 88 which form the intake ports 62 and 64 of the bladder assembly.

In a pump operation the planetary gear set serves as a gear reduction from the driving motor 10. As the sun gear is driven, the planet gears 20 walk around inside of the reaction ring gear 36. As the pinions orbit, they carry the rollers 40 about the axis of the sun gear squeezing the bladder assembly against the annular inner surface of the housing 16. As a roller passes the inlet ports 62 and 64 a pocket such as pocket 54 is formed between adjacent rollers which receives fluid supplied to the inlet ports. The pockets so formed carry the fluid in the direction of orbital motion of the rollers shown by the directional arrow in FIG. 4. Each of these pockets is exhausted as they serially reach the outlet ports. The teeth of the inner wall of the bladder mesh

with those on the outside diameter of the rollers aligning the bladder with the stationary ring gear and thus prevent creep of the bladder as the rollers orbit.

Since the inner wall of the bladder assembly forms an arc shorter than that of the outer wall it cannot collapse against the outer wall upon passing the inlet port so the unit can serve as a vacuum pump. The positive displacement feature provided by the sealed pockets permits the pump to be used as its own valve sealing against backflow when rotation is stopped. When either stopped or rotating fluid will be unable to flow past the sealing point provided by the roller and the inner and outer walls of the bladder assembly. Reversing of the drive motor causes the fluid flow to be in the opposite direction. The fluid being pumped contacts only the bladder making the pump useful for many fluids including those which are highly corrosive.

While this invention has been described in particular as a fluid pump, it can also be readily employed as a motor. In such a case pressure fluid can be supplied to the inlet ports to drive rollers 40 in an orbital path through the elastomeric bladder. Fluid exits from the discharge ports and the output is taken from the sun gear 14.

With this invention the planetary gearing is disposed within the housing 16 and the planetary gears with extensions 40 provide the desirable speed reduction plus the bladder squeezing action. Additionally since the teeth of the planet gears mesh with the fixed ring gear 36 and with the bladder assembly the bladder cannot creep and be subjected to undesirable fatigue.

To provide an even more compact and simplified unit the extensions 40 could have the same pitch diameter as the planet gears 20 and the unit provided with only one inlet and one outlet.

Although a preferred embodiment of the invention has been shown and described for purposes of illustrating the invention, there are other embodiments now obvious to those skilled in the art. Therefore the limitations of this invention are set forth in the following claims.

We claim:

1. A positive displacement fluid unit for use as a pump or motor comprising a housing, said housing having an inner curved surface therein, a flexible fluid-conducting tube means disposed in said housing adjacent to said inner curved surface, said tube means having spaced fluid inlet and outlet means, rotor means mounted for orbital movement about a first axis within said housing for progressively contacting said tube means to displace said tube means against said inner surface to squeeze the walls of said tube means together and form fluid receiving pockets therein at said fluid inlet means as said rotor means orbits past said inlet means, support means for supporting said rotor means for orbital movement about said first axis and for rotation about a second axis, and gear means operatively connecting said tube means and said housing to maintain said tube means in position and prevent rotary creep of said tube means within said housing in response to the supply of fluid into said inlet means and the discharge of fluid from said outlet means.

2. The fluid unit of claim 1 wherein said gear means comprise a planetary gear set with a plurality of planet gears mounted on said support means operatively connecting a sun gear and a ring gear, means for securing said ring gear within said housing, said rotor means

comprising a plurality of elongated rollers each operatively connected to one of said planet gears, said rollers and said tube means having meshing teeth which maintain said tube means in fixed position within said housing.

3. A positive displacement fluid unit comprising a housing, said housing having an annular surface therein, an annular flexible fluid-conducting tube disposed in said housing adjacent to said curved surface, said fluid conducting tube having fluid inlet and fluid outlet means therein arcuately spaced from each other, rotor means operatively disposed in said housing having a plurality of separate tube squeezing means for spaced point contact with said fluid conducting tube, and support means for movably mounting said rotor means for orbital movement in said housing so that each of said tube squeezing means progressively contacts said tube to force said tube against the curved walls in said housing and squeeze the walls of said tube together to form sealed fluid receiving pockets as said tube squeezing means orbits past said fluid inlet and gear means operatively connected to said tube, said rotor means and said housing to prevent creeping of said fluid conducting tube as said rotor means orbits in said housing.

4. The positive displacement fluid unit defined in claim 3 wherein said tube has side edges joined together and said pockets formed in said tube have a cross section with a height that progressively diminishes from the center of the cross section to zero height at the edges of said tube to provide for low tube profile and for low tube stress as said tube is flexed by said tube squeezing means.

5. The positive displacement fluid unit defined in claim 3 wherein said tube is formed by annular inner and outer walls which are reversely arced in cross section, said walls having side edges which are joined together to provide a fluid sealed bladder assembly having a low profile for low stress as said bladder assembly is flexed by said tube squeezing means.

6. The fluid unit defined in claim 5 wherein said outer wall is secured in said housing and the arc of said inner wall is less than the arc of said outer wall so that atmospheric pressure outside of said walls cannot collapse said pockets thereby allowing said fluid unit to operate as a vacuum pump.

7. In a fluid pump an input means, first gear means driven by said input means, planetary gear means meshingly engaged with said input gear means, reaction gear means meshing with said planetary gear means, housing means secured to said reaction gear means, said planetary gear means having elongated roller members secured thereto, each of said rollers having gear teeth therein, a flexible bladder assembly operatively disposed in said housing forming a fluid passage therein, said flexible bladder assembly having inlet passage means and outlet passage means arcuately spaced from each other, said flexible bladder means having teeth on the interior wall thereof, said rollers having

teeth which engage the teeth on said inner wall of said bladder assembly, and said bladder assembly forming fluid receiving pockets which move around the axis of said input from the inlet of said bladder to the outlet of said bladder being squeezed by said roller means to provide a fluid unit which pumps fluid from said inlet to said outlet.

8. A positive displacement fluid unit comprising a housing, a rotatable input, a planetary unit having a rotatable input member drivingly connected to said input and having a plurality of arcuately spaced planet members rotatably mounted on a planet carrier, said planet members being drivingly connected to said input member, a reaction member operatively connected to said planet members, each of said planet members having a roller connected thereto driven in a circular path in response to the drive of said input member, a fluid conducting bladder assembly disposed in said housing and around said rollers, said bladder assembly having a fluid inlet passage and a fluid outlet passage arcuately spaced from each other, said bladder having a fluid conducting passage therein extending in one direction from said inlet passage to said outlet passage and cooperating with said rollers which squeezes said bladder assembly to provide fluid conducting pockets therein between adjacent rollers that carry the fluid supplied to said inlet passage in the direction of motion of said rollers so that fluid is drawn into the unit as one of said pockets is formed at said inlet passage and is exhausted from the unit as said pocket reaches said outlet passage.

9. The fluid unit defined in claim 8 wherein the pockets formed in the bladder assembly have a large dimension at the center of each of said pockets which gradually diminish toward the edge of the bladder assembly to provide for low stress during the flexing of the bladder assembly during operation.

10. The fluid unit defined in claim 8 wherein said bladder assembly has an arcuate inner wall formed with an annular arrangement of gear teeth thereon that extend radially inwardly of said bladder assembly, said rollers having teeth which mesh with the teeth of said inner wall as said rollers orbit in said housing, said planetary unit being a planetary gear set with said reaction member being a ring gear secured to said housing to condition said gear set for a speed reducing drive and to cooperate with said meshing teeth of said rollers and said bladder assembly with the stationary ring gear and prevent creep of the bladder in said housing as said rollers orbit therein.

11. The fluid unit defined in claim 10 wherein said inlet and outlet passages are disposed at right angles to each other, said planet members comprising three planetary gears, one of said rollers extending coaxially from each of said planetary gears and cooperating with said inner wall of said bladder assembly to form at least three of said pockets in response to one revolution of said carrier member.

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