March 17, 1953 E. L. BAUGH ET AL 2,631,540

ROTARY FLUID PUMP

Filed Nov. 24, 1948

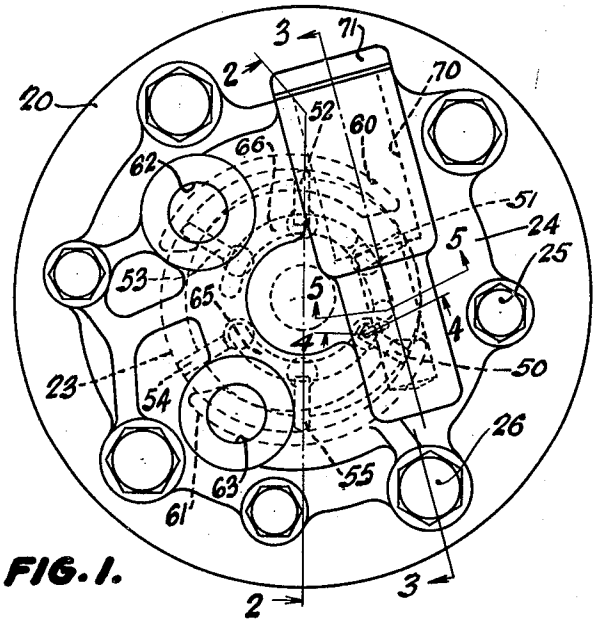


FIG. 1.

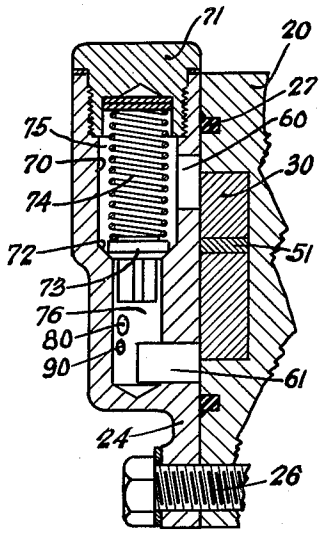


FIG. 3.

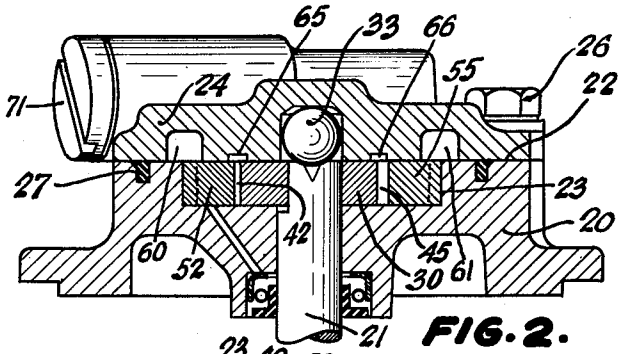


FIG. 2.

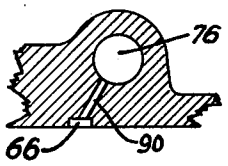


FIG. 4.

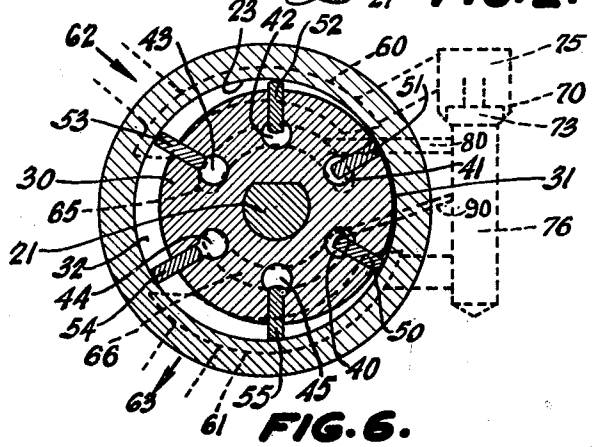


FIG. 6.

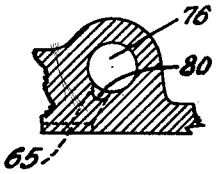


FIG. 5.

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ROTARY FLUID PUMP

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9 Claims. (Cl. 103—42)

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This invention relates to improvements in rotary fluid pumps, particularly of the vane type.

It is among the objects of the present invention to provide a rotary, vane-type fluid pump of simple structure and design, consisting of a minimum number of parts which may be produced commercially without requiring intricate machining operations and which may easily be assembled.

A further object of the present invention is to provide a rotary, vane-type fluid pump in which the vanes are urged into sealing engagement with the wall of the cylinder by fluid pressure provided by the pump itself. In the present invention the vanes moving along the cylinder wall in the region of the discharge port of the pump are urged against said wall at a greater pressure than the vanes moving along the cylinder wall in the region of the intake port.

This object is accomplished by providing the pump rotor with a fluid receiving space at the inner end of each radial slot in which a vane is slidably supported and in addition providing a cylinder end wall with two separate, arcuate recesses, the one recess interconnecting the fluid receiving spaces of the several vanes as they move in the cylinder within the region of the intake port of the pump, the second recess interconnecting the fluid receiving spaces of the several slots the vanes in which are moving in the cylinder within the region of the discharge port of the pump. The said one recess is in communication with the discharge port of the pump so that fluid, delivered under pressure by the pump, is directed against the inner ends of all of the vanes traversing the intake port region of the cylinder whereby said vanes, moving outwardly of the rotor, are urged against the cylinder wall at pump, fluid delivery pressure. As the rotor of the pump continues to turn the spaces at the inner ends of the slots are successively moved out of communication with the said one arcuate recess and then, filled with fluid, they are successively moved into communication with the second recess adjacent the discharge port of the pump. As the vanes move through the region of said discharge port they are moved inwardly of the rotor and thus become reciprocating pistons exerting a pressure upon the fluid contained in the respective slots of the vanes moving through this region and the fluid accumulated in the communicating arcuate recess. The fluid trapped in the spaces and the communicating arcuate recess resists the inward movement of the vanes and consequently said vanes frictionally engage the cylinder wall at a pressure greater than that at which the vanes

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moving through the intake port area engage the cylinder wall. In fact the trapped fluid substantially prevents inward movement of the vanes and therefor provides too great an impedance to the safe and proper operation of the pump.

Therefore it is another object of the present invention to provide a predetermined fluid leak for the arcuate recess adjacent the discharge port of the pump and the vane slot spaces communicating therewith whereby a predetermined resistance to the inward movement of the vanes in this region may be provided. Such a controlled fluid leak is obtained by providing a predeterminately sized duct connecting the said arcuate recess adjacent the discharge port of the pump with said discharge port.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a plan view of the pump.

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary sectional view taken along the line 4—4 of Fig. 1.

Fig. 5 is a view similar to Fig. 4, taken along the line 5—5 of Fig. 1.

Fig. 6 is a schematic view illustrating the rotor and cylinder with associated fluid passages.

As has previously been stated, the present invention relates to improvements in vane type, rotary fluid pumps. The pump illustrated in the accompanying drawings is designed to be applied to the starting motor for the engine of a motor vehicle, said pump being driven by said motor for the purpose of providing fluid pressure to operate top and window actuating devices.

Referring to the drawings, the pump is shown consisting of a base 20 which, when attached to the electric motor, forms one end housing thereof. A central opening in the base 20 has one end of the armature shaft 21 of the electric motor journalled therein. A flat outer surface 22 is provided on the base 20, this surface of said base has a circular recess 23, eccentric to the shaft 21 as illustrated in Fig. 6. A cover cap 24 is secured to the base 20 by bolts 25 and bolts 26 pass through the cover cap 24 and the base 20 into the frame of the electric motor to secure the pump thereto. An annular groove in the flat surface 22 of the base contains a sealing ring 27 which prevents the escape of fluid between the

base and cover cap. The recess 23 closed at one end by the cover cap, forms the cylinder of the pump.

In this recess 23 or cylinder there is provided a disc shaped rotor 30 having a central opening into which the end of the shaft 21 extends, anchoring means being provided so that the rotor turns with the shaft. The eccentricity of the shaft relatively to the recess or cylinder 23 and the diameter of the rotor 30 attached to the shaft are such that there is a sliding line contact or minimum space between said rotor and the annular wall of the recess or cylinder 23 as designated by the numeral 31 of Fig. 6. The rotor 30 thus forms a crescent shaped fluid displacement chamber 32 within the cylinder 23 each pointed end of said chamber substantially terminating at the line 31. An end thrust bearing in the form of a ball 33 is shown in the present drawing as interposed between the cover cap 24 and the end of the shaft 21.

In the present drawings the cylinder recess 23 is illustrated as being circular, however, if desired or considered necessary a cylinder deviating from the circular shape may readily be utilized in connection with the features of the present invention. Also, the present drawings show the shaft supporting opening in the base 20 to be eccentric relatively to the cylinder recess. To simplify machinery, this opening may be concentric with the cylinder recess, in which case said recess would not be the cylinder directly but would receive a ring shaped insert having an inner bore eccentric to the outer peripheral surface of the insert, said inner bore forming the cylinder space eccentric to the shaft opening. In this instance the insert ring with its eccentric opening could be preformed and made of any suitable material as for instance compressed and sintered powdered metal.

Referring particularly to Fig. 6, the rotor 30 is shown having a plurality of end to end openings 40, 41, 42, 43, 44 and 45 arranged in a circular row and equally spaced one from the other. Each opening forms the inner terminus chamber of a radial slot the outer end of which terminates in the outer peripheral surface of the rotor. Each slot slidably supports a fluid displacment vane. Opening slot 40 supports vane 50, 41 vane 51, 42 vane 52, 43 vane 53, 44 vane 54 and 45 vane 55. In operation the outer ends of these vanes constantly engage the wall of the cylinder and due to eccentricity are therefore reciprocated in the rotor slots as the rotor turns. They are so designed that when at the position indicated by numeral 31, the inner end of the vane extends within close proximity of the extreme inner portion of the opening of its respective slot while in the diametrically opposite position in the cylinder, or where the crescent shaped space 32 is widest, the inner end of the vane is outside the confines of the end to end opening of its respective slot.

The flat surface of the cover cap engaging the flat surface 22 of the base has a plurality of separate arcuate recesses. Two of these recesses 60 and 61 are concentric with the cylinder recess 23 and are diametrically opposed. The recess 60 is in direct communication with one end portion of the crescent shaped cylinder space 32 and has the fluid intake port 62 communicating therewith whereby fluid, introduced through port 62, enters the arcuate recess 60 and that portion of the crescent shaped cylinder space communicating therewith. Similarly recess 61 is in direct communication with the opposite end portion of the crescent shaped cylinder space 32 and has the fluid discharge port 63 communicating therewith whereby fluid displaced by the rotor vanes is forced under pressure from the pump.

The other two of the separate, oppositely disposed arcuate recess are designated by the numerals 65 and 66. While the recesses 60 and 61 are concentric of the cylinder 23, the recesses 65 and 66 are concentric of the rotor 30 and are spaced from the center of the rotor so that the several end to end openings 40 to 45 inclusive will register and communicate successively with the recesses 65 and 66 as the rotor turns. The arcuate recesses 65 and 66 in cap 24 are of such length respectively that, as shown, three end to end openings 40 to 45 may register with each recess at one time. Fig. 6 illustrates this clearly by showing that end to end openings 41, 42 and 43 may register and communicate with the arcuate recess 65 as the respective vanes 51, 52 and 53 move in the region of the intake recess 60 and likewise end to end openings 44, 45 and 40 register with recess 66 as the respective vanes 54, 55 and 50 move in the region of the discharge recess 61. In each instance as the leading end to end opening approaches the end of a respective recess 65 or 66 to break communication therewith, the second following end to end opening is completing communication with recess 65 or 66 respectively. In the meantime the intermediate end to end opening is midway between the ends of a respective recess 65 or 66.

A fluid receiving recess 70 is provided in the cover cap 24 the open end of said recess being closed by a screw plug 71. As shown in Fig. 3, recess 70 comprises two portions of different diameters forming an inner, annular shoulder or ledge 72 upon which the valve 73 is yieldably urged by a spring 74 interposed between the valve and screw plug. This valve 73 divides recess 70 into two chambers 75 and 76 normally not in communication with each other.

The chamber 75 has the one end of the recess 60 cutting thereinto so that said chamber 75 is constantly in communication with the recess 60 into which the intake port 62 opens. The chamber 76 is cut into by one end of recess 61 thereby placing said chamber 76 in constant communication with the recess 61 connected to the discharge port 63 of the pump. Thus as the rotating rotor of the pump builds up fluid pressure in the discharge recess 61 which pressure is directed into the chamber 76. As long as this pressure does not exceed a predetermined value valve 73 will be held upon the seat or ledge 72 by spring 74, however, if said fluid pressure becomes excessive then valve 73 will be lifted and chamber 75 will be opened to chamber 76, thereby permitting the fluid under pressure in chamber 76 to be dissipated through chamber 75 into the intake recess 60.

Chamber 76 is also in communication with the arcuate recess 65 by means of duct 80 which is of such size as to offer little or no restriction to the fluid flow from chamber 76 into said arcuate recess. Fluid, under pressure, flowing from chamber 76 through duct 80 into recess 65 will enter and fill each end to end opening 40 to 45 inclusive as each respective opening is moved to communicate with the recess 65. Thus fluid under pressure will be directed against the inner end of each vane as its respective slot and end to end opening traverses the region of the arcuate recess 65 and thereby communicates there-

with. This urges these vanes into sealing engagement with the cylinder wall as they slide along its surface within the region of the intake recess 60.

As soon as an end to end opening of a slot reaches the end of the arcuate recess 65, for instance in Fig. 6, as soon as end to end opening 43 is moved counterclockwise out of communication with the recess 65, fluid is trapped in said opening while it is moving toward the diametrically opposite, arcuate recess 66. However, as soon as the opening, for instance opening 43, is moved to communicate with said recess 66 the fluid in opening 43 will enter said recess 66 which, after a few revolutions of the pump, will become completely filled. Thus eventually all end to end openings communicating with the recess 66 as well as said recess will be filled with fluid.

By referring to Fig. 6 it may be seen that as the vanes are moved counterclockwise from the line 31 between the rotor and cylinder wall to the diametrically opposite side of the cylinder, they move radially outward relatively to the rotor. Likewise as said vanes are moved in the same direction for the remaining half of a rotation of the rotor, they will be moved radially inward relatively to the rotor. Thus in Fig. 6 the vanes 54, 55 and 59 become reciprocating pistons moving inwardly to exert a pressure upon the fluid in the end to end openings of their respective slots as well as upon the fluid within the communicating arcuate recess 66. Where only internal leakage in the pump is depended upon to relieve the fluid pressure within the arcuate recess 66 and the end to end openings communicating therewith, excessive resistance to the inward thrust of the several vanes will create too great a frictional engagement of said vanes with the cylinder wall and thus proper operation of the pump is seriously affected and breakage possible.

In order to avoid this undesirable condition the present pump is provided with a duct 90 of predetermined fluid flow capacity, said duct acting as a fluid pressure exhaust passage connecting the arcuate recess 66 with the fluid chamber 76. Duct 90 thus restricts fluid discharge from the recess 66 influenced by the inwardly moving vanes, to any desirable degree so that any desirable fluid pressure may be maintained within the recess 66 and its communicating end to end openings thereby resisting the inward movement of said vanes by the cylinder wall to any desirable degree.

From the aforegoing it may be seen that the improved pump of the present invention entirely eliminates the use of springs for urging the vanes into cylinder wall engagement and in lieu thereof uses the fluid at pump delivery pressure to urge those vanes against the cylinder wall that are passing through the region of fluid intake. While the vanes pass through the region of fluid discharge, the vanes themselves perform two functions. They not only displace the fluid within the cylinder but also act as reciprocative pistons tending to compress the fluid at their inner ends, said compressed fluid being exhausted from behind the vanes predeterminately so that a desired resistance to inward movement of the vanes is established and good sealing contact of the vanes with the cylinder wall maintained especially at the discharge region of the pump.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A rotary pump comprising a housing having a circular recess providing a cylinder; a drive shaft rotatably supported by the housing and extending eccentrically into said recess; a cover cap for the housing forming a closure for said cylinder; a disc-shaped rotor eccentrically supported within the cylinder by said drive shaft and forming a crescent shaped fluid displacement chamber within the cylinder; two diametrically opposite, segmental recesses in the cover cap, one forming a fluid intake port, the other a fluid discharge port; equally spaced, radial slots in the peripheral wall of the rotor; a vane slidably supported in each slot respectively; a chamber in said cover cap; a spring loaded valve in said chamber, dividing it into two separate compartments; means connecting the one compartment with the intake port; means connecting the other compartment with the discharge port; two separate arcuate channels in the cover cap, each being adjacent a segmental recess, the one channel connecting together only the slots of the respective vanes as they traverse the intake port, said one channel being in constant communication with the compartment connected to the discharge port, the other channel connecting together only the slots of the respective vanes as they traverse the discharge port; and a fluid flow restricting duct connecting said other channel with the compartment communicating with the discharge port.

2. A rotary pump comprising a housing having a circular recess providing a cylinder; a drive shaft journalled in the housing and extending into said cylinder eccentric thereof; a cover cap for the housing closing said cylinder; a circular rotor eccentrically supported within the cylinder by said drive shaft and forming a fluid displacement chamber therein; fluid intake and discharge ports in the cap, communicating with the displacement chamber; a chamber in the cap; a spring loaded valve in said chamber dividing it into two separate compartments, the one compartment on the spring engaged side of the valve being in communication with the intake port, the other with the discharge port; radial slots in the outer, peripheral wall of the rotor; a vane slidably supported in each slot respectively, the inner end of each slot being enlarged; two diametrically opposite, separate arcuate recesses in the cap capable of communicating with the enlarged ends of the slots, one of said recesses being connected to the said other compartment communicating with the discharge port and interconnecting several slots in the rotor only as the vanes of these several slots traverse the intake port, the other of said recesses interconnecting several slots in the rotor only as the vanes in said several slots traverse the discharge port; and a fluid flow controlling duct connecting said other recess with the compartment communicating with the discharge port, said duct providing a substantially constant, predetermined restriction to the flow of fluid from said other recess under the displacement effect of the inwardly moving vanes.

3. A rotary pump consisting of a housing having recesses providing a cylinder having an annular wall and a fluid chamber divided into two compartments; separate ducts connecting said cylinder and the respective compartments, one duct forming a fluid intake port, the other a fluid discharge port for the cylinder; a drive shaft; a fluid displacement member rotatably supported

by said drive shaft eccentrically within the cylinder, said member having a plurality of radial slots; a vane slidably supported in each slot and being adapted to engage the annular wall of the cylinder; a fluid passage providing communication between the one compartment of the fluid chamber and the inner ends of only those radial grooves in the displacement member whose vanes are traversing the intake port region of the cylinder; a second fluid passage providing communication between the inner ends of only those slots whose vanes are traversing the discharge port area of the cylinder; and a fluid passage having a flow restricting portion, said passage connecting said second passage with the said one compartment of the fluid chamber.

4. A rotary pump consisting of a housing having recesses providing a cylinder having an annular wall, a fluid chamber divided into two normally non-communicating compartments and ducts connecting the cylinder with the respective compartments of said chamber, one duct forming a fluid intake port, the other a fluid discharge port for said cylinder; a drive shaft; a rotary piston in the cylinder attached to the drive shaft eccentrically of the cylinder, said piston having a plurality of radial slots, the inner end of each terminating in a separate enlarged transverse opening in the piston, said transverse openings being arranged in a circular row concentric of the piston; a vane in each piston slot, slidable therein for engagement with the annular cylinder wall eccentric to the piston; two separate, arcuate grooves in the housing, concentric of the piston, one groove being adjacent the intake port and interconnecting the enlarged openings of only those grooves the vanes in which are traversing the intake port area of the cylinder, the second groove being adjacent the discharge port and interconnecting the enlarged openings of only those grooves the vanes in which are traversing the discharge port area of the cylinder; a fluid passage connecting the one compartment of the fluid chamber with the one groove; and a fluid passage of predetermined fluid restricting characteristics connecting the said one compartment of the fluid chamber with the second groove.

5. A rotary pump consisting of a housing rotatably supporting a drive shaft and having recesses providing a cylinder and a two compartment fluid chamber and separate ducts connecting said cylinder and the respective compartments of the chamber, one duct forming a fluid intake port, the other a fluid discharge port for the cylinder; a fluid displacement member rotatably supported by the drive shaft eccentrically within the cylinder, said member having a plurality of radial slots; a vane slidably supported in each slot and being adapted to engage the wall of the cylinder; two separate, arcuate grooves in the housing, one groove connected to one compartment of the fluid chamber and operative to interconnect hydraulically only the inner ends of those vanes in the fluid displacement member traversing the intake port area of the piston, the second groove, connected to the said one compartment of the fluid chamber by a duct of predetermined fluid restricting characteristics, being operative to interconnect hydraulically, the inner ends of those vanes traversing the discharge port area of the cylinder.

6. A rotary pump consisting of a housing rotatably supporting a drive shaft and having recesses providing a cylinder, a fluid chamber divided into two compartments and separate ducts connecting the cylinder with the respective compartments of said chamber, one duct forming a fluid intake port, the other a fluid discharge port for said cylinder; a rotary piston attached to the drive shaft and eccentric of the cylinder, said piston having a plurality of radial slots; a vane slidably supported in each slot and shorter than the depth of the slot, said vanes slidably engaging the cylinder wall; two separate fluid channels in the housing each operative to communicate with and interconnect certain of said vane supporting slots, the one channel with no more than one-half of said slots in the piston concurrently, the second channel with no more than the other half of said slots concurrently; and separate fluid passages connecting each channel with one compartment of the fluid chamber, one of said passages having greater fluid restricting characteristics than the other.

7. A device in accordance with claim 3 in which the fluid chamber is divided into two compartments by a spring loaded valve operative in response to fluid pressure in the compartment communicating with the discharge port, for connecting the said discharge port with the compartment communicating with the intake port.

8. A device in accordance with claim 4 in which the fluid chamber is divided into two compartments by a normally closed, spring loaded valve operative by fluid pressure in said one compartment, with which the discharge port communicates, for connecting both compartments, the fluid passages communicating with both arcuate grooves being connected to said one compartment.

9. A rotary pump consisting of a housing rotatably supporting a drive shaft and having recesses providing a cylinder and fluid chamber means providing two compartments and separate ducts connecting said cylinder and the respective compartments of the chamber means, one duct forming a fluid intake port, the other a fluid discharge port for the cylinder; a fluid displacement member rotatably supported by the drive shaft eccentrically within the cylinder, said member having a plurality of radial slots; a vane slidably supported in each slot and being adapted to engage the wall of the cylinder; two separate, arcuate grooves in the housing, one groove connected to one compartment of the fluid chamber means and operative to interconnect hydraulically only the inner ends of those vanes in the fluid displacement member traversing the intake port area of the piston, the second groove, connected to the said one compartment of the fluid chamber means by a duct of predetermined fluid restricting characteristics, being operative to inteconnect hydraulically, the inner ends of those vanes traversing the discharge port area of the cylinder.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
226,773	Newcomb	Apr. 20, 1880
2,411,602	Tweedale	Nov. 26, 1946