Sept. 13, 1938. A. J. GRANBERG 2,129,928

POSITIVE PRESSURE ROTARY PUMP

Filed May 8, 1937

Fig. 1.

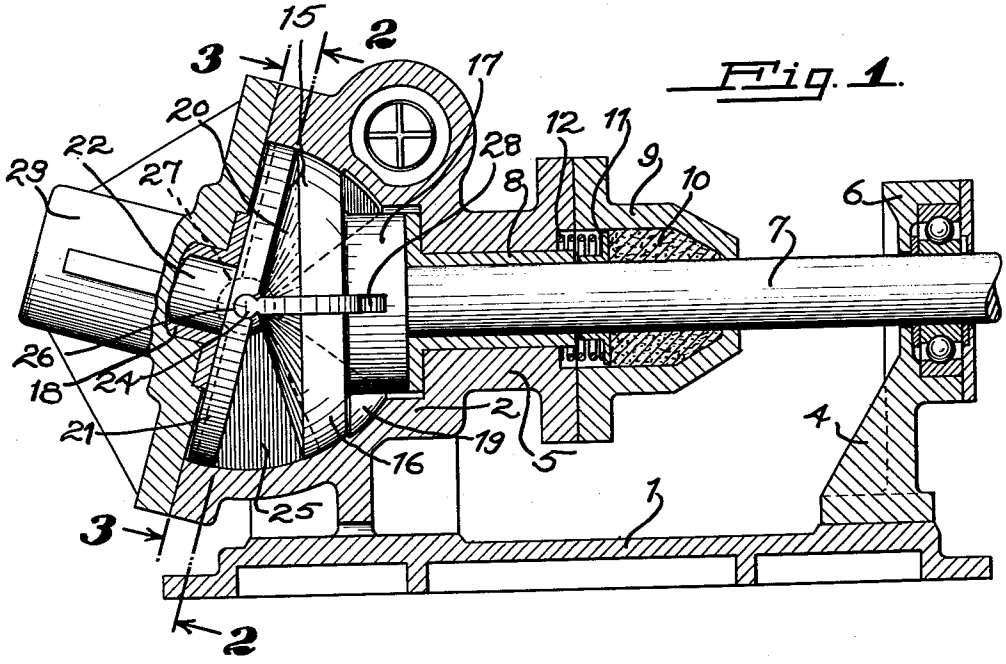


Fig. 3.

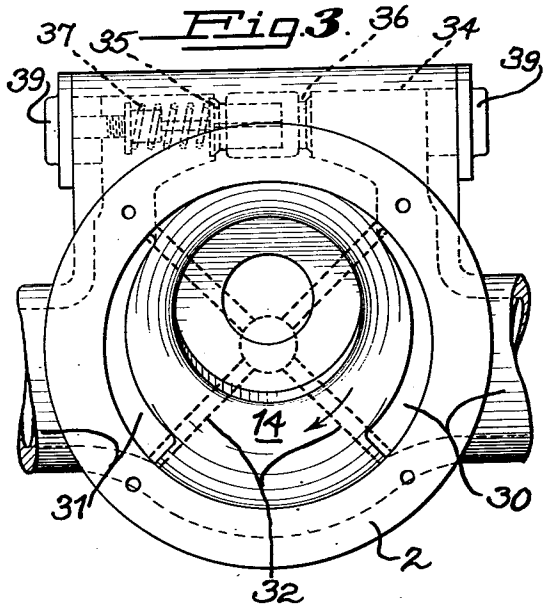
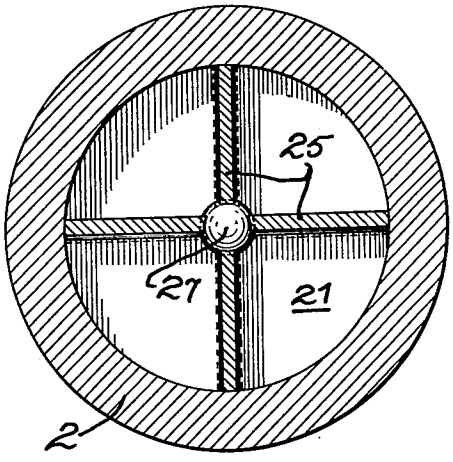


Fig. 2.



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POSITIVE PRESSURE ROTARY PUMP

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8 Claims. (Cl. 103—127)

My invention relates to rotary pumps, and more particularly to rotary pumps delivering liquids at positive pressures.

Among the objects of my invention are: to provide a rotary pump having the advantages of both centrifugal and gear type pumps: to provide a positive pressure pump for liquids; to provide a positive pressure pump particularly adapted for handling liquid fuels; to provide a rotary pump operating at positive pressures wherein the stresses are distributed to reduce wear and leakage; to provide a positive pressure rotary pump which may be operated in either direction; and to provide a new and unique rotary pump.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of the invention herein described, as various forms may be adopted within the scope of the claims.

It is well known in the art that centrifugal pumps are efficient and give a high delivery volume, but it is also well known that such pumps do not deliver positive pressures at the output and that they are also subject to the disadvantage of easily losing their prime. Vane and gear pumps have, therefore, largely supplanted centrifugal pumps where it is necessary that a positive pressure output be maintained and where it is not convenient to maintain a special priming system. Gear pumps, in general, are inefficient and are subject to excessive wear, and vane pumps of the usual types develop excessive friction due to the angles at which stresses are applied to the vanes. Hereinafter is described a novel type of pump having the positive action of the gear and vane pumps and which approaches, in its efficiency of operation, the centrifugal type.

My invention may be more readily understood by direct reference to an illustration of a preferred embodiment thereof, and in the drawing Fig. 1 is a longitudinal view, partly in section and partly in elevation, of the pump of my invention as developed for handling liquid fuels.

Fig. 2 is a sectional view taken as indicated by the line 2—2 in Fig. 1.

Fig. 3 is an elevational view, taken as indicated by the line 3—3 in Fig. 1, certain channels being indicated by dotted lines.

A pump base 1 is provided, carrying at one end a pump body casting 2, and at the other end an outboard bearing standard 4. The pump body casting 2 carries a pump body bearing 5 having therein a bearing bushing 8 cooperating with an outboard bearing 6 to position and support a main pump shaft 7. Pump body bearing 5 terminates in a packing cap 9, forcing packing 10 against the shaft and against packing flange 11, urged against the cap by packing spring 12. Packing glands of this type are self-packing and require little attention, as is well known in the art.

Pump casting 2 is provided with a pump chamber 14 having a substantially hemispherical surface, and pump shaft 7 terminates in a pump head 15. Pump head 15 is provided with a spherical zone 16 which bears against the hemispherical surface of the pump chamber. The pump head is also provided with a thrust bearing flange 17 engaging the end of pump casing bearing bushing 8.

Inasmuch as I prefer to make the spherical zone 16 narrow and the thrust bearing flange 17 cylindrical, it is obvious that there will be an annular casing chamber 19 surrounding the thrust bearing flange. The pump head 15 terminates in a coned surface 20, the apex of which lies on the axis of shaft 7 but terminates short of the center of the sphere described by the inner surface of the pump chamber 14.

Abutting the coned surface 20 is a rotatable vane plate 21 carried by a vane plate axle 22 rotating in a vane axle bushing 18 mounted in vane plate bearing 23. This vane plate is a disc, and the vane plate axle 22 is angularly positioned with respect to pump shaft 7, so that one radius of the disc closely abuts one radius of the coned surface 20 from near the apex to the periphery. The opposite radii of the disc and coned surface, respectively, will diverge to form an open space.

Mounted on the vane plate 21 are four triangular vanes 25 spaced along 90° radii of the disc. Each vane has a partially cylindrical side bearing 24 entering a partially cylindrical radial channel 26 in the disc. The radial channels 26 have an arc greater than 180°, and thus retain the vanes but allow them to rock slightly.

The center of the vane plate and the vane axle is provided with a recess in which is inserted a central ball 27 projecting a short distance also into the apex of coned surface 20, thus effectively forming a universal joint between the pump head 15 and the vane plate and vane axle assembly. The central portion of each vane is machined to fit this ball, thus providing a central seal between the quadrant compartments. The vanes extend into 90° vane slots 28 in the pump head 15, and their outer surfaces are contoured to fit the hemispherical wall of the pump chamber 14. Thus, at all times there will be four quadrant compartments completely separated by the vanes but of different capacity, due to the angular positioning of the vane plate shaft 22 and the pump shaft 7.

It is also to be noted that the vane slots 28 extend into the annular channel 19 so that the portions of these slots back of the vanes are in communication with each other at all times, and to further this intercommunication, I prefer

to slightly relieve the annular channel so that it is open above the periphery of the blades.

The hemispherical pump chamber 14 is provided with inlet and outlet ports 30 and 31, each port being of 90° extent and oppositely positioned. These ports are positioned with relation to the quadrant compartments, so that when any quadrant compartment is at full opening, in the vane position shown by the heavy broken line 32 in Fig. 3, neither inlet nor outlet port is open to that compartment.

As I prefer to design my pump to operate in either direction I provide a bypass channel, as indicated by the light broken line 34 in Fig. 3, connecting the inlet and outlet ports, and position in that port a removable relief valve 35 maintained against one of a pair of duplicate seats 36 by a relief valve spring 37. This relief valve may be reversed by removing relief valve caps 39, withdrawing the relief valve assembly, and inserting it in the other side of the pump.

In operation, the pump shaft 7 is rotated in any convenient manner. Pump head 15 will then rotate, and as the vanes engage both this pump head and the vane plate 21, the latter will also rotate, being driven through the vanes, the vanes rocking as they rotate. The quadrant chambers will then vary from maximum volume, where the vane plate 21 and the coned surface 20 are at maximum angular divergence, to minimum volume, where the vane plate is closest to the coned surface, and of course these two quadrants are directly opposite. One of the other two opposing quadrants will be increasing in volume, whereas the remaining quadrant will be decreasing in volume.

Inasmuch as the opening quadrant will be in communication with inlet port 30, liquid will enter until the opening quadrant reaches the position between the inlet and the outlet point where it is at maximum volume. An instant thereafter the leading vane of this quadrant passes on to the outlet port 31 and the quadrant will start to decrease in size, thus forcing liquid out of the outlet port. There will be, at all times, at least one vane blocking any communication between inlet and outlet ports. Thus, the device will operate as a positive pressure pump.

As the pump assembly rotates, the vanes will change their angular relationship to the vane plate 21 and will rock in channel 26 and move slightly over the central ball 27. Also, if there is any leakage past the blades through the vane slots 28, it will pass into the annular channel 19, but there will be no chance of locking the blades, even if this channel is filled with liquid, because the volume of this channel plus the free portions of the vane slots will always remain the same, due to the reciprocation of the blades in opposite phase.

There are a number of advantages inherent in the type of pump herein described. In the first place, the vanes are supported by both radial edges. Therefore, the friction developed is distributed over the wide surfaces of the vane in contact with the pump head and vane plate. The stresses do not tend to bend the blades nor to force them against the hemispherical surface of the pump chamber, and thus wear at this point is greatly reduced, delivery is at a positive pressure, and the pump may be rotated at high speeds, thus giving a high volumetric delivery at a high efficiency. No springs are needed nor are they desirable, and it is not necessary to rely on centrifugal force to maintain a vane seal.

Furthermore, in the embodiment shown, the vane disc 21, disc axle 22, and disc axle bearing 23, together with bushing 18, may be removed as a unit from the casting 2, carrying the vanes with the disc. This allows the pump chamber to be cleaned and makes for easy service. It will also be apparent that if the circular segmental surface of the flange 17 wears, due to thrust, the head will still maintain its seal where the spherical surfaces are in contact. All compartments will increase in size equally if the head moves away from the disc, due to wear, and the delivery will not be affected.

The specific embodiment of my invention shown and described herein utilizes a hemispherical chamber surface bearing against the outer ends of the vanes as they rotate, and a spherical segment on the head. This spherical segment, bearing against the hemispherical surface, provides an extensive thrust bearing for the head in addition to the bearing on the flange 17. However, I wish it distinctly understood that the form shown is illustrative only, and that, reduced to simplest terms, the pump will operate satisfactorily where the hemispherical surface has been cut down to a spherical wedge surrounding the quadrant compartments. Furthermore, it is obvious that the disc axle 22 may be dispensed with, inasmuch as the disc will remain in proper location without it. It will only be necessary when heavy loads are to be carried.

The coned surface 20 may be machined directly on the end of shaft 7 and the spherical segment 15 thereby dispensed with, providing other arrangements are made to take up thrust. Under these circumstances the vane slots 28 will be cut directly into the material of the shaft 7, which will be enlarged at this point and which may then have an annular channel cut in it so as to connect the vane slots.

It is therefore to be understood that in its most simple form my pump need consist only of a rotating member having a coned surface, a disc having one radius parallel and adjacent one radius of the coned surface, the vanes, a spherical wedge surface surrounding the pump chamber, and means for rotating the assembly. It is also obvious that while it is more advantageous, from a practical standpoint, to drive the pump head, that the disc could be driven if it is desired.

I also do not wish to be limited to any particular number of vanes, as it is obvious that more than four vanes could be used with appropriate repositioning of the inlet and outlet ports. All of these modifications will be apparent to those skilled in the art, and are to be considered full equivalents within the scope of the appended claims.

In common with most pumps, the device herein described and claimed is reversible in action, i. e., it will act as a motor when supplied with fluid under pressure. The word pump, therefore, as used herein, is deemed to include this inherent feature. As the device is a positive pressure pump, so also it is a positive motor when driven and can be used for metering fluids.

I claim:

1. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a spherically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof par-

allel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes mounted on said disc and extending into slots in said pump head, means for maintaining a tight sliding contact between said vanes and said pump chamber and means for rotating said head and disc.

2. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a spherically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof parallel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes mounted on said disc and extending into slots in said pump head, means for maintaining a tight sliding contact between said vanes and said pump chamber and a rotatable power shaft attached to said head.

3. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a spherically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof parallel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes mounted on said disc and extending into slots in said pump head, said vanes contacting the surface of said chamber to produce a plurality of separate compartments therein, means for maintaining a tight working fit between said vanes and said pump chamber, oppositely disposed inlet and outlet ports opening into opposite compartments, and means for rotating said head and disc.

4. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a spherically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof parallel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes mounted on said disc and extending into slots in said pump head, said vanes contacting the surface of said chamber to produce a plurality of separate compartments therein, means for maintaining a tight working fit between said vanes and said pump chamber, oppositely disposed inlet and outlet ports opening into opposite compartments of less than maximum volume, and means for rotating said head and disc.

5. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a spherically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof parallel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes rotatably mounted along equally spaced radii of said disc and extending into slots in said pump head, means for maintaining a tight working fit between said vanes and said chamber surface, and means for rotating said head and disc.

6. A rotary pump comprising a casting having a spherically segmental inner chamber, a rotatable pump head in said chamber having a sperically segmental surface engaging said chamber, a coaxial coned surface on said pump head extending into said chamber, a rotatable disc positioned with a planar surface thereof parallel to one radius of said coned surface, the center of said planar surface lying in the axis of said coned surface, a plurality of vanes rotatably mounted along equally spaced radii of said disc and extending into slots in said pump head, a free ball mounted in recesses in head and disc at the axial junction thereof, a plurality of vanes rotatably mounted along equally spaced radii of said disc and extending into slots in said pump head, the inner end of said vanes bearing against said ball and the outer end against the wall of said chamber to provide separate compartments therein, means for maintaining a tight sliding fit between said vanes and said spherical chamber and between said spherically segmental pump head surface and said chamber, an inlet port and outlet port in communication with opposite compartments of less than maximum volume, and means for rotating head and disc.

7. A rotary pump comprising a casting having an inner wall describing a spherical surface, a pump shaft, a pump head on said shaft and having a spherical zone bearing on said spherical surface, a coaxial coned surface on said head and based on the largest circle of said zone, a disc positioned to have one radius adjacent and parallel with one radius of said coned surface, a plurality of vanes rotatably mounted on and along equally spaced radii of said disc and extending into slots in said pump head, a free ball mounted in recesses in said head and disc at the axial junction thereof, and contacting the inner ends of all of said vanes, the outer ends of said vanes contacting said spherical surface to form separate compartments, means for maintaining a tight sliding fit between said vanes and said spherical chamber and between said spherically segmental pump head surface and said chamber and inlet and outlet ports connected to opposite compartments of less than maximum size.

8. A rotary pump comprising a casting having an inner wall describing a spherical surface, a pump shaft, a pump head on said shaft and having a spherical zone bearing on said spherical surface, a coaxial coned surface on said head and based on the largest circle of said zone, a disc positioned to have one radius adjacent and parallel with one radius of said coned surface, a plurality of vanes rotatably mounted on and along equally spaced radii of said disc and extending into slots in said pump head, a free ball mounted in recesses in said head and disc at the axial junction thereof, and contacting the inner ends of all of said vanes, the outer ends of said vanes contacting said spherical surface to form separate compartments, means for maintaining a tight sliding fit between said vanes and said spherical chamber and between said spherically segmental pump head surface and said chamber and inlet and outlet ports connected to opposite compartments of less than maximum size, said slots being interconnected back of said vanes.

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