Dec. 7, 1943. H. A. BULLARD 2,336,344

ROTARY PUMP

Filed May 3, 1941 2 Sheets-Sheet 1

FIG. 1.

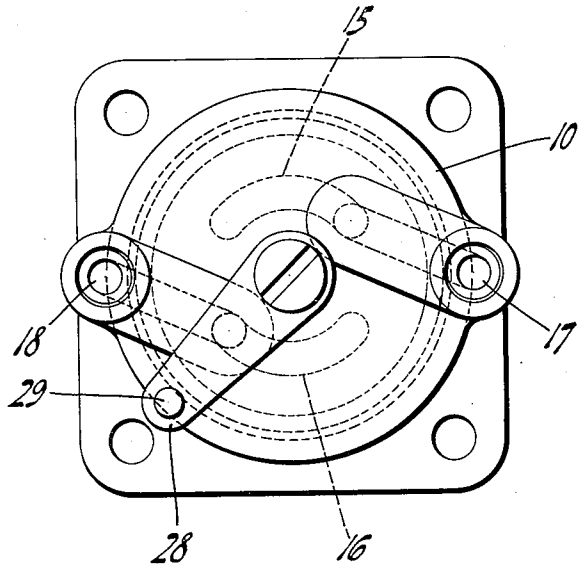
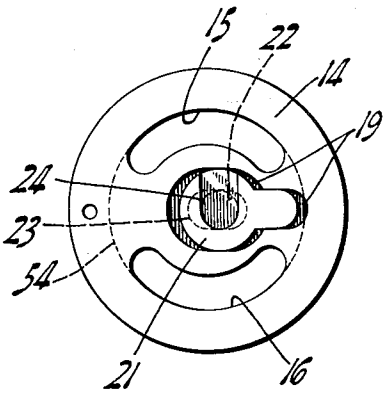


FIG. 5.



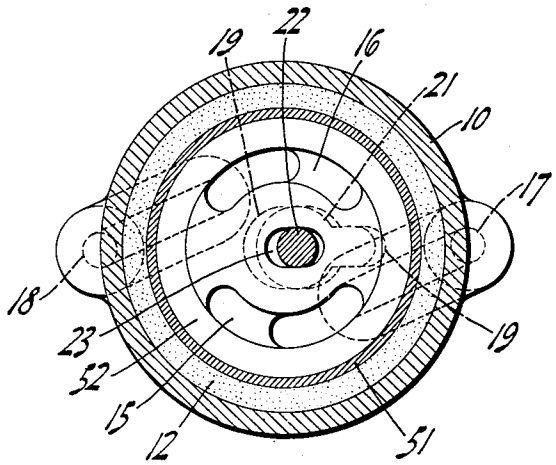


FIG. 4.

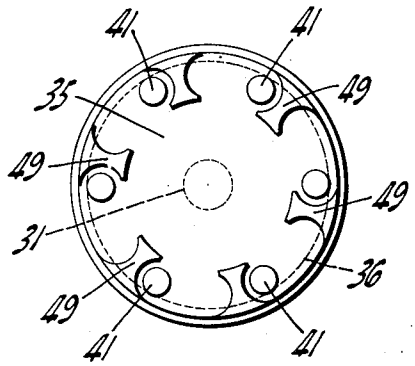


FIG. 6.

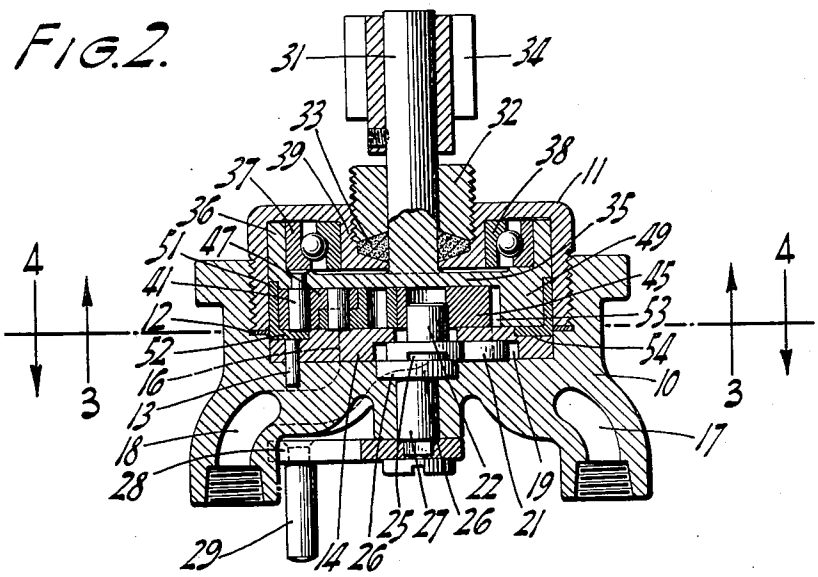
INVENTORS
HERBERT A. BULLARD DECEASED, BY AUGUST MERRILL ADMINISTRATOR, AND BROOKS B. BRADSHAW.
BY
Beau, Brooks, Buckley & Beau.
ATTORNEYS

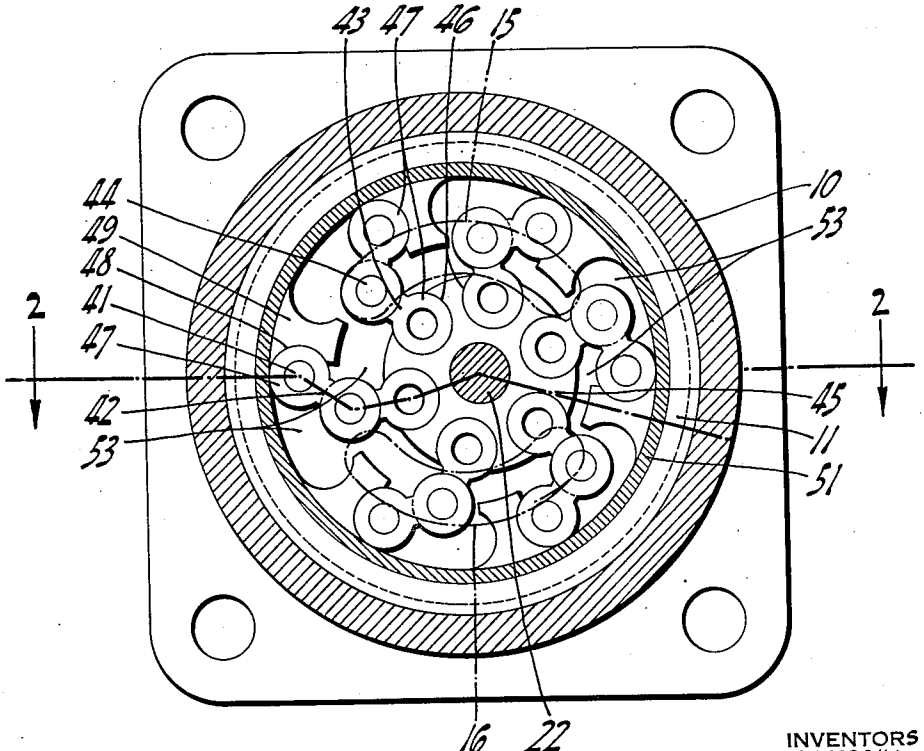
Dec. 7, 1943. H. A. BULLARD 2,336,344

ROTARY PUMP

Filed May 3, 1941 2 Sheets-Sheet 2

FIG. 2.





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FIG. 3.

Patented Dec. 7, 1943 2,336,344

UNITED STATES PATENT OFFICE

2,336,344

ROTARY PUMP

Herbert A. Bullard, deceased, late of Syracuse, N. Y., by August Merrill, administrator, Utica, and Brooks B. Bradshaw, Syracuse, N. Y.

Application May 3, 1941, Serial No. 391,677

7 Claims. (Cl. 103—121)

This invention relates to rotary pumps and similar fluid displacement mechanisms, and has particular relation to such devices of the type wherein a plurality of vanes are rotatable about an eccentric axis.

According to the invention inner and outer rotors are connected by pairs of hinged vanes, each such pair of vanes being hinged to both rotors. When the rotors are operated on eccentric axes, the chambers between the vanes contract and expand during each revolution, and a casing around the rotors is provided with inlet and outlet ports for admitting fluid to the expanding chambers and for exhausting fluid from the contracting chambers.

The construction, by providing a pivoted or hinged connection between each pair of vanes and both rotors, enables broad working surfaces to be provided between the relatively moving parts, and also permits the capacity or displacement of the device to be varied by merely shifting the axis of rotation of the inner rotor toward or away from the axis of rotation of the outer rotor.

The invention contemplates means for effecting such shifting, which means may comprise a crank carried by the casing, and operable from the exterior thereof, for moving a trunnion about which the inner rotor moves, radially with respect to the axis of rotation of the outer rotor. By these means the capacity of the device may be adjusted or varied from zero to the maximum without creating any undue back pressure on the pump, and such adjustment being effected without producing any substantial surging of the fluid.

While the invention is applicable to devices of any desired size, it has been found that even when constructed as a pump with small dimensions, it is operable to deliver a relatively large flow of liquid under a relatively high pressure, and these and other characteristics render it particularly adaptable for use as a motor fuel pump for airplane engines and the like. Due to its ability to be adjusted accurately as to volume of discharge, and its constancy of delivery, no carburetor valve is needed, the pump acting as a throttle for the engine.

These and other objects and advantages will become apparent from the following description of the typical embodiments of the invention shown in the accompanying drawings, wherein:

Fig. 1 is an end view of a complete pump;

Fig. 2 is a sectional view taken in a plane at right angles to that of Fig. 1 and along line 2—2 of Fig. 3;

Fig. 3 is an enlarged sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken along line 4—4 of Fig. 2; and,

Figs. 5 and 6 are detail views of parts of the pump.

As shown in the drawings the device includes a casing body 10 and a casing cover 11 screw threaded together with a gasket 12 of any suitable material disposed between their opposed faces. Seated in a recess in the casing body and held against rotation therein by a pin 13 is a plate 14 provided with ports 15 and 16 communicating respectively with passages 17 and 18 formed in the casing body. The plate 14 has a guide recess 19 formed in the face thereof adjacent the casing body, for slidingly receiving the head 21 of a trunnion 22 which extends through an elongated opening 23 in the opposite face of plate 14.

The trunnion head 21 has a slot 24 extending at right angles to the direction of movement of the trunnion as determined by guide recess 19, and engaging in this slot 24 is a crank pin 25. The latter extends from the head 26 of a shaft 27, being eccentric to the latter, whereby upon turning of the shaft the trunnion 22 will be shifted in guided relation to plate 14. For effecting such turning of the shaft, the latter is provided, exteriorly of the casing, with a crank arm 28 having crank pin 29.

Casing cover 11 journals a centrally disposed drive shaft 31 which is encircled by a gland nut 32 that is screw threaded to the cover and functions to compress a packing 33 for the shaft. The outer end of the shaft may carry a gear 34 or other means for imparting rotary motion, and formed integrally with or secured to the inner end of the shaft is an outer rotor member comprising a disc-like central portion 35 having an outwardly directed peripheral flange 36 receiving the outer race 37 of a ball bearing assembly whose inner race 38 is supported by the central portion 39 of cover 11.

The outer rotor has secured thereto near its periphery a plurality of inwardly directed equally spaced pins 41, which are parallel to shaft 31 and to trunnion 22. Pivoted by these pins to the outer rotor are outer pump vanes 42, each such vane being pivoted to an inner vane 43 by a pin 44, and the inner vane being pivoted to an inner rotor member 45 on axes spaced equally thereabout. The inner rotor is mounted for rotation on the trunnion 22 and is provided adjacent its periphery with cylindrical recesses 46 in which

are received cylindrical ends 47 of the vanes 43 to effect the pivotal connection between the vanes and the inner rotor.

The outer and inner vanes, 42 and 43, may be identical in size and shape, if desired, and each pair of them constitutes a pair of pivoted links pivotally connecting the inner and outer rotors. The cylindrical ends 47 of the outer vanes may engage cylindrical surfaces 48 formed on projections 49 which extend in an axial direction from the outer rotor. With this arrangement of parts it will be seen that broad bearing surfaces are provided between the outer rotor and the outer vanes, between the outer and inner vanes, and between the inner vanes and the inner rotor, thereby obviating the likelihood of undue wear and leakage difficulties that occur in constructions where a single line contact is provided between relatively moving working parts.

The assembly of the outer vanes upon the outer rotor is maintained by a ring 51 which preferably has a press fit upon the outer rotor, and constitutes, in effect, a part of the latter. The ring 51 has an inwardly directed flange 52 engaging the faces of the outer vanes opposite to the faces thereof engaged with the central portion 35 of the rotor, and the flange is seated within a peripheral groove 54 in plate 14, whereby its inner face may be flush with the face portion of the plate 14 that engages the vanes.

By reason of the gasket 12 the cover 11 may be secured in fluid tight relation to the casing body 10 while allowing considerable latitude of axial adjustment of the cover relative to the casing body, so that sufficient clearance may be provided between the opposed faces of rotor 35 and plate 14 for free operation of the vanes.

The construction described provides a plurality of working chambers 53 between the pairs of vanes. In operation, with the crank 28 in the position shown and the trunnion 22 in eccentric relation to the axis of rotation of shaft 31 and the outer rotor, rotation of the latter will, through the vanes, impart rotation to the inner rotor 45, and the working chambers 53 will expand and contract once during each such rotation.

With the parts rotated in the direction of the arrow in Fig. 3, i. e., clockwise, the expanding chambers will receive fluid from passage 18 through port 16 in plate 14, while fluid will be exhausted from the contracting chambers through port 15 into passage 17. The passages 18 and 17 may therefore be connected, respectively, to a source of fluid to be pumped and to a conduit or chamber to which such fluid is to be delivered. It will be understood, however, that if the pump elements are rotated in the opposite direction, counterclockwise in Fig. 3, then passage 17 will become the pump inlet and passage 18 the outlet.

By moving the crank 28 to shift the trunnion 22 into greater eccentricity with the axis of rotation of shaft 31, the maximum and minimum capacities of the chambers 53 will be further increased and decreased, respectively, thereby increasing the fluid displacement of the device. Likewise, by moving the trunnion into a lesser degree of eccentricity, the capacity of the device will be reduced; and, if the trunnion is moved into concentricity with shaft 31, the chambers 53 will remain of constant size during rotation thereof, and no pumping action will occur.

Thus, the construction, by providing vanes in the form of pivoted links pivoted to both the outer and inner rotors, enables the pumping action by expansion and contraction of the chambers between the vanes without shifting of the points of connection of the vanes to either of the rotors, and enables the relative eccentricity of the rotors to be varied, as desired, while the device is in operation, so that the quantity of fluid received and discharged may be varied smoothly, without introducing surges into the flow of fluid.

As mentioned hereinbefore, the construction affords broad bearing surfaces between the working parts, thereby reducing wear and enabling the device to pump fluid under high pressures without substantial leakage. In this connection, the ring 51 with flange 52 functions to prevent leakage of liquid from one chamber to the next, the flange serving as a seal to prevent leakage between the outer rotor and the non-rotating plate 14.

The rotors are economical to manufacture, and the vanes 42, 43 may be economically formed by a broaching operation, whereby an initial close tolerance is obtained between the ends of the vanes and the engaging surfaces of the rotors, and due to the oscillations of the vanes these surfaces quickly wear in to form good fluid seal, rendering the pump capable of delivering fluid at high pressures.

While the embodiment herein is a liquid pump, it will be understood that the same principles may be employed in pumps for any kind of fluids and in motors operated by fluid under pressure. It will be understood further that the structure shown and illustrated herein is merely illustrative of the inventive principles involved, and that these may be otherwise embodied without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In a rotary fluid displacement device, a casing, a pair of rotors in said casing adapted to rotate about offset axes, a shaft connected to one of said rotors and a trunnion supporting the other of said rotors, a plurality of pairs of vanes, one vane of each pair being pivotally connected to one rotor at a point spaced radially from the axis of rotation of said one rotor, the other vane of each pair being pivotally connected to the other rotor at a point spaced radially from the axis of rotation of said other rotor, said vanes of each pair being pivotally joined together at their adjacent ends, an annular member encircling the periphery of said outer rotor and being formed with an inwardly extending flange partially overlying said vanes, a plate having a part thereof arranged within said flange and with the face of said part adjacent said vanes, said plate having inlet and outlet ports opening into the spaces between pairs of vanes in an axial direction relative to said rotors, and means operable from the exterior of the device for shifting said trunnion to vary the degree of offset relation of said rotors and thereby to vary the fluid displacement of the device.

2. A rotary fluid displacement device comprising a casing, a shaft journaled in the casing and an outer rotor in the casing and connected to said shaft, said rotor being formed adjacent its periphery with a plurality of circumferentially spaced apart projecting portions extending axially of said shaft, an inner rotor arranged within the projections of said outer rotor and having a plurality of recesses formed about its periphery, a plurality of pairs of vanes, one vane of each pair being pivotally connected to the outer rotor in liquid tight relation to one of said projections

thereon, and the other vane of each pair being pivotally connected to the inner rotor and engaging in liquid tight relation in one of the recesses therein, said vanes of each pair being pivotally joined together at their adjacent ends in liquid tight relation, an annular member encircling the projections of said outer rotor and being arranged in liquid tight relation thereto, said inner rotor being journaled on a trunnion movably mounted upon one wall of the casing to adjust the inner rotor into varying degrees of eccentricity relative to said outer rotor, said wall being provided with fluid inlet and outlet ports, and means carried by the casing and operable exteriorly thereof for moving said trunnion relative to said casing radially of the axis of rotation of said shaft during rotation of said rotors for varying the fluid displacement rate of the device.

3. A rotary fluid displacement device comprising a casing, a shaft journaled in the casing and an outer rotor connected to the shaft and within the casing, said rotor comprising a disc having a plurality of circumferentially spaced apart pins projecting from the face thereof, an inner rotor formed with a plurality of peripheral recesses of cylindrical formation, said outer and inner rotors being connected together by a plurality of pairs of inner and outer vanes, the vanes of each pair being pivotally joined at their adjacent ends, said inner vanes being journaled at their opposite ends in the respective recesses of the inner rotor, and the outer vanes being pivotally mounted on the respective pins carried by the outer rotor, said inner rotor being journaled on a trunnion movably mounted upon one end wall of the casing to adjust the inner rotor into different degrees of eccentricity relative to said outer rotor, means carried by the casing and operable exteriorly thereof for moving said trunnion during rotation of said rotors, and said end wall of the casing having inlet and outlet ports for conducting fluid into and from the spaces between adjacent pairs of rotors.

4. A rotary fluid displacement device comprising a casing, a shaft journaled in the casing and an outer rotor connected to the shaft and within the casing, said rotor comprising a discoidal portion having a plurality of circumferentially spaced apart projections extending from one face thereof, an inner rotor arranged within said projections, said rotors being connected by a plurality of pairs of vanes, one vane of each pair being pivotally connected to the outer rotor, and the other vane of each pair being pivotally connected to the inner rotor, and said vanes of each pair being pivotally joined together at their adjacent ends, a plate arranged in the casing and overlying said projections on the outer rotor and being formed with a centrally arranged aperture, a trunnion mounted in said aperture and being movable radially toward and from the axis of said plate, said inner rotor being journaled upon said trunnion, means operable exteriorly of the casing for effecting movement of said trunnion, and fluid inlet and outlet ports opening through said plate.

5. A rotary fluid displacement device comprising a casing, a shaft journaled in the casing and a rotary unit in the latter and connected to said shaft, said unit comprising an outer rotor, an inner rotor, a plurality of pairs of vanes connecting said rotors, the vanes of each pair being pivotally joined together at their adjacent ends and being pivotally connected at their opposite ends to said inner and outer rotors respectively, said unit also including an annular member encircling the periphery of said outer rotor and being formed with an inwardly extending flange partially overlying said vanes, a plate having a part thereof arranged within said flange and with the face of said part adjacent said vanes, a trunnion carried by said plate and being movable radially toward and from the axis thereof, said inner rotor being journaled upon said trunnion, means operable exteriorly of the casing to move said trunnion into and out of axial alinement with said outer rotor during rotation of said rotor unit, and fluid inlet and outlet ports opening through said plate into the spaces between adjacent pairs of vanes.

6. In a rotary fluid displacement device, a casing, a rotor shaft journaled in the casing-and an outer rotor within the casing and connected to said rotor shaft, an inner rotor and a plurality of pairs of vanes, one vane of each pair being pivotally connected to one rotor at a point spaced radially from the axis of rotation of said one rotor, the other vane of each pair being pivotally connected to the other rotor at a point spaced radially from the axis of rotation of said other rotor, said vanes of each pair being pivotally joined together at their adjacent ends, an annular member encircling the periphery of said outer rotor and being formed with an inwardly extending flange partially overlying said vanes, a plate having a part thereof arranged within said flange and with the face of said part adjacent said vanes, said plate having fluid inlet and outlet ports for said device, a trunnion carried by said plate and journaling said inner rotor, said trunnion being guided for movement with respect to said casing to adjust it to varying degrees of eccentricity relative to the outer rotor, and a crank carried by the casing and having an eccentric crank pin engaging said trunnion for adjusting the latter.

7. In a rotary fluid displacement device, a casing, a rotor shaft journaled in the casing and an outer rotor within the casing and connected to said rotor shaft, an inner rotor and a plurality of pairs of vanes, one vane of each pair being pivotally connected to one rotor at a point spaced radially from the axis of rotation of said one rotor, the other vane of each pair being pivotally connected to the other rotor at a point spaced radially from the axis of rotation of said other rotor, said vanes of each pair being pivotally joined together at their adjacent ends, said casing having an end wall with a face adjacent to said vanes, said wall having fluid inlet and outlet ports for said device, a trunnion extending through said wall and journaling said inner rotor, said trunnion being guided for movement with respect to said casing to adjust it to varying degrees of eccentricity relative to the outer rotor, and a crank carried by the casing and having an eccentric crank pin engaging said trunnion for adjusting the latter relative to said casing in directions radially of the axis of rotation of said shaft for varying the fluid displacement rate of the device, said crank having a shaft portion extending from the casing substantially axially of the rotor shaft.

AUGUST MERRILL,
Administrator of the Estate of Herbert A. Bullard, Deceased.

BROOKS B. BRADSHAW.