

Dec. 27, 1949

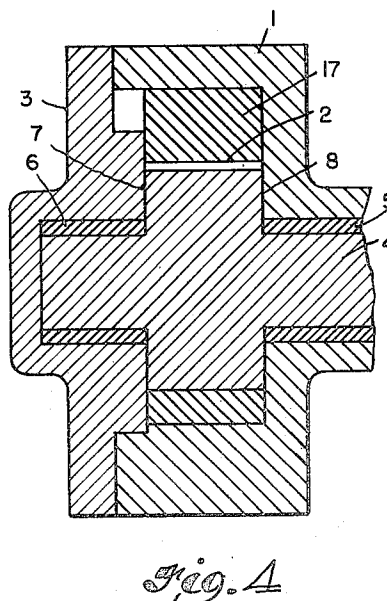
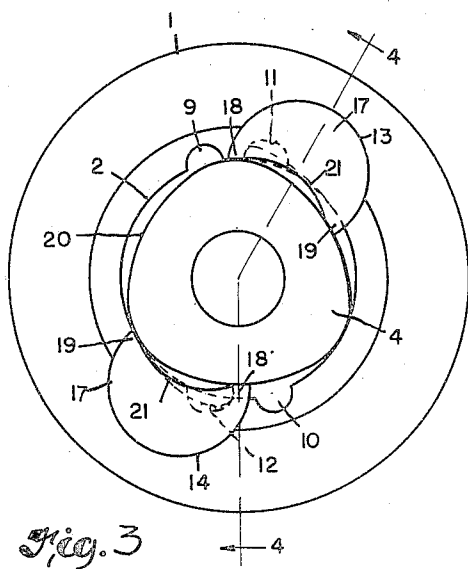
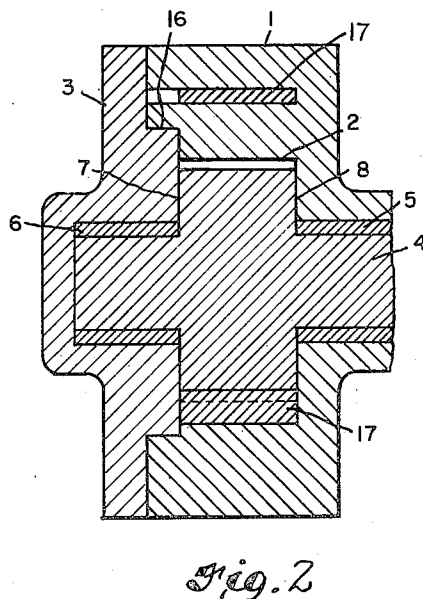
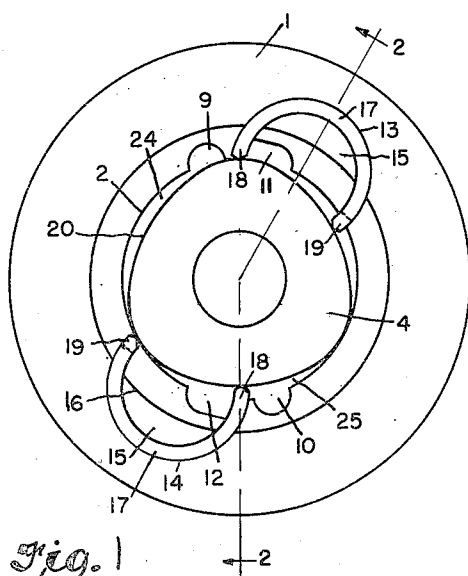
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2,492,869

OSCILLATING ABUTMENT ROTARY PUMP

Filed April 8, 1946

2 Sheets-Sheet 1



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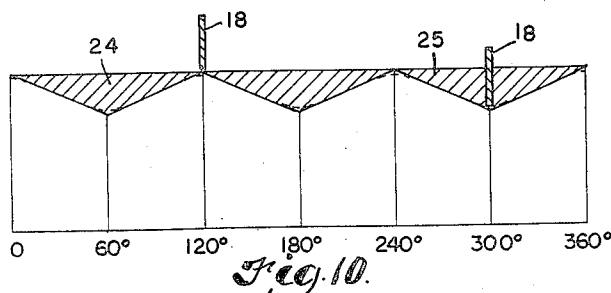
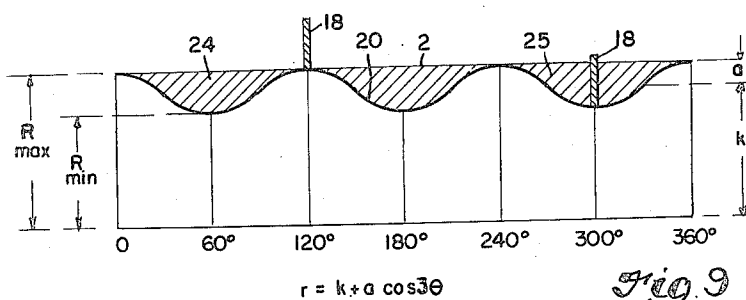
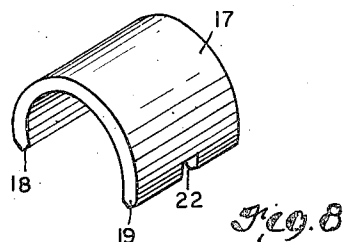
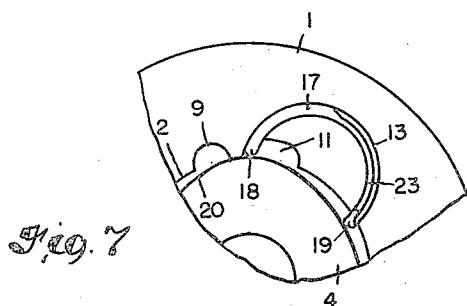
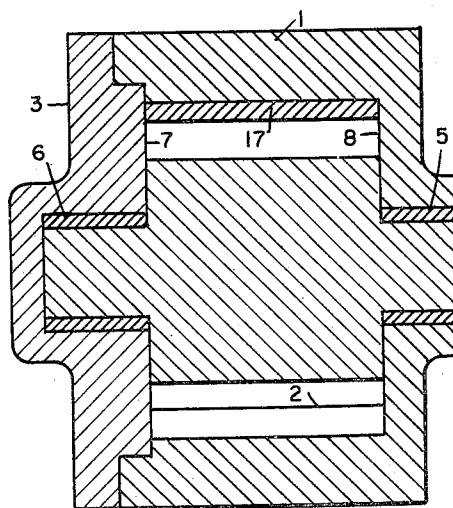
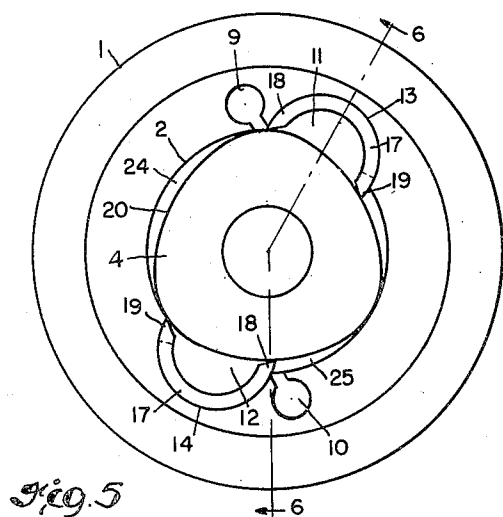
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OSCILLATING ABUTMENT ROTARY PUMP

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OSCILLATING ABUTMENT ROTARY PUMP

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5 Claims. (Cl. 103—124)

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The present invention relates to improvements in rotary pumps of the sliding vane type wherein a vane oscillates toward and away from the axis of rotation of a rotor which is rotatably mounted within a stator. It is an object of this invention to provide a pump which is capable of displacing fluid thereinto and therefrom without pulsation and without mechanical shock. That is to say that a constant volume of fluid is displaced during every increment of rotation of the rotor with smooth and gradual actuation of the vanes.

It is another object of this invention to provide a novel form of cam surface and vane arrangement for eliminating pulsation in the delivery of the pump and also mechanical shock therein.

It is another object of this invention to provide a pump which can be operated at high speeds without throwing the vanes toward or away as the case may be from the cam surface which actuates the same.

It is another object of this invention to provide a pump in which the vanes are positively actuated so as not to become inoperative when the pump is used for pressurizing highly viscous fluids.

It is another object of this invention to provide novel means for maintaining the vanes in continuous sealing engagement with the cam surface which actuates the same.

It is another object of this invention to provide novel means for assuring that the rotor will operate freely and efficiently in spite of irregularities in the vane actuating cam surface thereof.

Additional objects and advantages of the invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In the drawings:

Fig. 1 is an end view of one form of my invention with the cover plate thereof removed to clearly illustrate the construction of the vanes, rotor and stator;

Fig. 2 is a longitudinal cross section view taken along line 2—2 of Fig. 1;

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Fig. 3 is an end view similar to that of Fig. 1 except showing a modified form of vane therein;

Fig. 4 is a longitudinal cross section view taken along the line 4—4 of Fig. 3;

Fig. 5 is a view similar to that of Fig. 1 except that it shows a simplified form of recess for vanes which are of considerable length;

Fig. 6 is a longitudinal cross section view taken along line 6—6 of Fig. 5;

Fig. 7 is a fragmentary end view similar to that of Fig. 1 except that it shows a vane which is capable of yielding to accommodate variation or irregularity in the cam surface of the rotor;

Fig. 8 is a perspective view of the vane shown in Figs. 1 and 5;

Fig. 9 is a diagrammatic developed view of the preferred form of vane actuating cam surface; and

Fig. 10 is a diagrammatic developed view of a modified form of vane actuating cam surface.

Referring now to the drawings and first generally to Figs. 1—7 wherein like parts are designated by like numerals, there is shown therein four substantially identical pumps each of which comprises a stator 1 having a cylindrical bore 2 therein closed by a cover plate 3 which defines with such bore a pump chamber. A rotor 4 is rotatably mounted within such pump chamber in suitable bearings 5 and 6 in the stator and cover plate respectively and is in sealing contact with the end walls 7 and 8 of such chamber and also with circumferentially spaced points about the cylindrical wall of bore 2.

The stator 1 is provided in the wall of its bore 2 with adjacent pairs of diametrically opposed passages 9, 10 and 11, 12 and in the preferred arrangement wherein the rotor is intended to be rotated clockwise, as viewed in Figs. 1, 3, 5 and 7, passages 9 and 10 are joined into a single discharge passage not shown and passages 11 and 12 are joined into a single inlet passage not shown. It is to be understood that the rotor can with equal facility be rotated counter-clockwise, as viewed in these figures, in which case, passages 9 and 10 and 11 and 12 will be inlet and discharge passages respectively. It is also to be understood that while the term "pump" is used throughout the specification and claims, my invention can be used as a motor to translate energy of fluid under pressure into mechanical rotation.

Stator 1 is provided with diametrically opposed recesses 13 and 14 of cylindrical form which intersect the cylindrical wall of bore 2 and which have axes parallel to that of bore 2, such recesses

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being less than fully cylindrical and preferably approximately semi-cylindrical as shown. In the form of pump shown in Figs. 1 and 7, such recesses include both an inner wall and an outer wall for accurately slide guiding the hereinafter to be described vanes which are disposed in such recesses. In order to preclude the possibility of displacement of the sections 15 of such recesses to cause binding or pinching of the vanes engaged therewith, such sections are counter-bored as at 16 to snugly receive a cylindrical extension on the cover plate 3. In the form of pump shown in Fig. 5, wherein the pump chamber is quite deep, it is preferred that no such inner section 15 be provided because of the difficulty of performing a trepanning operation to such great depth.

Fitted into each of such recesses 13 and 14 for rocking or oscillating movement therein is a vane 17 having at least a portion of its outer cylindrical surface in sliding sealing engagement with its recess to preclude the possibility of fluid bypassing between the inlet and discharge passages of the stator. Each vane 17 is also of approximately semi-cylindrical form but is of greater extent than the recess in which it is disposed so that the opposite ends 18 and 19 thereof will project radially inward beyond the wall of bore 2 into engagement with the exterior non-cylindrical wall 20 of the rotor 4. In the form of pump shown in Figs. 1, 5 and 7, the vane is in the form of a relatively thin blade curved to fit into the recess in the stator, while in the pump shown in Fig. 3, the vane is in the form of a solid cylindrical body provided with a relieved face 21 to provide the rotor contacting ends 18 and 19. Each vane includes a notch or recess 22 in end 19 thereof so that such end will merely serve as a guide to hold the end 18 in sealed relation to the rotor and to permit free passage of fluid through such notch or recess 22. The end 18 of each vane is disposed between each pair of passages 9 and 11 and 10 and 12 to continuously separate the same.

As indicated above, the exterior wall 20 of the rotor 4 is non-cylindrical and it necessarily follows that in order that the ends 18 and 19 of the vanes will continuously engage such wall during rotation of the rotor such wall must be of form such that the sum of the lengths of any two radii thereof having a central angle equal to that subtended by the points of contact between the ends 18 and 19 of the vanes therewith is a constant. In this way rotation of the rotor will effect a rocking back and forth of the vanes with the ends of such vanes in continuous engagement therewith. It will be observed that while the vane ends move in a circular path they are self-compensating so that they will at all positions subtend the same central angle relative to the axis of the rotor. It might be well at this point of the description to indicate that in the form of vane shown in Fig. 7, the vane is of reduced cross section at 23 and out of contact with recess 13. With such construction the ends 18 and 19 may yieldably engage the rotor whereby in spite of slight irregularities or variations in the trueness of wall 20 there will be a continuous engagement between the ends 18 and 19 and the wall 20 without any impeding of the free rotation of the rotor as would be the case if such ends were rigid relative to one another or without causing bypassing of fluid if such variation in trueness were

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such that both ends of the vane could not reach the wall 20.

The exterior wall 20 of the rotor is of radius equal to that of bore 2 at three uniformly spaced points and between such points the wall gradually moves away from and closer to the wall of bore 2 to define three pump cavities, the widest section of each pump cavity being at a point mid-way between the points of contact of the wall 20 with the wall of bore 2. Inasmuch as there are three maximum radii and three minimum radii, the radius of wall 20 must increase and decrease from maximum to minimum and vice versa during each 120° interval and in so doing the length of any two radii having a 60° central angle must total the sum of a maximum radius plus a minimum radius.

Such condition can be satisfied by any of several forms of curves as will be presently referred to, but I prefer to use the form defined by the following equation:

$$r = k + a \cos b\theta$$

wherein r is the radius of the curve at any angle θ from a reference point, a is one-half the difference between the maximum and minimum radius, b is an integer determining the period of such curve, and k is the mean radius.

Applying this equation to the particular form of curve shown in the drawing, it becomes

$$r = k + a \cos 3\theta$$

which provides six equally spaced and true inflection points, three of which are maximum points and three of which are minimum points, all normal to radii thereto.

In Fig. 9, the equation

$$r = k + a \cos 3\theta$$

is developed or translated into rectangular coordinates, and, as shown, the curve is smooth and gradually changes from minimum to maximum and from maximum to minimum whereby the vane ends engaged therewith will be gradually accelerated and decelerated without mechanical shock in changing their direction of oscillation. The curve shown in Fig. 10 comprises six similar and alternately opposite Archimedean spiral sections joined together. Such latter curve will also produce the result of constant sum of any two radii having a 60° central angle therebetween but such curve does not include the six true inflection points and thus there will be mechanical shock when the direction of movement of the vanes is changed from one direction to the other. However, this shock condition can be minimized by forming the sharp corners as shown dotted in Fig. 10.

In studying the diagrams shown in Figs. 9 and 10, it will be evident that during each cycle of movement of the rotor the volume of fluid discharged from one of the discharge passages gradually varies from zero to maximum to zero and, therefore, in order that the total discharge from the pump be uniform and without pulsation, it is essential that the volume of fluid discharged from a second passage joined with the first passage at the same time gradually varies from maximum to zero to maximum whereby the sum of the volumes discharged from such passages at any instant is constant. Such condition can readily be obtained by spacing the vanes 180° apart with the ends 18 thereof in sealed engagement with the rotor between the passages 9 and 11 and 10 and 12. In such case, the sum of the

volumes of discharge from passages 9 and 10 will at any instant be equal to a constant. This can best be seen by reference to Fig. 9 wherein $R_{\max}$ represents the radius of bore 2 of the stator and also the maximum radius of the rotor wall 29 and $R_{\min}$ represents the minimum radius of the wall 28. Now, if the rotor moves toward the right as viewed in Fig. 9 (clockwise as viewed in Figs. 1, 3, 5 and 7) fluid from cavities 24 and 25 will be discharged and at any instant the sum will obviously be a constant. That is, the area of the elemental rectangle $2ade$ multiplied by the length of the cavities.

It will be obvious to those skilled in the art that while I have accomplished the desired ends by using a pump having three pumping cavities, it is possible to do so by providing 4, 5, 6 or more cavities just so long as the vanes are spaced apart at least the extent of $1\frac{1}{2}$ cavities and so that there will at all times be at least one point of sealing between the rotor wall and the stator between such vanes. Of course, if elimination of pulsation is not of the essence, a pump with two cavities may be utilized in which there are two diametrically opposed rockably mounted vanes.

In the above description and in the claims, where I have used the terms "contact" and "engagement" with reference to the stator and rotor and with reference to the vanes and rotor, it is to be understood that such terms are not to be construed to be limited to actual physical contact. For example, it would be well nigh impossible to make the maximum radii of the rotor and the radius of the stator bore precisely the same and, therefore, in actual practice minute clearances are provided to assure freedom of rotation of the rotor but yet provide a fluid tight seal. The same applies to the rotor and vanes except that in the case of the vanes of Fig. 7, there will be actual physical contact but such contact does not materially impede free rotation of the rotor inasmuch as it is not excessive and is a yieldable contact.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A rotary pump comprising a stator member provided with a bore therein including a pair of diametrically opposed inlet passages and a pair of diametrically opposed discharge passages, a rotor member rotatably mounted in such bore, said rotor member and such bore including opposed walls in contact at circumferentially spaced points and defining at least three cavities between such points, and two vanes movably carried by said stator member and each having its opposite ends in contact with the wall of said rotor member, one of the ends of one vane being disposed between one of such inlet passages and one of such discharge passages and in continuous sealed contact with such rotor wall and one of the ends of the other vane being disposed between the other of such inlet passages and the other of such discharge passages and in continuous sealed contact with such rotor wall, the contour of the wall with which the vane ends contact being such that the sum of the radii at the extremities of a central angle thereof subtended by the points of contact of said vanes therewith is constant, the other ends of said vanes being formed with portions continuously

out of contact with such rotor wall to afford communication between opposite sides of the vanes at such other ends thereof.

2. A rotary pump comprising a stator member provided with a bore therein including a pair of diametrically opposed inlet passages and a pair of diametrically opposed discharge passages, a rotor member rotatably mounted in such bore, said rotor member and such bore including opposed walls in contact at circumferentially spaced points and defining three cavities of variable radial dimension between such points, and two diametrically opposed vanes movably carried by said stator member and each having its opposite ends in contact with the wall of said rotor member, one of the ends of one vane being disposed between one of such inlet passages and one of such discharge passages and in continuous sealed contact with such rotor wall and one of the ends of the other vane being disposed between the other of such inlet passages and the other of such discharge passages and in continuous sealed contact with such rotor wall, the contour of the wall with which the vane ends contact being such that the sum of the radii at the extremities of a central angle thereof subtended by the points of contact of said vanes therewith is constant, the other ends of said vanes being formed with portions continuously out of contact with such rotor wall to afford communication between opposite sides of the vanes at such other ends thereof.

3. A rotary pump comprising a stator member provided with a cylindrical bore therein including a pair of diametrically opposed inlet passages and a pair of diametrically opposed outlet passages, a rotor member rotatably mounted in such bore provided with a non-cylindrical wall in contact with the wall of such bore at three uniformly spaced points and spaced therefrom between such points in such manner that the sum of the lengths of any two radial lines 60° apart to the extremities of such rotor wall is constant, diametrically opposed vanes rockably mounted in said stator and each provided with spaced ends in engagement with points on such rotor wall spaced 60° apart, one end only of each vane being in sealed relation to such rotor wall, and said one end of one vane being disposed between one of such inlet passages and one of such outlet passages and said one end of the other vane being disposed between the other of such inlet passages and the other of such outlet passages.

4. A rotary pump comprising a stator provided with a cylindrical bore therein including inlet and outlet passages, a rotor rotatably mounted in such bore provided with a non-cylindrical exterior surface of form such that a plurality of uniformly spaced points thereof are of radius equal to the radius of such bore and that the sum of the lengths of any two radii spaced apart a predetermined angle to the extremity of such surface is constant, said stator being provided with an annular recess of semi-cylindrical form with its axis parallel to the axis of such stator bore, and a vane of arcuate form slidably engaged in such recess having spaced ends extending inward of said stator into engagement with said rotor at points spaced apart such predetermined angle, said vane including a relatively thinner yieldable portion from one end to an intermediate portion out of engagement throughout its axial extent with one wall of such recess whereby such one end of said vane is capable of yielding relative to the other end thereof.

5. A rotary pump comprising a stator member provided with a bore therein including a pair of diametrically opposed inlet passages and a pair of diametrically opposed discharge passages, a rotor member rotatably mounted in such bore, said rotor member and such bore including opposed walls in contact at circumferentially spaced points and defining at least three cavities between such points, and two vanes movably carried by said stator member and each having its opposite ends in contact with the wall of said rotor member, one of the ends of one vane being disposed between one of such inlet passages and one of such discharge passages and in continuous sealed contact with such rotor wall and one of the ends of the other vane being disposed between the other of such inlet passages and the other of such discharge passages and in continuous sealed contact with such rotor wall, the contour of the wall with which the vane ends in contact being such that the sum of the radii at the extremities of a central angle thereof subtended by the points of contact of said vanes

therewith is constant, the other ends of said vanes being formed with notches therethrough affording communication between opposite sides of the vanes at such other ends.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
383,811	Hoyt	May 29, 1888
401,203	Parker	Apr. 9, 1889
993,648	Calkins	May 30, 1911
1,972,302	Hutchison	Sept. 4, 1934
1,983,034	Hutchison	Dec. 4, 1934
2,272,635	Davis	Feb. 10, 1942

FOREIGN PATENTS

Number	Country	Date
509,953	Great Britain	July 25, 1939