

April 9, 1935.

C. S. McCANN

1,996,875

FLUID MOTOR AND PUMP

Filed June 19, 1933

2 Sheets-Sheet 1

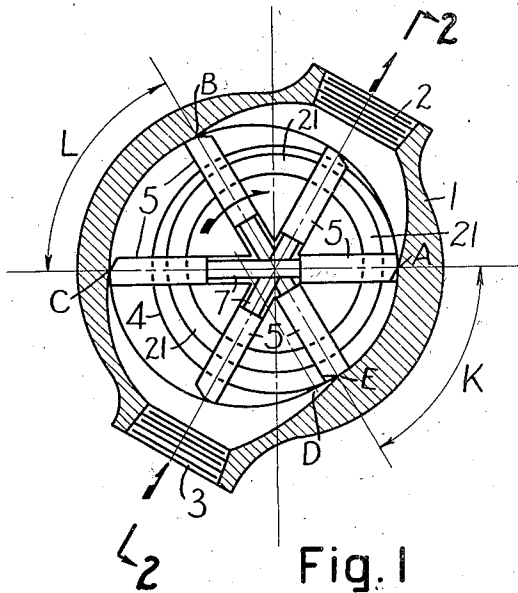


Fig. 1

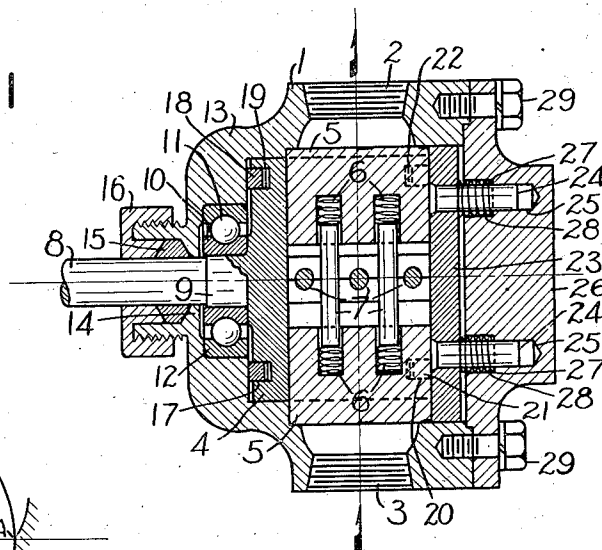


Fig. 2

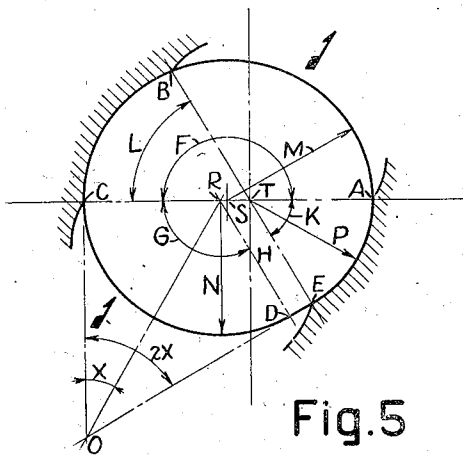


Fig. 5

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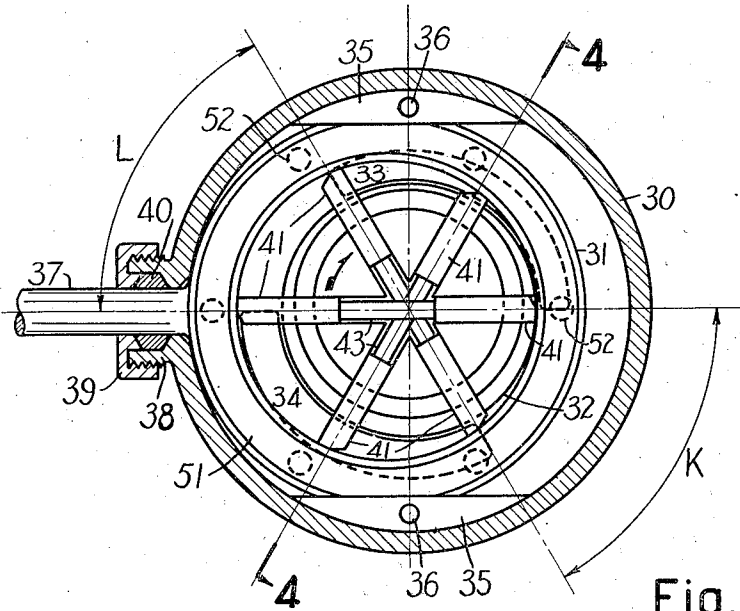


Fig. 3

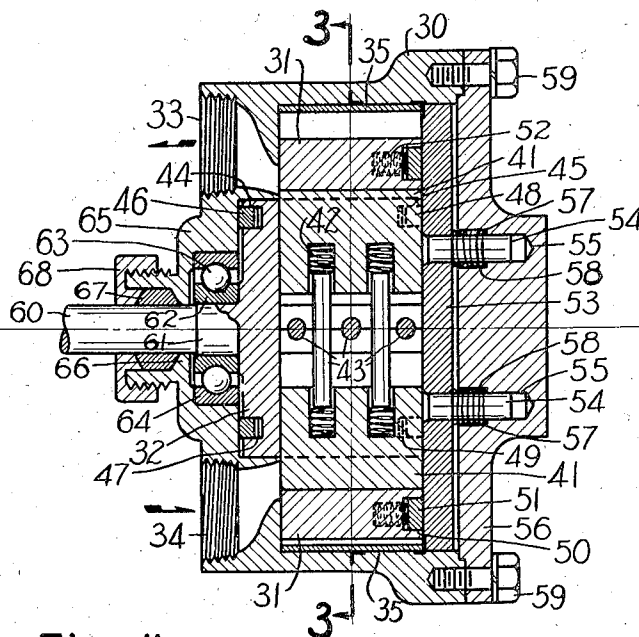


Fig. 4

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UNITED STATES PATENT OFFICE

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FLUID MOTOR AND PUMP

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1 Claim. (Cl. 103—138)

This invention relates to new and useful improvements in fluid motors and pumps.

It is one of the principal objects of the invention to provide a fluid motor of the vane type, whose rotor is mounted eccentrically within the bore of a housing which has correct porting with respect to rotor eccentricity and distance between adjacent vanes.

It is another object of this invention to provide a fluid motor with a housing bore of such special form as to give the utmost efficiency in forward direction of rotation, and which bore also allows the motor to run in the reverse direction of rotation without compression of the motive fluid. This special bore is of such form that it is inexpensive to machine; and since all of its component parts connect tangentially, the movement of the rotor vanes radially is gradual to improve the speed characteristics of the fluid motor.

Another object of my invention is to provide eccentric packing rings in front, and back of the rotor head to seal against a radial flow of the fluid.

Still another object of my invention is to provide a sealing plate which presses against the edges of the vanes, and hence seals against a circumferential flow of the fluid. A sealing ring is also provided in the side of the control ring of the variable displacement pump.

Other important and incidental objects will be brought out in the following specification and particularly set forth in the subjoined claim.

In the accompanying drawings illustrating my invention, Figure 1 is a cross sectional view of my rotary vane fluid motor of fixed displacement, showing the special bore. Figure 2 is a longitudinal sectional view taken through the same on the line 2—2 of Figure 1. Figure 3 is a sectional view of the rotary vane fluid pump of variable displacement, with circular bore, taken on the line 3—3 of Figure 4. Figure 4 is a longitudinal sectional view taken through the same on the line 4—4 of Figure 3. And Figure 5 is a diagrammatic drawing, showing the formation of the special bore employed in the motor illustrated in Figure 1.

Referring to the accompanying drawings for a detailed description of my invention, the numeral 1 designates the housing of a rotary vane type fluid motor of fixed displacement, using the special bore form as indicated diagrammatically in Figure 5. The numeral 2 designates the outlet port, while 3 designates the inlet or high pressure port in the housing 1, for direction of rotation indicated by the arrow on the face of the rotor

4. Within this rotor are slots containing six vanes 5. In cavities in each vane 5 there are springs 6, 6 with guide pins 7, 7 interposed. These pins and springs are so arranged as to clear each other through the central part of the rotor where they cross.

The motor rotor 4 has an integral shaft extension 8. Secured to an enlarged portion 9 of this shaft extension is an annular, inner race member 10 to receive ball bearings 11. The latter contacts an outer stationary race member 12 which is secured to the inner surface of an offset portion 13 of the motor housing 1. This housing is formed around the shaft extension 8 with an inward projection 14 against which packing material 15 is tightened by a packing nut 16 which screws onto the housing.

Formed in the shaft side of the rotor 4 is a slightly eccentric groove 17 to receive a sealing ring 18, which is urged outwardly from this groove by a sinusoidally formed ring spring 19. As shown in Figure 2, the ring 18, which is between the rotor and housing 1, is for the purpose of sealing against the radial flow of fluid at this point.

In the cover plate face of the rotor 4 is a similar eccentric groove 20 which is formed to receive a ring 21 that is cut into segments to conform to the vane slots in the rotor. Each segment of the ring 21 is urged outwardly against a sealing plate to be hereinafter described, by a sine spring 22, to seal against the radial flow of the fluid on this face of the rotor.

Fitted within the bore of the motor housing 1, is a sealing plate 23, attached to which are guide pins 24, 24, which in turn project into holes 25, 25 in the cover plate 26. These holes are formed with enlargements 27, 27 at their inner ends to receive coil springs 28, 28 respectively for the purpose of pressing the sealing plate 23 against the edges of the rotating vanes 5, to seal against a circumferential flow or by-passing leakage of the fluid. The cover plate 26 is secured to the motor housing 1 by means of bolts 29. The form of, and reasons for using, the special housing bore shown in Figure 1 will be discussed in detail later when describing Figure 5.

Referring to Figures 3 and 4, the numeral 30 designates the housing of a rotary vane type fluid pump of variable displacement and reversible flow, and using a circular bore. For the position of the control ring 31 and the direction of rotation of the rotor 32 as shown and indicated in Figure 3, the high pressure or outlet port is indicated by the

numeral 33, while the low pressure or inlet port is designated by the numeral 34.

The control ring 31 has flattened sides which slide against segmental blocks 35, 35 that are secured to the housing 30 by means of pins 36, 36. This control ring has a projecting shaft 37 by means of which the eccentricity of the ring may be changed to either side of the center of the rotor 32. Surrounding the shaft 37 and squeezed between the housing projection 38 and a packing nut 39, is packing material 40 for the purpose of preventing fluid leakage at this point.

Slidably mounted within slots in the rotor 32 are vanes 41, in this instance six. In cavities in each vane there are springs 42 with guide pins 43, similar to springs 6 and guide pins 7. These pins and springs are also arranged to clear each other through the central part of the rotor where they cross. It is to be noted that the bevel on the outer extremities of the vanes 41 is the reverse of that shown for the vanes 5, for the same direction of rotation. Later, when the principles of operation are described, it will be obvious why this is done.

The two faces of the rotor 32 contain eccentric grooves 44 and 45; a sealing ring 46 and sine spring 47; a segmental sealing ring 48 and sine springs 49, similar to those shown in Figures 1 and 2.

The outer face of the control ring 31 has a groove 50 formed therein to receive a sealing ring 51 which is urged outwardly from the groove by coil springs 52. This construction is for the purpose of preventing leakage of the fluid past the sides of the control ring. The bore of the control ring 31 is of circular form, as the special form indicated in Figure 5 is not needed in this case and it is cheaper to fabricate.

Fitted within the bore of the pump housing 30, is a sealing plate 53, attached to which are guide pins 54, 54 that project into holes 55, 55 in the cover plate 56. At their inner ends these holes have enlarged portions 57, 57, to receive coil springs 58, 58 for the purpose of pressing the sealing plate 53 against the edges of the rotating vanes 41, to seal against a circumferential flow or by-passing leakage of the fluid. The sealing ring 51 in the control ring 31, also bears against the sealing plate 53. The cover plate 56 is secured to the pump housing 30 by means of bolts 59.

The pump rotor 32 has an integral shaft extension 60. Secured to an enlarged portion 61 of this shaft extension is an annular, inner race member 62 to receive ball bearings 63. The latter contacts an outer stationary race member 64 which is secured to the inner surface of a projecting portion 65 of the pump housing 30. This housing has formed around the shaft extension 60 an inward projection 66 against which packing material 67 is tightened by a packing nut 68, on said housing.

Figure 5 is a diagrammatic view showing the special bore of the housing of the fluid motor in Figure 1. Starting from the point A, a semi-circular arc A—B—C is drawn throughout angle F, which is 180 degrees and whose radius is M. From C and arc C—D is drawn through the angle G, whose radius is N and which is tangential with arc A—B—C at the junction point C. D—E is a straight line which is tangential with arc C—D at the junction point D. From E, to the starting point A, is an arc E—A, with a radius P which is but minutely larger than the radius of rotor 4, through the angle K. As here shown, the angle K equals the angle L, although this need not neces-

sarily be the case. It is thus seen that the bore form as herein described is composed of the arc A—B—C, the arc C—D, the straight line D—E, and arc E—A, all of which are tangential with each other at their several junction points. The advantages of this bore form and reasons for its use will be brought out later.

The principles of operation of the fluid motor and pumps above described is as follows:

Referring to Figure 1 which shows the fixed displacement fluid motor of special bore, it will be seen that the outer extremities of the rotating vanes 5 remain practically flush with the outer periphery of the rotor 4 while they rotate through the arc A—E. From E to D and on to C, the vanes move radially outward, being so urged by the springs 6 and centrifugal force, until they have reached their full outward projection at the point C. From C to B and thence back to A, the vanes are forced back to their original and innermost positions by the shape of the housing bore. It is thus seen that the high pressure motive fluid which comes into the port opening 3, is acting against both sides of the extended vanes from the time they leave the point E until they reach the point C. The high pressure port ends at the point C, where the high pressure is cut off from the leading side of the vane and acts only on the trailing vane side. It is this force acting on one side of each vane at point C, which forces each successive vane from C to B.

The exhaust or low pressure port opening extends from the point B to the point A. The point B is placed at such a distance from point C, that just as one vane closes off the port opening at C, the preceding vane at that moment is ready to uncover the port opening at B. This is very important, since if the arc C—B is greater than this amount, there will be attempted between adjacent vanes, fluid compression which results in useless inefficiency if the fluid is compressible, and would prevent rotation if an incompressible fluid is being used. It is also important to have the vanes moving inward throughout the arc C—B, since a naturally good seal is thus obtained without depending upon the spring-loading pressure. This also creates a force on the vane extremities which has a tendency to reduce the friction on the sides of the vanes in the rotor slots. From B to A, the vanes are forced to their innermost positions radially, and all fluid is expelled from between the vanes.

The advantages of using this special bore form in a rotary vane fluid motor are as follows: Since the high pressure fluid fills the port opening 3, and extends from point C to point E, and the vanes have no projection at point E, which would not be so if a circular bore were used, all available power is used against the vanes at point C to turn the rotor in one direction. If the vanes extended any at the point E, this would tend to turn the rotor in the reverse direction, and this "reverse" force would subtract from the "forward" force. The angle K, it is thus seen, may be anything equal to or greater than the center-to-center distance between any two adjacent vanes, providing the arc combinations and tangential conditions set forth in Figure 5 are not changed.

Another advantage of this bore is seen when one tries to run this fluid motor in the reverse direction from that shown, by changing the high and low pressure connections to openings 2 and 3. In this case, the high pressure will force each successive vane from the point B to point C and thus revolve the rotor in the reverse direction. It is

seen that if the form of the bore were not such that the vanes are completely "in" radially at the point where the port opening ends at E, there would be fluid trapped ahead of each vane, and if no slippage or leakage were present, the motor could not run in the reverse direction. By having all of the component parts of the bore join tangentially, with no sudden changes in direction, there will be no rapid changes in radial movement of the vanes, which is of benefit both as to speed characteristics, as well as noise in operation.

The variable displacement fluid pump shown in Figures 3 and 4, functions as follows: Take the case of the control ring 31 in the position shown and the rotor turning in the direction indicated by the arrow in Figure 3. It is here seen that the vanes are moving radially outward through the arc below the horizontal center line, while they are moving radially inward through the arc above the horizontal center line. Thus port opening 34 will be the intake, and the port opening 33 will be in the high pressure or exhaust opening.

Ports 33 and 34 extend from the extremities of the angles K and L. The angle K can be any angle equal to, or greater than, the angle between any two adjacent vanes, and must have its upper extremity on the horizontal center line. The angle L must be such that when one vane is just closing off one port, the adjacent vane will be just about to open to the other port, and one extremity of this angle must begin at the horizontal center line. These angles must be as described here, or there will be by-passing (leakage), or attempted fluid compression between adjacent vanes. When the control ring 31 is shifted so that its center is concentric with the rotor center, there will be no pumping; and when its center is eccentrically disposed on the other side of the rotor center, the direction of pumping will be reversed if the direction of rotor rotation is

unchanged. Thus, it is seen that the amount of pumping for a given speed of rotation of the rotor and vanes, is dependent upon the amount of eccentricity of the control ring 31; and the greater the eccentricity, the greater the amount of pumping for either direction of flow.

I do not wish to be limited to the construction and arrangement shown and described, since any changes or alterations may be made therein within the scope of the subjoined claim. For example, the number of vanes used need not necessarily be as shown in the accompanying drawings. Also, a variation of the type shown in Figures 1 and 2, could be a fluid pump, in which case the vanes would have the bevel as shown in Figure 3, and if it were not run at slow speed, there need not be any pins 7 or springs 6. In this case, the rotor vane slots need not extend diametrically across the rotor and the rotor could be keyed on a through shaft, which could then be journaled in a bearing on each side of the rotor. Also, in this case, the bore could be circular instead of the special type herein shown.

Having described my invention, I claim:

In a device of the type described, a rotor housing having an eccentric bore, a rotor mounted in said bore, radially movable vanes carried by the rotor, means for maintaining contact between the outer ends of the vanes and the inner wall of the bore, and ports arranged to admit fluid to, and discharge it from, the rotor and its vanes within said housing, the bore of the latter comprising a semi-circular portion, an arc to which the latter is tangentially joined, the radius of said arc being slightly greater than the radius of said rotor, a straight-line portion tangentially joined to said arc, and a second arc portion tangentially joined to both the straight-lined and semi-circular portions.

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