United States Patent

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[54] **FLUID MOTOR**
7 Claims, 9 Drawing Figs.

[52] U.S. Cl. **91/196,** 91/339, 92/122
[51] Int. Cl. **F01b 15/00,** F01c 9/00
[50] Field of Search 91/196, 217, 223, 339, 340, 167

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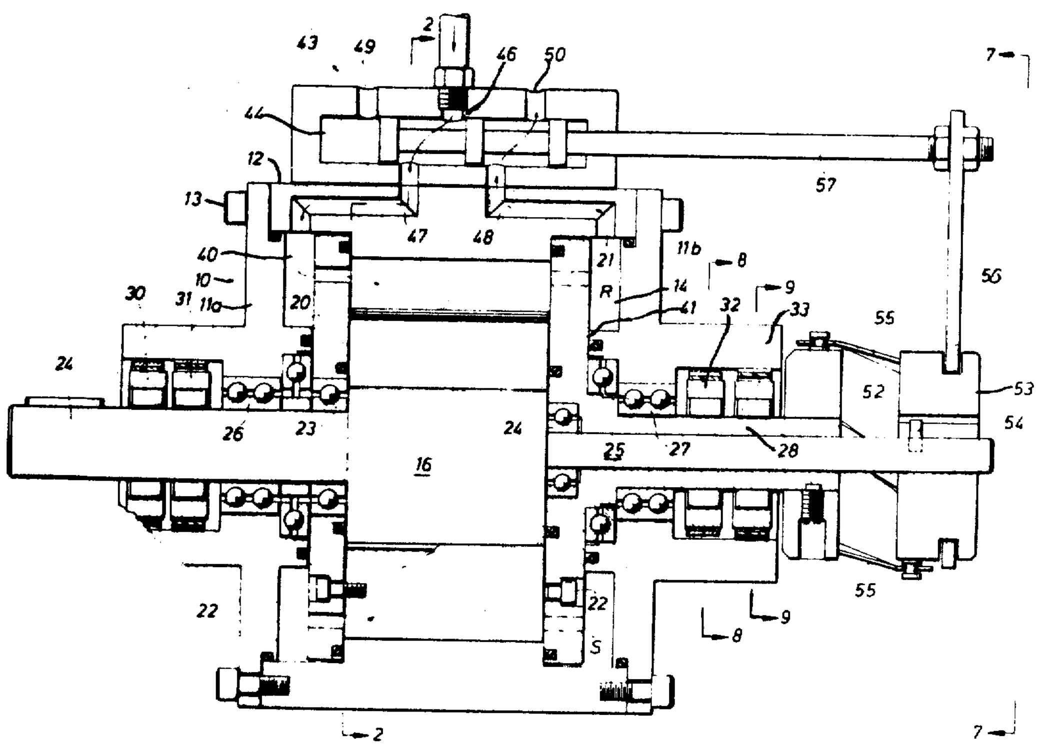
ABSTRACT: A motor is disclosed that has abutment vanes and power vanes moving around an annular chamber. Fluid under pressure is first injected between an abutment vane and a power vane while exhausting the other sides thereof to move the vanes apart. Then the pressure fluid is injected on the outer sides while the space between them is exhausted to move them together. This switching of the injecting and exhausting functions is determined by the relative position of the vanes.



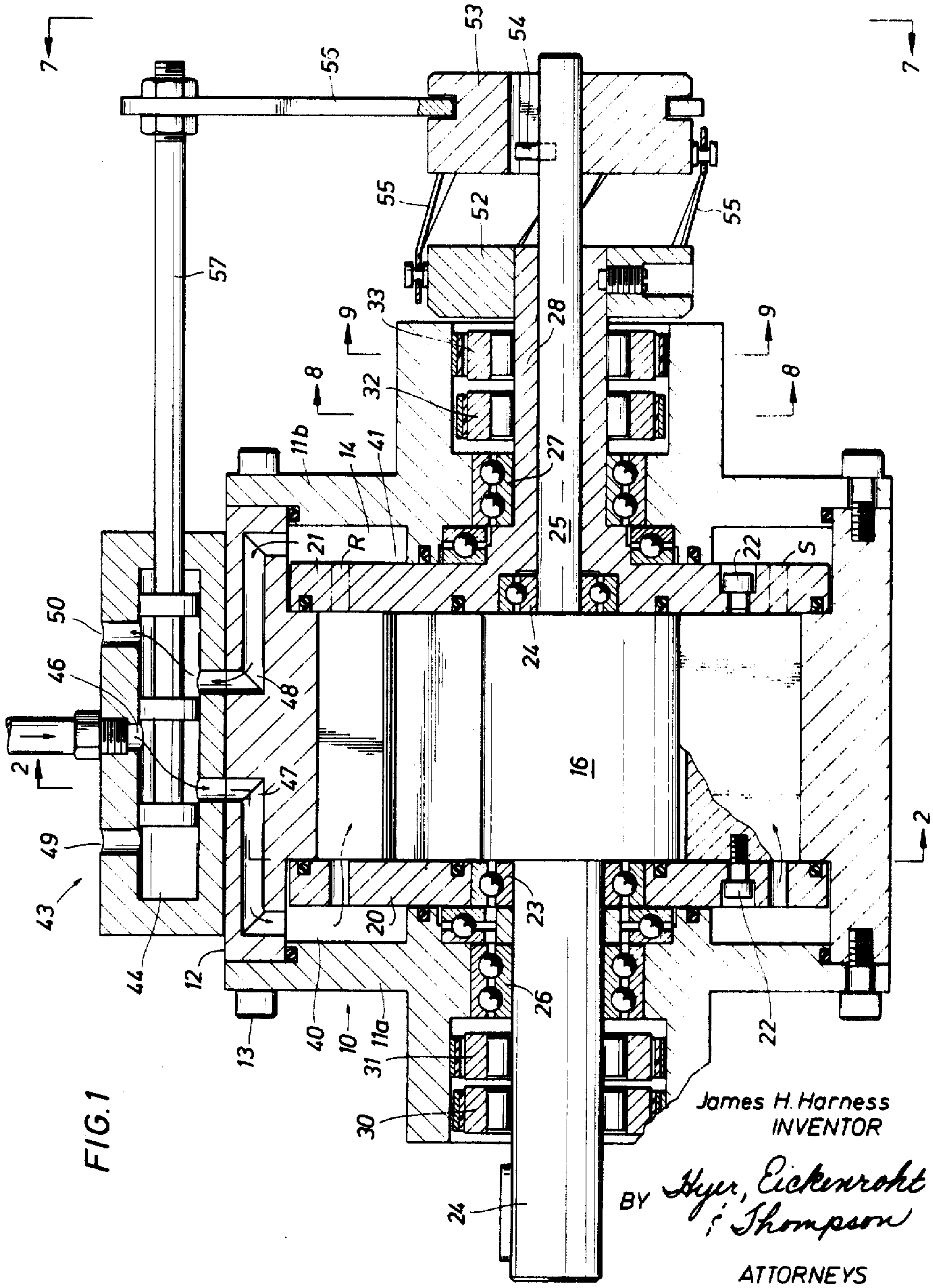


FIG.1

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FIG. 2

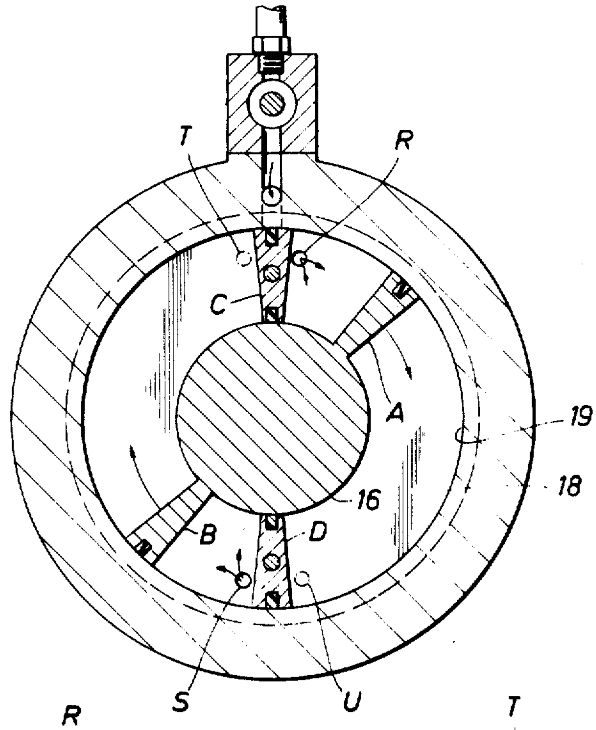
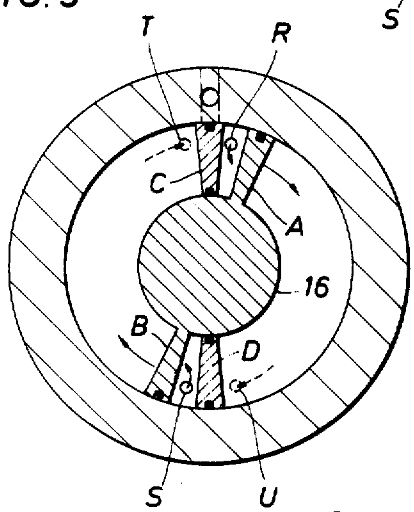


FIG. 3



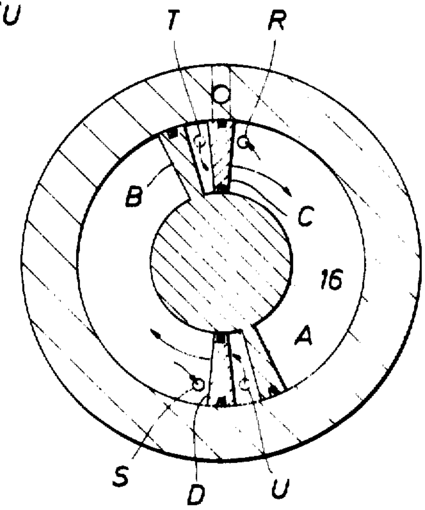


FIG. 4

FIG. 5

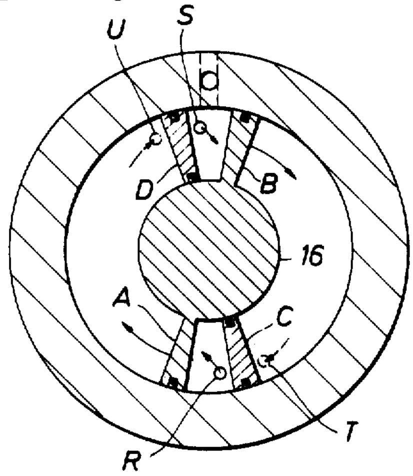


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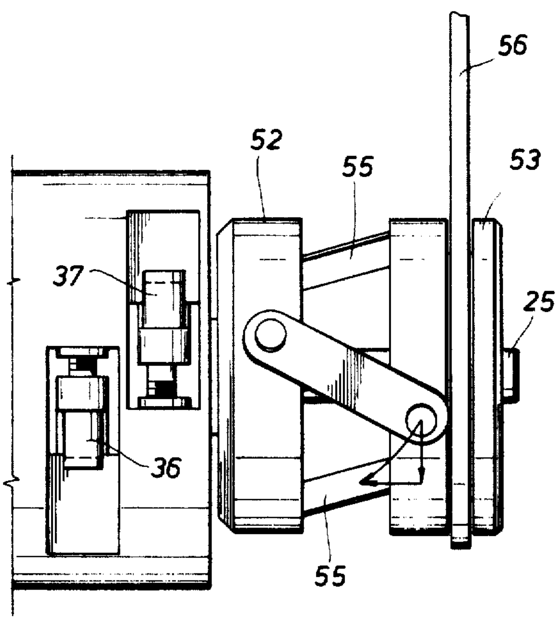
FIG. 6



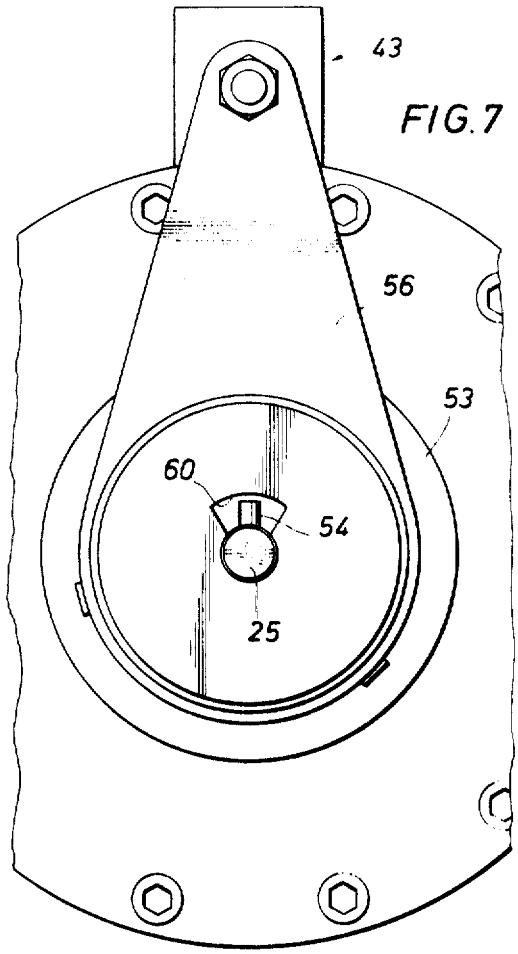


FIG. 7

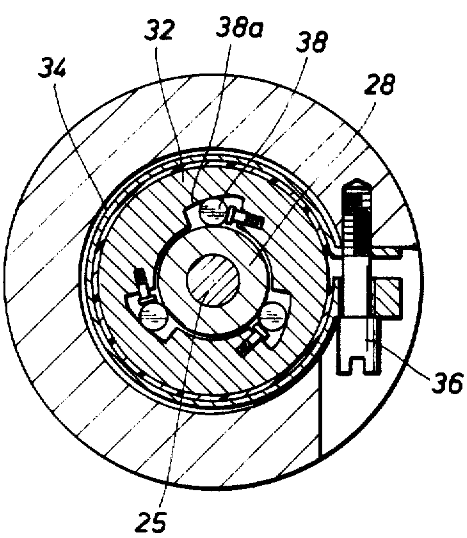


FIG. 8

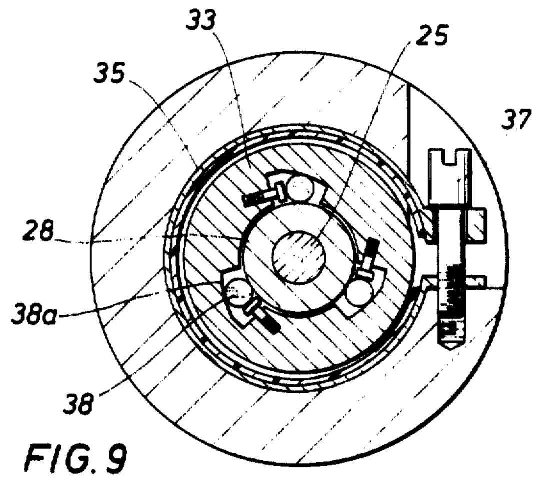


FIG. 9

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FLUID MOTOR

This invention relates to fluid motors generally and in particular to fluid motors having vanes that are sequentially moved apart and then together by alternating the sides thereof that are exposed to fluid under pressure.

In motors of the type to which this invention relates, vanes, which are usually rectangular in shape, move around an annular chamber in steps as pressure fluid is introduced into the chamber to move half the vanes forward and then to move the other half forward, while the first half is decelerated. To accomplish this, the pressure fluid is injected first on one side of every other vane and then the other side. One of the problems with this type of motor has been controlling the injection of the pressure fluid and, generally, the pressure fluid has been controlled, heretofore, in response to the position of the vanes with respect to a stationary part of the motor, generally, the housing.

It is an object of this invention to provide a fluid motor of this type wherein the injection of the pressure fluid and the exhausting thereof is controlled by the relative position of the vanes themselves and is independent of the position of the vanes with respect to the stationary housing of the motor.

It is a further object of this invention to provide a fluid motor wherein the relative angular position of two sets of vanes control the valves that direct the pressure fluid and exhaust the pressure fluid from the working pressure chambers of the motor.

It is another object of this invention to provide a fluid motor of the type described above that can be reversed readily without having to make any adjustments or changes in the valve means that controls the injection and exhausting of pressure fluid from the annular chamber of the motor.

These and other objects, advantages, and features of the invention will be apparent to those skilled in the art from a consideration of this specification, including the attached drawings and appended claims.

In the drawings:

FIG. 1 is a vertical cross-sectional view through one embodiment of the motor of this invention;

FIGS. 2—5 are sections taken along line 2–2 of FIG. 1 showing the vanes of the motor as they are moved through approximately one revolution of the output shaft;

FIG. 6 is a view in elevation from one side showing the clutch-actuating apparatus that controls the direction of rotation of the motor and a portion of the valve-operating means of the motor;

FIG. 7 is an end view taken along line 7–7 of FIG. 1;

FIG. 8 is a sectional view taken along line 8–8 of FIG. 1; and

FIG. 9 is a sectional view taken along line 9–9 of FIG. 1.

The motor includes housing **10** made up of an assembly of end plates **11***a* and **11***b* and cylindrical side member **12**. These members are connected together by bolts **13** and combine to form an enclosed cavity **14**.

A first vane assembly is located in cavity **14** and includes central shaft **16** and radially extending vanes A and B. The vanes are connected to shaft **16** for rotation with it and to move through annular chamber **18** formed between the inner cylindrical surface **19** of side member **12** of the housing and the outside surface of shaft **16**.

A second vane assembly is also located in cavity **14**. In the embodiment shown, the second vane assembly includes discs **20** and **21** and vanes C and D. Discs **20** and **21** are parallel to each other and spaced apart with vanes C and D extending between them. The vanes are attached to the discs for rotation with the discs by capscrews **22**.

Means are provided to mount the vane assemblies for coaxial rotation relative to each other and to the housing with the vanes on the two assemblies moving along the same circular path and alternately positioned in the path. In other words, the two vane assemblies are assembled so that vane C is located between vanes A and B as also is D on the opposite side. Bearings **23** and **24** support discs **20** and **21** for rotation on shaft **16**, actually bearings **23** and **24** are located on sections **24** and **25** of the shaft which are of reduced diameter from the central portion **16**. So mounted the two vane assemblies will rotate around the same axis, which is the longitudinal axis of shaft **16**. The first vane assembly that includes shaft **16** is in turn mounted for rotation relative to housing **10** by bearings **26** and **27**. Bearing **26** directly supports section **24** of shaft **16** for rotation. Bearing **27**, however, is located between housing **10** and elongated tubular member **28**, which is connected to disc **21** and through which section **25** of shaft **16** extends. Bearing **24**, in turn, as explained above, supports discs **21** and tubular member **28** for rotation on portion **25** of the shaft.

Means are also provided to hold the vane assemblies from rotation in one direction. Actually in the embodiment shown, means are provided for holding the assemblies from rotation in either direction, i.e., the direction of rotation of the assemblies can be selected but, of course, for the motor to operate the assemblies must be held against rotation in the same direction. This will be clear from the description of the operation of the motor set out below.

To control the direction of rotation of first vane assembly, one-way bearings **30** and **31** are mounted on section **24** of shaft **16**. To control the direction of rotation of the second vane assembly one-way bearings **32** and **33** are mounted on tubular member **28**. The function and structure of these two bearing assemblies is the same so only one will be described in detail.

Referring to FIGS. **1**, **8**, and **9**, bearings **32** and **33** are shown encircled by brake bands **34** and **35**, respectively. Bolts **36** and **37** can be rotated to cause the brake bands to grip the outside races of bearing **32** or **33**, as the case may be. These bearings are of the type having balls or rollers **38** that are positioned in pockets having inclined sides **38***a* so that there is room for the ball or roller to freely rotate at one end of the pocket but not at the other. Thus, rotation of the shaft in one direction will move the ball or roller toward the narrow end of the pocket and wedge the ball or roller between the shaft and the inclined side of the pocket and hold it against rotation since the race is held against rotation by its associated brake band and the housing. Rotation of the shaft from the other direction can occur freely, of course, since this moves the balls or rollers to the large ends of the pockets. This type bearing is readily available on the market and may be purchased from several different bearing manufacturers. With the brake bands out of engagement with the outer races of the bearings, the shaft and tubular member **28** can freely rotate in either direction. By tightening up on one of the brake bands so that it connects the race of one of bearing **32** and **33** to the housing, rotation in one direction of tubular member **28** and the second vane assembly will be prevented. Thus, depending upon the direction of rotation desired, either brake band can be energized for that purpose. The same can be done with the first vane assembly through one-way bearings **30** and **31** and brake bands **30***a* and **31***a*.

Means are provided that are responsive to the relative position of the vanes to alternately inject pressure fluid on first one side and then the other of each vane of one assembly while exhausting the fluid on the side opposite the side exposed to the injected pressure fluid to cause the vane assemblies to rotate in the same direction. In the embodiment shown, discs **20** and **21** are provided with ports R and S that are located on the same side of vanes C and D of the second vane assembly. In the embodiment shown, these ports are located in disc **21**. Disc **20** on the other hand is provided with ports T and U and these ports are located on the opposite side of vanes C and D. These ports are shown in broken lines in FIGS. **2** through **5**, to indicate their positions relative to the other ports. Housing **10** has annular chambers **40** and **41** that act as headers from which pressure fluid can enter the ports or into which the ports can exhaust regardless of the position of the discs.

The means for controlling the injection of the fluid and the exhausting thereof also includes valve means, and in the embodiment shown slide valve **43** is employed. This valve has cylindrical bore **44** in which valve member **45** reciprocates. Discs on the valve member move from one side to the other of inlet port **46** to alternately connect passageways **47** and **48** to the inlet pressure. When one is connected to the inlet pressure the other is connected to exhaust through either of ports **49** and **50**.

To operate valve **43** in response to the relative positions of the vanes, first and second hubs **52** and **53** are mounted on tubular member **28** and shaft **25**, respectively. Hub **53** is mounted to rotate with the shaft but it also can move axially along the shaft. It is connected to the shaft by key **54**. Hub **52** is fixed to rotate with tubular member **28**. As will be more fully explained below, tubular member **28** and shaft **25** will move at varying speeds, relative to each other, as the vanes on the two vane assemblies move together and apart in response to the injection and exhausting of the pressure fluid. This relative rotation of tubular member **28** and shaft **25** will cause hub **53** to move axially on the shaft, since it is connected to hub **52** through link arms **55**. The link arms are pivotally connected to both of the hubs, as shown in FIG. **6**, so that as the two hubs move relative to each other hub **53** will move either in or out depending upon the relative movement. Thus, the relative position of the vanes will determine the distance between hubs **52** and **53**. This distance is transmitted to valve **53** to position this valve as required to inject the pressure fluid to the proper ports in response to the relative position of the vanes. Yoke **56** transmits this actual movement of hub **53** to actuator arm **57** of the valve.

In operation, as shown in FIGS. **2** through **5**, injection and exhausting of the spaces defined by the vanes is as follows. First, in FIG. **3** vanes A and B, which are the power vanes since they are connected to the output shaft, are positioned adjacent to and ahead of vanes C and D, which are referred to as abutment vanes, since it is their function to act as reaction surfaces for the force exerted on the power vanes. In FIG. **3** pressure fluid is being injected through ports R and S between vanes A and C and B and D, respectively. Vanes C and D abutment vanes cannot move counterclockwise since in this particular explanation we will assume this is the direction against which the assemblies are being held against rotation. The pressure fluid then entering the space between the two pair of vanes will force vane A and vane B to move clockwise away from vanes C and D, respectively. This will exert torque on shaft **16** and produce power. FIG. **3** is the beginning of this particular sequence. In FIG. **2** vanes A and B have moved further away from abutment vanes C and D and in FIG. **4** they are approaching the end of their power stroke.

At this point (FIG. **4**) power vanes A and B are approaching abutment vanes C and D which must now move out of the way to reposition themselves for another power stroke. At this stage, the relative rotation of tubular member **28** and shaft **25** will be such as to cause valve **43** to switch the injection of fluid from port **48** to **47**, which is the position shown in FIG. **1**. Pressure fluid now is being introduced through ports T and U and ports R and S are opened to exhaust. Pressure fluid now will move abutment vanes C and D away from vanes B and A, respectively, again in a clockwise direction. The abutment vanes will move around until they have positioned themselves as shown in FIG. **5** adjacent to power vanes A and B, at which time movement of hub **53** will reverse the position of valve **43** and again introduce pressure fluid through ports R and S and power will be transmitted to output shaft **16**. With pressure fluid entering through ports R and S, ports T and U are now connected to exhaust to permit the fluid ahead of vanes A and B to be displaced. The cycle is continued as the motor is operated.

With the valve in arrangement described above, it is not necessary that the vanes come to a stop each time they act as an abutment vane. All they need do is decelerate to the point that the other vane, or the vane ahead of it, can be repositioned or accelerated so that it will catch up to the vane ahead of it and position itself for a reversal of the injection ports. Thus, as shown in the figures, when we are ready again for a power stroke as in FIG. **5**, vanes A and B have moved forward as the abutment vanes C and D were being repositioned. This is a very important feature of the invention, since it results in the operation of the control valve being independent of the position of the vanes relative to the stationary housing, which tends to limit the speed of this type motor.

In order for the switching of the valve to occur quickly and decisively toward the end of each step of the vanes, a lost-motion connection, as shown in FIG. **7**, is employed between hub **53** and shaft **25**. Key **54** extends into an enlarged keyway slot **60** so that there can be substantial relative movement between the two shaft and member **28** before movement of the hub occurs that will actuate the valve. This allows the cutoff and the switching of the introduction of the pressure fluid to occur quickly toward the end of each step of the vane. The angle and the position of the cutoff, of course, can be adjusted as desired.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

The invention having been described, what I claim is:

1. A motor adapted to be powered by pressurized fluid from a source remote from said motor, said motor comprising a housing having a cavity therein, a first vane assembly located in the cavity including a central shaft and at least one radially extending vane, a second vane assembly located in the cavity including two spaced discs and at least one vane extending between the discs and attached thereto, means mounting the vane assemblies for coaxial rotation relative to each other and to the housing with the vanes on the two assemblies moving along the same circular path and alternately positioned in said path, means holding the vane assemblies from rotation in one direction and means responsive to the relative position of the vanes for alternately injecting pressure fluid on first one side and then the other of each vane of one assembly while exhausting the fluid on the side opposite the side exposed to the injected pressure fluid to cause the vane assemblies to rotate in the same direction.

2. The motor of claim **1** further provided with an output shaft that is attached to the first vane assembly.

3. The motor of claim **1** in which the fluid injecting and exhausting means includes a valve for alternating the flow of fluid into and out of the chamber through the ports, a valve actuator that operates the valve by reciprocation of the actuator and means responsive to the relative position of the vanes on the first and second vane assemblies to control the valve means, said valve control means including first and second valve-actuating members attached to the first and second vane assemblies respectively for rotation with the assemblies around the same axis, means operatively connected to the valve actuator and mounted on one of the valve-actuating members to rotate with the member while reciprocating axially relative to the member, and link means pivotally connected to the means and the other member to reciprocate the means and the valve actuator to operate the valve as the relative angular position of the valve-actuating members change.

4. The motor of claim **1** in which the means for holding the vane assemblies from rotation in one direction includes means for holding each vane assembly from rotation in each direction and means for selectively actuating the holding means to permit the vane assemblies to be rotated in either a clockwise or counterclockwise direction.

5. The motor of claim **1** in which the cavity in the housing has a cylindrical side surface to combine with the discs of the second vane assembly and the central shaft of the first vane assembly to form said annular chamber.

6. An engine adapted to be powered by pressurized fluid from a source remote from the engine comprising a housing with spaced end walls and a sidewall having a cylindrical inner surface to combine with the end walls to provide a cylindrical cavity in the housing, an output shaft positioned in the cavity for axial rotation relative to the housing, two parallel discs located in the cavity and mounted for rotation coaxial with the shaft and relative to the shaft and the housing, said discs being spaced from each axially along the shaft to form with the shaft and the cylindrical inner surface of the housing an annular cylindrical chamber, at least one abutment vane extending axially of the shaft between the discs and attached to the discs for rotation therewith, at least one power vane extending axially of the shaft between the discs and attached to the shaft for rotation therewith, each of said abutment and power vane extending radially from the shaft to the cylindrical inner surface of the housing, means holding the shaft and discs from rotating in one direction, first ports through one of the discs, each port located adjacent to one of the abutment vanes to travel ahead of the vane as it moves around the annular cavity, second ports through the other disc, each port located adjacent one of the abutment vanes to trail said vane as the vane travels around the annular chamber, means responsive to the relative position of the abutment vanes and power vanes for injecting pressurized fluid into the annular chamber through the first and second ports alternately to move each of the power vanes in the same direction away from the trailing abutment vane when the fluid is injected through the first ports and then to move each of the trailing abutment vanes ahead toward the preceding power vane when the pressurized fluid is injected through the second port.

7. The fluid motor of claim 6 in which the means for alternately injecting pressurized fluid through the first and second ports includes valve means for switching the flow of such fluid to said ports, a member attached to one of the discs and extending alongside the shaft for coaxial rotation with the shaft, means operatively connected to the valve and mounted on one of said shaft and member for rotation therewith and for movement axially of the shaft, and link means connecting the means with the other of the shaft or member upon which said means is not mounted to cause axial movement of the means due to changes in the relative angular position of the shaft and member.