June 9, 1953 E. F. KLESSIG 2,641,193

POWER TRANSMISSION

Filed Oct. 19, 1950 3 Sheets-Sheet 1

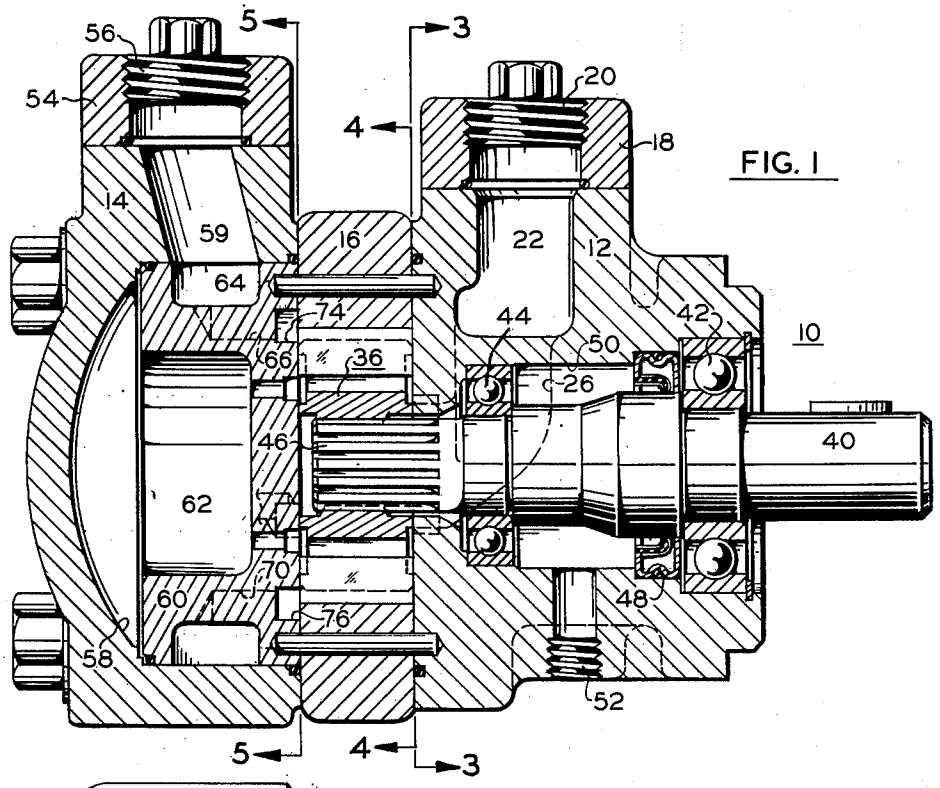


FIG. 1

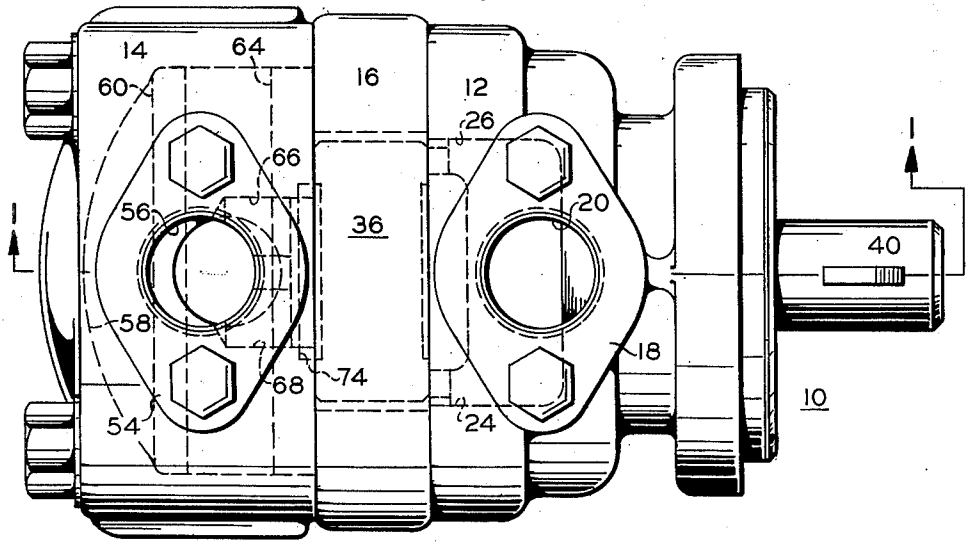


FIG. 2

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POWER TRANSMISSION

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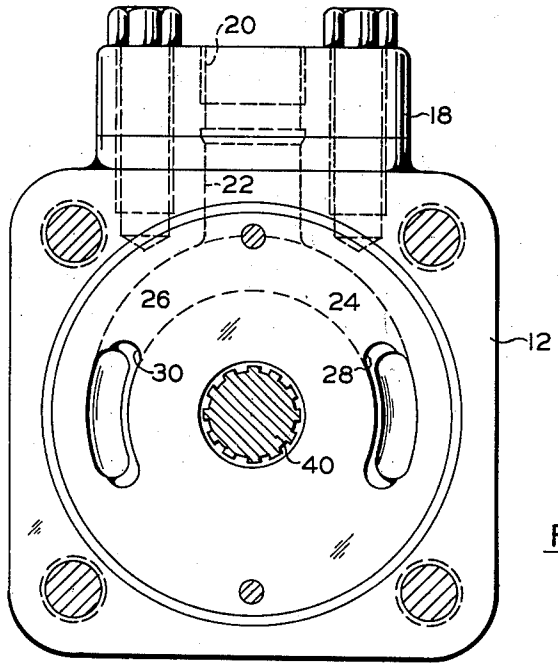


FIG. 3

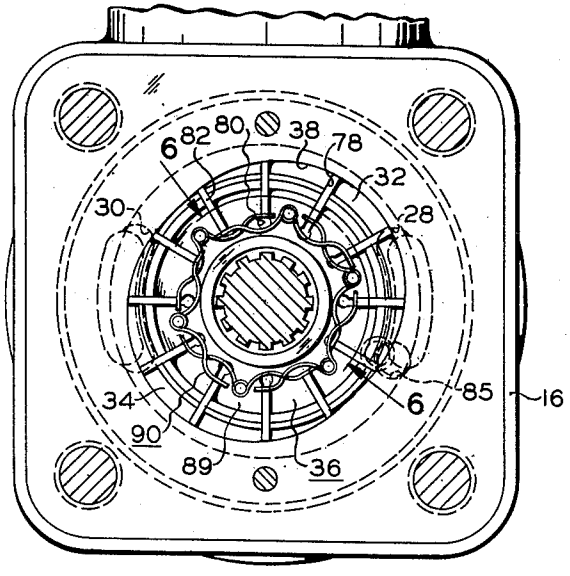


FIG. 4

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POWER TRANSMISSION

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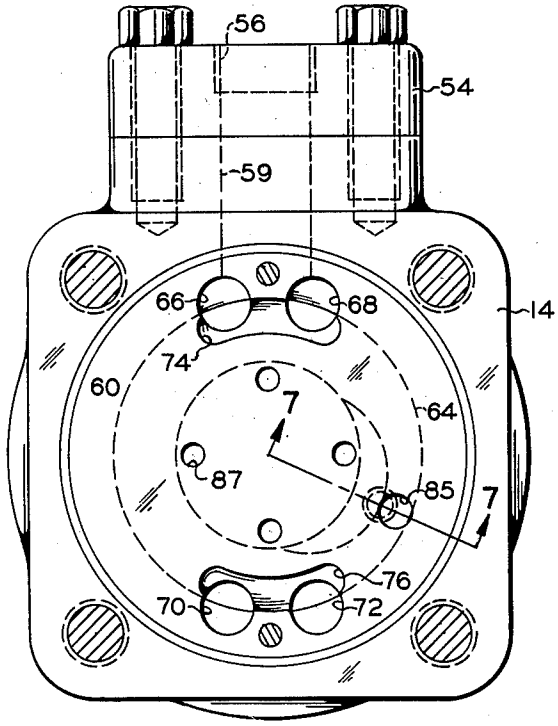


FIG. 5

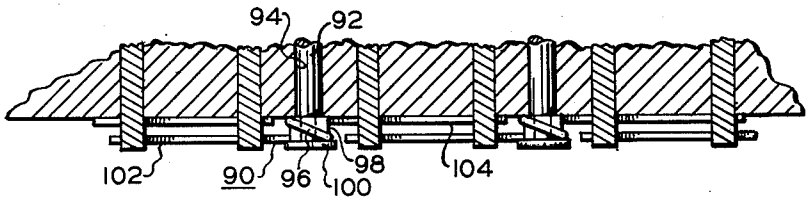


FIG. 6

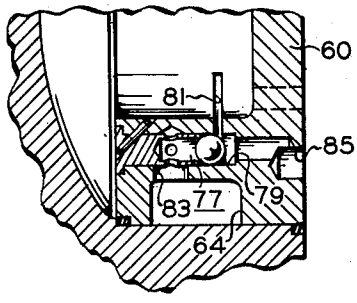


FIG. 7

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UNITED STATES PATENT OFFICE

2,641,193

POWER TRANSMISSION

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Application October 19, 1950, Serial No. 190,958

8 Claims. (Cl. 103—136)

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This invention relates to power transmissions, and is particularly applicable to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

This invention is more particularly concerned with a vane pump or motor construction adapted for use in hydraulic power transmission systems.

A form of pump in common use in the hydraulic power transmission field utilizes a rotor having a plurality of substantially radial vanes rotatable therewith and slidable relative thereto. The rotor is mounted within a chamber, the contour of which forms a vane track against which the outer ends of the vanes are adapted to be maintained in contact. The chamber forming the vane track may comprise the inner portion of a vane track ring. The vane track is adapted to control the movement of the vanes and cooperates with the rotor in forming working chambers through which the vanes pass as the rotor turns. The external connection ports lead by passage means to the working chambers so as to form separated fluid inlet and outlet zones.

Some means in addition to centrifugal force is utilized to maintain the outer ends of the vanes in contact with the vane track, which is essential for efficient operation. One method has been to connect the high pressure side of the device to the inner ends of the vanes. However, a problem arises in maintaining the contact when there is no pressure available. When the device is utilized as a motor it is particularly important at starting operation that some slight force be employed for urging the vanes outward in contact with the track, otherwise leakage would occur around the outer ends of the vanes and cause free wheeling of the device. It is also important that contact be maintained as the vanes pass over the sections forming the separation between the inlet and outlet fluid zones. In addition, as the vanes pass through the high pressure zone of the device, there is a tendency for the vanes to separate from the track because of the outer ends being exposed to said high pressure.

Attempts have been made to solve this problem by the use of individual coil springs for each vane and which have failed to meet commercial requirements. The space available in the rotor for mounting the springs is very limited. Due to the fact that the spring is subjected to severe operating conditions, such as the numerous flexings of each spring and the speed at which they

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must contract and expand, they fatigue rapidly. In order to meet commercial operating requirements, the rotor size would have to be greatly increased to provide proper mounting area for the larger types of springs demanded. This is impractical when size, weight and cost are to be considered.

Where the individual coil spring type of construction is utilized the spring is continuously subjected to the full travel of the vane. Where the device is of the double throw type, i. e., each vane having two complete strokes per rotor revolution, and the rotor speed is in excess of 1000 R. P. M. it can be clearly seen that each spring is subjected to over 2000 full travel strokes of the vane each minute. The fatigue life of the coil spring is thus certain to be short.

It is therefore an object of this invention to provide in devices of this type an improved means of preloading the vanes into contact with the vane track.

It is a further object to provide preloading of the vanes into contact with the vane track by utilizing bell crank members which are not subject to the short fatigue life of the individual spring type of construction.

It is another object to provide bell crank members for the purpose stated which are pivotally connected at their central portions to the rotor and the arms of which by lever action transmit the motion of one vane to another complementary vane.

It is another object to provide members of the type and for the purposes mentioned which are resilient so as to produce the preloading of the vanes desired but arranged to produce the lever action required without significant bending action as the vanes travel through their full strokes.

It is still another object of this invention to provide a novel, economical means for selectively preloading the vanes in contact with the vane track which is efficient over a long useful life.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figure 1 is a sectional view of a rotary vane type pump or motor.

Figure 2 is a plan view of a rotary vane type pump or motor.

Figure 3 is a sectional view taken on line 3—3 of Figure 1.

Figure 4 is a sectional view taken on line 4—4

of Figure 1 and embodying a preferred form of the present invention.

Figure 5 is a sectional view taken on line 5—5 of Figure 1.

Figure 6 is a partial sectional view illustrating the overlapping relationship of the members which preload the vanes in contact with the vane track.

Figure 7 is a partial sectional view taken on line 7—7 of Figure 5.

Referring now to Figure 1 there is shown a rotary vane pump or motor 10, the body of which comprises a right end housing 12, a left end housing 14, and a central housing member or cam ring 16 which is sandwiched between and suitably bolted to the end housing members. The right end housing 12 is provided with a flange member 18 having an external connection port 20 which registers with a fluid passage 22 in the housing 12. The passage 22 has two branches 24 and 26 (Figure 3) which terminate respectively in arcuately shaped fluid openings 28 and 30. The openings 28 and 30 register respectively with a portion of a pair of diametrically opposed working chambers 32 and 34. (Figure 4).

The working chambers 32 and 34 are formed by the mounting of a rotor 36 within the cam ring 16, the inner contour of which is generally elliptical in shape and forms a vane track indicated by the numeral 38. The rotor 36 is connected to a shaft 40 rotatably mounted and supported in bearings 42 and 44 completely in the right end housing 12, said rotor being spline connected at 46 to the mating spline of the shaft. A shaft seal 48 is provided and the shaft bore 50 may be drained through an external connection port 52 connected to the bore.

Referring now to Figures 1 and 5, the left end housing member is provided with a flange member 54 having an external connection port 56 registering with a passage 59 in the housing member which leads to a recess 58. The open end of the recess is closed by the cam ring and rotor.

A side plate 60 is floatably mounted in the recess to form a pressure chamber 62. The side plate 60 is adapted to be maintained in engagement against the cam ring 16 and in fluid sealing engagement with the rotor by means of pressure fluid delivered to the chamber. The side plate has a peripheral groove 64 connected to which are two diametrically opposed pairs of drilled passages 66 and 68 and 70 and 72. The side plate also has on the face thereof immediately adjacent to the rotor two arcuately shaped fluid openings 74 and 76. The drilled passages 66 and 68 are connected to the opening 74 while the drilled passages 70 and 72 are connected to the opening 76. The openings 74 and 76 are diametrically opposed and register with portions of the working chambers 32 and 34.

Means have been provided in the side plate 60 for connecting the high pressure side of the device to the pressure chamber 62 regardless of the direction of operation of the device. Thus there is provided a shuttle valve 77 mounted in a bore 79 connected to the pressure chamber 62 by a passage 81. The shuttle valve 77 is connected at one end thereof to the side plate groove 64 by a passage 83 and connected at its opposite end to that portion of the working chamber 32 which registers with the fluid opening 28 by a passage 85. From the pressure chamber 62 pressure fluid is directed to the inner enlarged portions of the vane slots in the rotor, hereinafter described, by

means of a plurality of ports 87 extending completely through the side plate and which lead to a recess 89 in the rotor, the latter being connected to the enlarged slot portion 80. The opposite face of the rotor 36 is provided with a duplicate circular recess 89.

The rotor 36 is constructed with a plurality of substantially radially extending slots 78 having the aforementioned enlarged portions 80 at their inner end. Slidably mounted in the slots 78 are vanes 82 substantially rectangular in shape, the outer ends of which are adapted to engage the vane track 38.

The construction of the device as herein described constitutes a balanced rotary vane device of the double throw type, the contour of the cam ring being substantially elliptical in shape and with two pairs of diametrically opposed fluid openings registering with the working chambers formed. Each vane will be retracted completely twice during one rotor revolution. Each vane on a retracting stroke has a complementary vane which is adapted to be urged outwardly in contact with the vane track during a corresponding outward stroke. In the device illustrated which is provided with twelve slots and vanes, the complementary pairs of vanes are 90 degrees apart although it should be understood that in a single throw unit the spacing will be 180°, in a triple throw 60°, etc.

Means for urging and maintaining the outer ends of the vanes in contact with the vane track 38 in addition to pressure fluid directed to the inner ends of the vanes has been provided by rockably or pivotally mounting bell crank members 90 in the rotor. As shown in Figures 4 and 6 the bell crank members 90 are connected at their central portions to a plurality of pivot pins 92 which are loosely, rotatably mounted in bores 94 arranged in circular formation and extending through the rotor, said bores opening at opposite ends to the recesses. Each bell crank member is coiled at its central portion indicated by the numeral 96 so that it may be pivotally connected at the coiled portion to a bushing 98 having a flange 100 which may be suitably riveted to the end portion of the pivot pin. The two arms of each member indicated by the numerals 102 and 104 are on different planes to provide a proper staggered relationship of the members around the rotor and permitting free movement of the same. The coiled section is thus loosely pivoted between the surface surrounding the pivot pin bore and the flange 100.

The arms of the bell crank members illustrated lie between the planes containing the axially spaced edges of the vanes. They also underlie the inner ends of all intermediate vanes within the span between complementary vanes. The arms of the members are bent to avoid the intermediate vanes and at their ends to engage the inner ends of complementary vanes and resiliently load said vanes in engagement with the track. There is thus no interference with intermediate vanes with which the members do not cooperate. As the arms of each member are on different planes the alternating arms will be properly staggered around the rotor for efficient continual lever action without interference of adjoining members.

Each vane is urged outwardly by the opposing arms of two bell crank members on opposite sides of the rotor while the complementary vane which is 90 degrees apart therefrom is urged in contact with the vane track by the remaining two opposing arms of the said two bell crank members.

The arms of the bell crank members are of predetermined resiliency so that when the outer portions are placed under the vanes that the vanes will be urged into contact with the vane track thereby preloading said vane. However, the arms should preferably be of sufficient strength so that the motion of a vane on an inward stroke may be transferred by the one arm by lever action to the other arm so as to urge the complementary vane outwardly in contact with the track without substantial flexure of the arms.

In operation when the device is operated as a motor and pressure fluid is directed to the external connection port 20, pressure fluid is conducted by the passage 22, branch passages 24 and 26 and fluid openings 26 and 28 to that portion of the working chambers 32 and 34 registering with said openings. Pressure fluid acting on the outer portions of the vane causes counterclockwise rotation of the rotor and fluid will be displaced from the remaining portions of the working chamber as the vanes pass therethrough by means of the openings 74 and 76, drilled passages 66, 68, 70 and 72, and the groove 64, all of which are in the side plate 60, housing passage 59 and external connection port 56. Pressure fluid from the inlet side of the device passing into the working chamber 32 in registry with the opening 28 is conducted to the pressure chamber 62 by means of the passage 85 in side plate 60, bore 79, shuttle valve 77 and passage 81. From the pressure chamber fluid is conducted to the inner portions 80 of the vane slots 78 by means of the side plate port 67 and recess 89 in the rotor 36. Pressure fluid acting at the inner ends of the vane slots will urge the outer ends of the vanes in contact with the vane track 38. For reversal, pressure fluid is directed to the external connection port 58 and fluid is conducted to that portion of the working chambers registering with the openings 74 and 76 in the side plate 60. The passage of fluid is as follows, external connection port 56, passage 59, groove 64, drilled passages 66, 68, 70 and 72 and the openings 74 and 76 in the side plate 60. Pressure fluid is conducted to the pressure chamber 62 from the side plate groove by means of passage 83, shuttle valve 77 and passage 81. From the pressure chamber pressure fluid is directed to the inner ends of the vane slots by the ports 87 in the side plate 60. The side plate 60 will be maintained in engagement against a portion of the cam ring 16 and in fluid sealing engagement with the rotor by means of pressure fluid directed from the high pressure side of the device to the pressure chamber 62. No matter what the direction of the operation of the device, the high pressure side of the device is constantly connected to the pressure chamber by reason of the shuttle valve and associated passages in the side plate.

At starting and at times when there is no pressure available the bell crank members 90 will maintain the outer ends of the vane in contact with the vane track. In addition, they will supply the slight additional force required to prevent the vanes separating from the track as they pass through the inlet zones. As the vane track causes each vane to shift inwardly, at the start of an inward stroke, a complementary vane 90 degrees apart is adapted to be starting an outward stroke. The arms of the opposing members which are forced inwardly will transfer by lever action the inward motion of its complementary vane to produce an outward motion of the remaining arms of the members. This outward motion of the remaining arms will cause an outward stroke of the complementary vanes.

It should thus be noted that the bell crank members perform two functions. They serve to preload the vanes in contact with the vane track. In addition, they cause the inward motion of the vanes to be transferred to complementary vanes on a corresponding outward stroke. As the members are loosely pivotally connected at their central portions, this motion is transferred by lever action. Without substantial flexure they are not therefore subject to the short fatigue life of the individual coil spring construction.

It should be noted that no positive connection of the arms to the vanes is necessary. Another feature is that the rotor does not have to be increased in size to provide mounting space for the bell crank members. In addition the length of the slot does not have to be increased as in the individual coil spring type of construction. Instead the mounting recess may be constructed starting at substanitally the middle of the vane slots. This recess will not only serve to provide mounting space for the members but in devices constructed as illustrated the recess serves to connect the pressure ports in the side plate to the under portions of the vanes thereby connecting the pressure chamber to the vane slots.

As the pins for the members are mounted between the vane slots and on a level above the enlarged portions of the vane slots there will be sufficient space for the full travel of the lever arm. The downwardly curved portion of the arm prevents interference with vanes immediately adjacent to the pins and with which the arm is not adapted to cooperate. As the arms of the members are on two planes there will be no interference between immediately adjacent arms of adjacent members.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which is pivotally mounted at its central portion on the rotor between a pair of complementary vanes and outwardly of the innermost ends of the vane slots, the arms of each member underlying the inner ends of all intermediate vanes within the span between complementary vanes and the outer ends of the arms engaging the inner ends of complementary vanes, said arms of each member being on two planes to avoid interference with the arms of adjacent members and being flexible to resiliently load the complementary vanes in engagement with the track, and said arms being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

2. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a rotor chamber, a rotor mounted within the chamber having a plurality of vane slots and each slot having a vane slidably mounted therein, the contour of the chamber forming a vane track against which the outer ends of the vanes are adapted to be constantly urged and said track causing complete inward strokes of each vane during a rotor revolution, each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which is pivotally mounted at its central portion on the rotor between a pair of complementary vanes and between the innermost ends of the vane slots and the periphery of the rotor, the arms of each member being bent to avoid interference with intermediate vanes between complementary vanes and at their ends to engage the inner ends of complementary vanes, said arms of each member being on two planes to avoid interference with the arms of adjacent members and being flexible to load the complementary vanes in engagement with the track, and said arms being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

3. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising means forming recesses on opposite faces of the rotor, a plurality of pivot pins mounted in the rotor the opposite ends of which extend into the recesses, one between each pair of complementary vanes, and a bell crank member on each end of each pin, the members being pivotally connected at their central portions on the ends of said pins, the arms of each member underlying the inner ends of all intermediate vanes within the span between a pair of complementary vanes and the outer ends of the arms engaging the inner ends of a pair of complementary vanes, said arms of each member being on two planes to avoid interference with the arms of adjacent members and being flexible to resiliently load the vanes in engagement with the track, and said arms being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

4. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which comprises a single strand of wire coiled at its central portion to form the arms of the member in two planes, a plurality of pivot pins mounted in the rotor the ends of which extend from the rotor, one between each pair of complementary vanes, and a bell crank member pivotally mounted on each end of each pin, the members being mounted by their coiled portions on the ends of said pins, the arms of each member underlying the inner ends of all intermediate vanes within the span between complementary vanes and the outer ends of the arms engaging the inner ends of complementary vanes, said arms being flexible to resiliently load the complementary vanes in engagement with the track and being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

5. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising means forming recesses on opposite faces of the rotor, a plurality of pivot pins mounted in the rotor the opposite ends of which extend into the recesses, one between each pair of complementary vanes, a plurality of bell crank members on opposite sides of the rotor, one on each end of each pin, each member comprising a single strand of wire coiled at its central section to form the arms in two planes and being pivotally connected by its coiled portion on the end of the pin, and a flange on the end of each pin retaining the member on the pin, the arms of each member being bent to avoid interference with intermediate vanes within the span between complementary vanes and at their ends to engage the inner ends of complementary vanes, said arms being flexible to resiliently load the complementary vanes in engagement with the track and of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

6. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which is pivotally mounted at its central portion on the rotor between a pair of complementary vanes and outwardly of the innermost ends of the adjoining vane slots, said arms engaging at their outer ends the inner ends of a pair of complementary vanes, said arms of each member be-

ing on two planes to avoid interference with the arms of adjacent members and being flexible to resiliently load the complementary vanes in engagement with the track, and said arms being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said vane.

7. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which is pivotally mounted at its central portion on the rotor between a pair of complementary vanes and outwardly of the innermost ends of the vane slots, the arms of each member lying between the planes containing the axially spaced edges of the vanes and being bent to avoid interference with the inner ends of all intermediate vanes within the span between complementary vanes and at their outer ends to engage the inner ends of complementary vanes, said arms being flexible to resiliently load the complementary vanes in engagement with the track, and said arms being of sufficient strength to transfer by lever action without substantial flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said complementary vane.

8. In a fluid pressure energy translating device of the rotary vane type comprising a housing having a vane track of non-circular contour and a rotor mounted within the track having a plurality of generally radial slots, each slot having a vane slidably mounted therein the outer end of which is adapted to be constantly urged against the track, said track causing complete inward strokes of the vanes during a rotor revolution and each vane on an inward stroke having a complementary vane adapted to be on an outward stroke, that improvement comprising a plurality of bell crank members each of which is pivotally mounted at its central portion on the rotor between a pair of complementary vanes and between the innermost ends of the adjoining vane slots and the periphery of the rotor, said arms engaging at their outer ends the inner ends of a pair of complementary vanes and said arms being bent to underlie the inner ends of all intermediate vanes within the span between complementary vanes, said arms being of sufficient strength to transfer by lever action without sufficient flexure the inward motion of one vane to its complementary vane to cause the outward stroke of said complementary vane.

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