

July 4, 1967

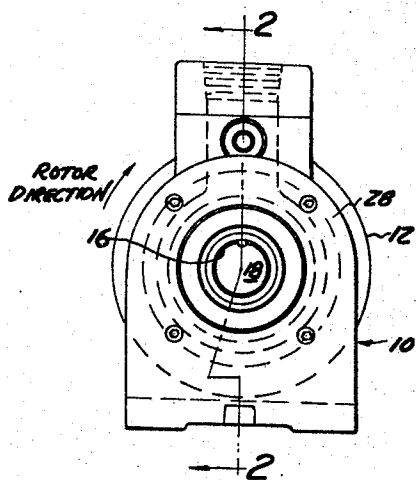
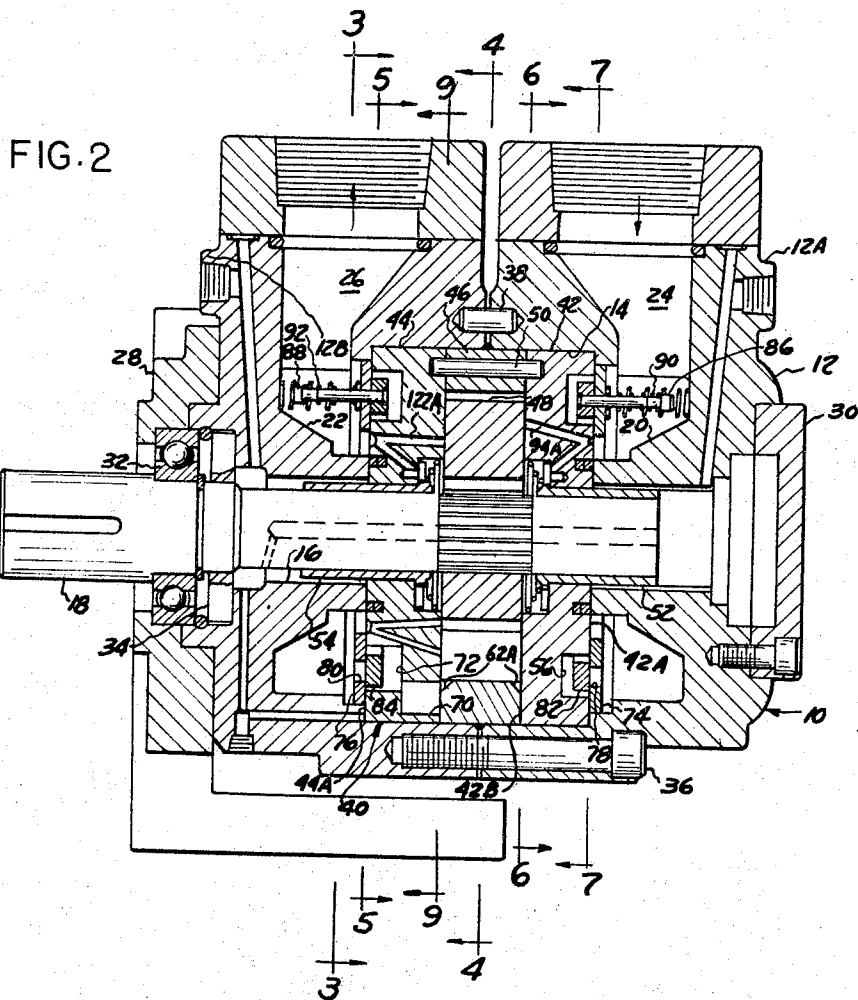
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3,329,067

FLUID MOTORS

Filed Nov. 23, 1964

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FIG. 6

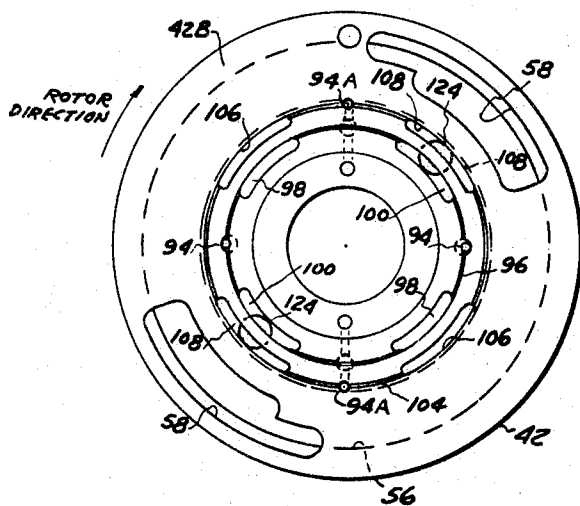


FIG. 9

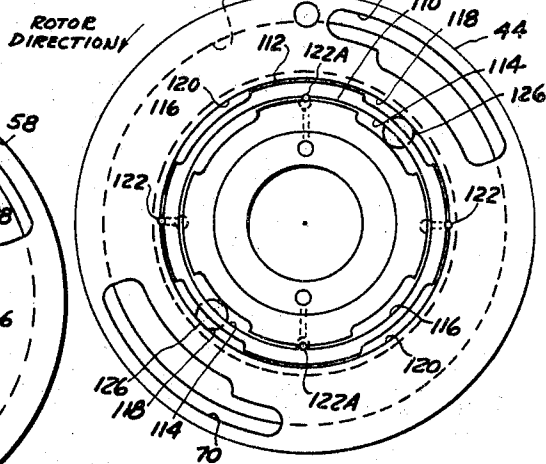


FIG. 7

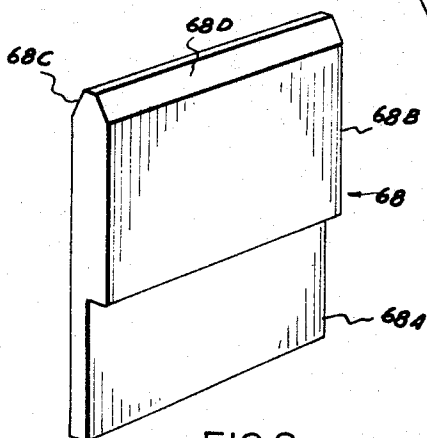
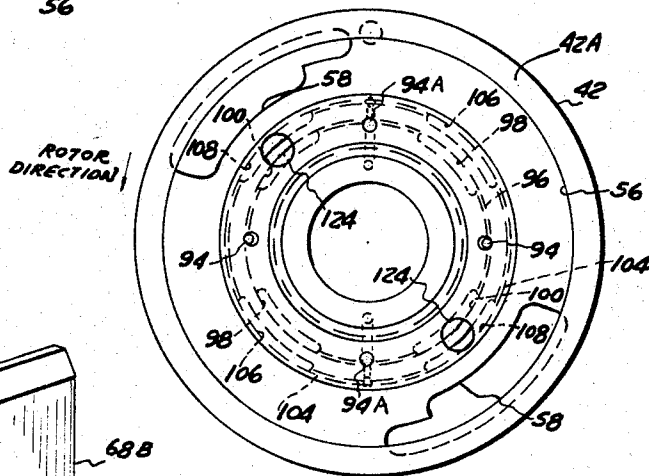


FIG. 8

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FIG. 10

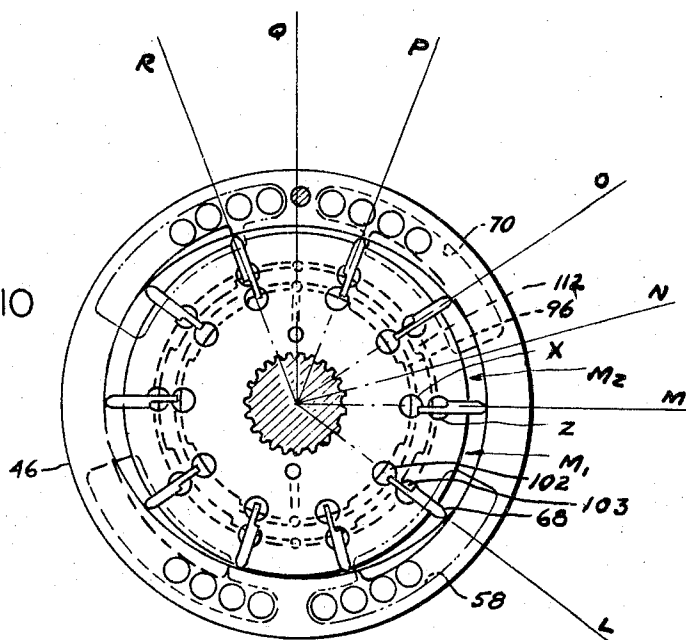


FIG. 11

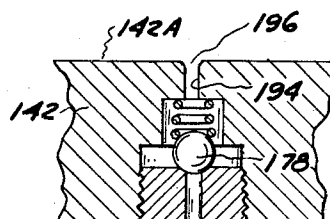
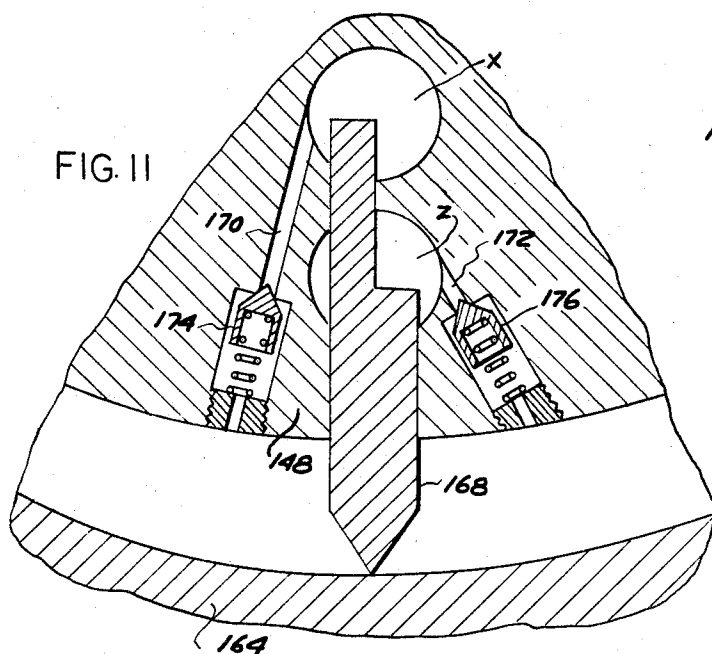


FIG. 12

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FLUID MOTORS

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9 Claims. (Cl. 91-138)

My invention relates to vane-type fluid pressure driven motors and more particularly to such motors having improved vane balancing means.

In a motor of the present type, a rotor is carried in the fluid chamber of a housing to which is open a fluid discharge passage and a fluid intake passage connected with a source of pressure fluid. The rotor has a plurality of slots spaced around its periphery in which are slidably carried a set of vanes. A contoured cam ring surrounds the rotor and is engaged by the outer ends of the vanes, which move in and out due to the cam ring contour, as the rotor is rotated by fluid pressure on the vanes. The motor thus operates on fluid displacement through the fluid chamber, with high fluid pressure at the intake decreasing to a relatively lower pressure at discharge.

In such motors, it is conventional to introduce fluid pressure beneath the vanes to hold them in engagement with the cam ring, and it is also conventional to vary the pressure beneath the vanes in an attempt to achieve some pressure balance end to end, otherwise the load on the cam ring is too great when the vanes move into the lower pressure discharge area, and excessive wear of the vanes and cam ring as well as noise and erratic performance result.

It will be seen that the more closely pressures at the inner ends of the vanes are matched to the pressures existing at the outer ends, the more smoothly and efficiently will the motor function.

It is, therefore, an object of the present invention to provide improved vane-type fluid motor operation by achieving greater uniformity of and improved control over vane balancing.

It is another object of the invention to improve vane-type fluid motor performance by separately pressure-balancing the leading and trailing portions of the vanes.

It is a further object of the invention to facilitate vane balancing in motors of the present type by providing an improved system for proportioning fluid balancing pressures at the inner ends of the vanes.

These and other objects of the invention, and a more complete understanding thereof, will be had on reference to the accompanying drawings illustrating a preferred embodiment of the invention in which like reference characters refer to like parts throughout the several views and in which

FIG. 1 is an elevational end view of the motor embodying the present invention.

FIG. 2 is a longitudinal cross-sectional view taken substantially on the line 2-2 of FIG. 1.

FIG. 3 is a transverse cross-sectional view taken substantially on the line 3-3 of FIG. 2.

FIG. 4 is a transverse cross-sectional view taken substantially on the line 4-4 of FIG. 2 with the housing removed for simplification.

FIG. 5 is an elevational view of one side of a cheek plate in the motor as seen substantially from the line 5-5 of FIG. 2.

FIGS. 6 and 7 are elevational views of the opposite

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sides of the other cheek plate in the motor respectively as seen from the lines 6-6 and 7-7 of FIG. 2.

FIG. 8 is a perspective view of one of the vanes used in the present motor.

FIG. 9 is an elevational view of the opposite side of the cheek plate of FIG. 5 as seen substantially from the line 9-9 of FIG. 2.

FIG. 10 is a diagrammatic view illustrating operation of the invention showing parts as seen from the line 6-6 of FIG. 2 but looking to the left.

FIG. 11 is a fragmentary view of a modification of the invention, and

FIG. 12 is a cross-sectional view of a value used with the modification of FIG. 11.

Description

Referring to the drawings, FIGS. 1-3, a motor structure 10 is illustrated as comprising a main housing 12 having a central fluid chamber 14 and an axial bore 16 adapted to receive a power take-off shaft 18.

An annular intake chamber 20 and an annular discharge chamber 22 openly communicate with the chamber 14 and respectively with inlet 24 and outlet 26. The housing is closed by end caps 28 and 30 as illustrated best in FIG. 2. The shaft 18 projects through the end cap 28 and is supported therein by a ball bearing structure 32. A seal 34 seals the shaft 18 with the housing 12. The main housing is for convenience made in two separate portions 12a and 12b, secured together by any means such as bolts 36 and aligned for assembly purposes by means of pins 38.

A motor assembly 40 is carried in the fluid chamber 14 and comprises an inlet side cheek plate 42, an outlet side cheek plate 44, a cam ring 46, and a rotor 48. As may readily be seen in FIG. 4, the rotor 48 will rotate within the cam ring 46 and as seen in FIG. 2 both are sandwiched between the two cheek plates 42 and 44.

The rotor is splined to the shaft 18 as shown in FIGS. 2 and 4. The cheek plates 42 and 44 and the cam ring 46 are aligned by any means such as a pin 50. The shaft 18 is axially aligned with and supported by the cheek plates 42 and 44 through bushings 52 and 54.

As shown in FIGS. 6 and 7, the cheek plate 42 has on its outer face 42A an annular groove 56 to which fluid under pressure will be admitted. This fluid is then directed through ports 58 to the inner face 42B which is adjacent the cam ring 46 shown in FIG. 4. The cam ring 46 has a series of holes 60 for communicating the fluid pressure to opposite sides of the cam ring 46. The cam ring 46 has intake bevels 62 communicating the pressure to the outer periphery of the rotor 48 in the area adjacent with the inner surface 64 of the cam ring 46 is enlarged.

The rotor, as seen in FIG. 4, has a series of radial slots 66 around its periphery with, in each slot 66, a rotor vane 68 which, as the rotor is rotated by fluid pressure operating on the vanes, will move radially in and out of the slot 66, the outer end of the rotor vane 68 being guided by the inner surface of the cam ring 46. The fluid, after its energy is utilized to rotate the rotor by pressure on the vanes 68, will be exhausted past bevels 62A of the cam ring through ports 70 in the cheek plate 44 (FIGS. 4 and 5). The ports 70 communicate with an annular groove 72 on the outer face 44A of the cheek plate 44. The opposite sides of the cam ring are balanced in this area through the pressure of a second set of through holes 60A.

It will be apparent that the terms "inlet" and "outlet" as herein used refer to the pressure flow direction selected for purposes of description. The present structure is so arranged that the pressure flow may be in the opposite direction and the rotor would then, of course, be rotated in the opposite direction to the one illustrated.

As shown in FIG. 2, the annular grooves 56 and 72 in the cheek plate 42 and 44, are closed by annular valve plates 74 and 76 respectively. These valve plates are spring loaded to close the annular grooves 56 and 72. Holes 78 and 80 in the valve plates 82 and 84 respectively, carried on supporting pins 86 and 88 which carry springs 90 and 92 to bias the secondary valve plates 82 and 84 toward their closed positions. It will be apparent that regardless of the direction of fluid flow, the valves will open and close in such a way as to permit the fluid to enter one cheek plate outer face annular groove and exit from the other cheek plate outer face annular groove, as necessary, and yet when the system is not in use, the valves are all closed to prevent fluid from draining out of the motor.

Further, it will be apparent that some pressure drop will be experienced across the valves when the motor is in operation, although with the weak springs used, this pressure drop is not great.

Fluid under pressure is admitted through passages 94 and 94A provided in the cheek plate 42 (shown in FIG. 6) to an area adjacent one side face of the rotor 48. The passages 94 communicate with a radially inward positioned annular groove 96 provided on the inner surface 42B of the cheek plate 42. The annular groove 96 is provided with spaced enlarged areas 98 and 100.

It will be seen in FIG. 4 that the rotor is provided with annularly spaced through-holes 102 disposed to intersect the radially inner ends of the slots 66 in which the rotor vanes slide. The shape of the rotor vane 68 is shown in FIG. 8 as having an inner portion 68A which is thinner than an outer portion 68B, and these two portions respectively slide in thinner and wider portions of the slot 66, so that only the inner end of the inner portion 68A will be in communication with the pressure in the holes 102, and these holes 102 are in communication at all times with the annular groove 96 in the cheek plate 42.

As shown in FIGS. 6 and 7, the cheek plate 42 is also provided with another annular groove 104 spaced radially outwardly of the groove 96 and passages 94A connect with groove 104. The groove 104 is provided with enlarged portions 106 and 108. The groove 104 communicates with a second set of annularly spaced through-holes 103 provided through the rotor 48, which holes 103 register with the wider portions of the rotor slots 66 and thus communicate only with the inner ends of the thicker rotor vane portions 103.

On the opposite face of the rotor 48, the cheek plate 44 shown in FIGS. 5 and 9, is provided with annular grooves 110 and 112, respectively having enlarged areas 114, 116, 118 and 120, all similar to the grooves and enlarged areas of the cheek plate 42. However, the cheek plate 44 has passages 122 communicating between the outer groove 112 and the discharge chamber 22 and passages 122A communicating between the inner groove 110 and the discharge chamber 22. The grooves 110 and 112 respectively communicate with the ends of the holes 102 and 103 in the rotor opposite the ends communicating with the grooves 96 and 104 of the cheek plate 42.

It will be seen, therefore, that the inner ends of the vane portions 68A will be subjected to the pressure existing in the inner annular grooves 96 and 110 of cheek plates 42 and 44 respectively, while the inner ends of the vane portions 68B will be subjected to the pressures existing in the outer annular grooves 104 and 112 of cheek plates 42 and 44 respectively.

In FIGS. 6 and 7, showing cheek plate 42, it will be noted that passages 94 and 94A provide pressure communication to, respectively, the inner and outer grooves 96 and 104 at points intermediate enlarged areas 98 and

100. It will also be seen that there are recesses 124 communicating the enlarged areas 100 with the enlarged areas 108 of the outer annular grooves 104. Since the recesses 124 are also to the outwardly facing side 42A of the cheek plate 42, they will also communicate with intake pressure in chamber 20 shown in FIG. 2.

In FIGS. 4, 5 and 9, it will be seen that the passages 122 and 122A are disposed intermediate the enlarged areas 118 and 120, and areas 114 and 116, and provide outlet pressure communication with the chamber 22. There are also recesses 126 communicating the enlarged areas 114 with the enlarged areas 118 as well as with the chamber 22.

The grooves 96, 104, 110 and 112 are, except in the enlarged areas, extremely small, for reasons of ensuring proper pressure drops between the enlarged areas, and it will be apparent that the drawings show the grooves larger for purposes of clarity.

Since the cheek plates 42 and 44 are respectively on the pressure and discharge sides of the motor, it will be seen that there will be pressure drops effective to variably pressurize the inner ends 68A and 68B of the vanes as the vane slots alternately are communicated to different parts of the grooves in the cheek plates.

FIG. 10 illustrates diagrammatically the progress of a vane 68 as it moves through $\frac{1}{2}$ cycle, from position L to position R, as follows:

Position L

(1) Pressure fluid from port 58 (shown in phantom) in cheek plate 42 fills the space between the rotor and cam ring on both leading and trailing outer ends of vane 68.

(2) Pressure fluid from recess 124 (see FIGS. 6 and 7) in cheek plate 42 is admitted to the bores 102 and 103, through groove portions 100 and 108, at the inner ends of both, balancing portions of the vane 68 at a slightly higher pressure, urging the vane outwardly against the cam ring 46.

Position M

(1) Space M_1 on the trailing side of the vane is under pressure from the port 58 in cheek plate 42.

(2) Space M_2 on leading side of the vane is open to discharge through the port 70 in cheek plate 44.

Note.—Spaces M_1 and M_2 refer throughout to the spaces on the trailing and leading sides respectively of any given vane as it moves through its cycle of operation.

(3) Space X under the trailing inner end of the vane is under pressure from the recess 124 (FIGS. 6 and 7) through the groove 96 and from the hole 94 in cheek plate 42.

(4) Space Z under the leading inner end of the vane is unloaded to the recess 126 and to the hole 122 (FIGS. 5 and 9) through the groove 112 in cheek plate 44.

Position N

(1) Space M_1 carries forward and is under the same pressure as it was in position M.

(2) Space M_2 carries forward and is open to discharge as it was in position M.

(3) Space X is still under pressure but less than in position M, due to the gradual pressure drop along the groove 96.

(4) Space Z is still unloaded as it was in position M.

Position O

(1) The spaces on both the leading and trailing outer ends of the vane are unloaded to discharge through the ports 70 in cheek plate 44.

(2) Spaces X and Z are both unloaded to discharge through the recess 126 (FIGS. 5 and 9) in cheek plate 44.

Position P

(1) Space M_1 on the trailing side of the vane is still unloaded.

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- (2) Space M_2 on the leading side of the vane is starting to pressurize due to leakage past the preceding vane.
 (3) Space X is still unloaded through the recess 126 (FIGS. 5 and 9) in the cheek plate 44.
 (4) Space Z is starting to pressurize.

Position Q

- (1) Space M_1 is unloaded through the port 70.
 (2) Space M_2 is almost to maximum pressure due to leakage past the preceding vane.
 (3) Space X is still unloaded.
 (4) Space Z is under pressure from the recess 124 (FIGS. 6 and 7) through the groove 104 and the hole 94A.

Position R

- (1) Space M_1 is almost to full pressure.
 (2) Space M_2 is under full pressure.
 (3) Space X is under full pressure from the groove 96 in the plate 42 (FIGS. 6 and 9).
 (4) Space Z is under full pressure from the recess 124 (FIGS. 6 and 9).

It will be noted that the vanes 68 as shown in FIG. 8 preferably have a flat outer edge which will slightly decrease the effective area of the outer vane portions subject to pressure so that a slight differential between the inner and outer ends will tend to keep the vanes loaded radially outwardly against the cam ring surface 64.

In FIG. 11, a modification is illustrated in which the rotor 148 has vanes 168 (only one shown) operating in slots 166 and guided by a cam ring 164 as in FIG. 4, but in this case the spaces X and Z at the inner end surfaces of the vane 168 are connected, through passages 170 and 172 provided with valves 174 and 176, respectively to the spaces M_1 and M_2 at the trailing and leading outer vane ends so that, when the respective spaces M_1 and M_2 unload, the respective valves 174 and 176 will open to vanes, and consequently less tendency to damage the motor due to unbalanced pressures.

Although I have only shown and described one preferred embodiment of my invention, it will be apparent to one skilled in the art to which the invention pertains that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A vane-type fluid-driven motor, comprising,
 - (a) a housing structure having a chamber and a rotor therein,
 - (b) said rotor having slots spaced on the periphery and single vanes slidable in said slots, said vanes having inner and outer leading and trailing end portions,
 - (c) a cam ring radially spaced from the rotor periphery and guiding said vanes for movement in said slots,
 - (d) pressure fluid intake means and fluid discharge means opening to annularly spaced portions of the space between said cam ring and said rotor periphery whereby pressure fluid impels said vanes to drive said rotor,
 - (e) means having no direct connection with said annularly spaced portions subjecting each vane inner end leading and trailing portions to pressures substantially proportionate to pressures to which the outer end leading and trailing portions are subjected.
2. The motor as defined in claim 1 and in which said last mentioned means comprises balancing fluid passages connected with said intake and discharge passages and separately opening to said vane inner leading and trailing end portions.
3. The motor as defined in claim 2 and in which said vane inner leading and trailing end portions are radially spaced, and said balancing passages opening thereto are similarly radially spaced to register with said rotor slots

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under said vane inner radially spaced leading and trailing end portions.

4. A vane-type fluid driven motor comprising,
 - (a) a housing structure having a chamber,
 - (b) a pressure fluid intake passage and a discharge passage in said housing structure and open to said chamber,
 - (c) a rotor carried in said chamber and having a plurality of slots with a single vane in each slot for driving said rotor with fluid pressure,
 - (d) each said vane having leading and trailing portions of inner and outer ends thereof, the outer end portions being at times subject to different fluid pressures,
 - (e) means separately subjecting the inner end portions to different pressures separated from the pressure to which the outer end portions are subjected and substantially balancing the outer end portions, and
 - (f) wherein said last mentioned means comprises fluid passages in said housing structure open to said inner end portions and connected with said intake and said discharge passages separately from communication thereof with the vane outer end portion.
5. The motor as defined in claim 4 and in which,
 - (a) said housing structure comprises cheek plates disposed on either side of said rotor, and
 - (b) said means comprises fluid passages in said cheek plates respectively connected with said intake and discharge and open to said vane inner end portions.
6. A vane-type fluid-driven motor comprising,
 - (a) a housing structure having a chamber,
 - (b) a rotor in said housing and having drive means comprising a plurality of vanes,
 - (c) a pressure fluid intake passage and a discharge passage in said housing structure,
 - (d) said passages opening to said rotor at annularly spaced portions whereby pressure fluid flowing through said chamber from the intake to the discharge passage impels said vanes to drive said rotor,
 - (e) said vanes having leading and trailing portions of inner and outer ends thereof, the outer end portions being exposed to said pressure fluid flowing through said chamber and at times subject to different pressures,
 - (f) means separately subjecting the inner end portions to pressures separately from the pressures to which the outer end portions are subjected and substantially balancing said outer end portions, and
 - (g) wherein said means comprises fluid passages in said housing openly connecting each vane inner end portions with said intake and discharge passages separately from communication thereof with the vane outer end portions.
7. A vane-type fluid-driven motor comprising,
 - (a) a housing having a fluid chamber, and an inlet and an outlet open to spaced portions of said chamber,
 - (b) a rotor in said chamber and carrying vanes operable to be driven by pressure fluid flowing from said inlet to said outlet, each vane having inner and outer ends each having leading and trailing portions, the portions of the outer end being subject at some periods of operation to different pressures,
 - (c) the inner end of said vane being stepped to provide said leading and trailing portions with inner ends spaced radially differently from the outer end portions,
 - (d) means separately subjecting the portions of the inner end to pressures separately from the pressures to which the outer end portions are subjected and substantially proportional to the pressures to which the outer end portions are subjected, said means comprising pressure directing means connecting the leading and trailing portion inner ends to fluid pressures at said inlet and outlet in ratios substantially

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corresponding to pressure ratios effective across the leading and trailing portion outer ends, and
 (e) cheek plates disposed on opposite faces of said rotor, said pressure directing means comprising passages in said cheek plates registering with spaces under the inner ends of said vanes. 5

8. The motor as defined claim 7 and further comprising, 10

(a) radially spaced annular grooves in said cheek plates registering respectively with spaces under the leading and trailing side inner ends of said vanes, and means opening annularly spaced portions of said grooves respectively to said inlet and said outlet.

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9. The motor as defined in claim 7 in which said inner end portions are spaced at different radial dimensions from the outer end portions.

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