United States Patent

[11] 3,587,401

[72] Inventor **Fritz Agne Johansson**
Skelleftea, Sweden
[21] Appl. No. **803,759**
[22] Filed **Mar. 3, 1969**
[45] Patented **June 28, 1971**
[32] Priority **Mar. 7, 1968**
[33] **Sweden**
[31] **3039/1968**

[54] **HYDRAULIC RADIAL MOTOR**
3 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **91/496,** 91/180
[51] **Int. Cl.** **F01b 1/06,** F01b 13/06, F01l 33/02
[50] **Field of Search** .... 91/180, 175, (Cursory), 205

[56] **References Cited**

UNITED STATES PATENTS

20,613 6/1858 Ambrose 91/205
593,078 11/1897 Beyer 91/205
1,989,212 1/1935 Pascolini 91/180

Primary Examiner—Paul E. Maslousky
Attorney—Fred C. Philpitt

ABSTRACT: The present invention relates to an hydraulic motor having a number of pistons arranged for radial motion in a cylinder block which preferably forms the stationary part of the motor. The pistons are, over piston rods extending outwardly of the pistons, connected to cam rollers arranged for cooperation with at least one circumferentially closed cam curve radially surrounding said cam rollers. The cam curve is rigidly connected to the motor casing and rotatable relatively the cylinder block. The number of cams on the cam curve is different from the number of pistons. The pistons are arranged upon supply of a pressure fluid to working chambers located radially inside the pistons to cause the cam curve and thereby also the motor casing to rotate relatively the cylinder block.

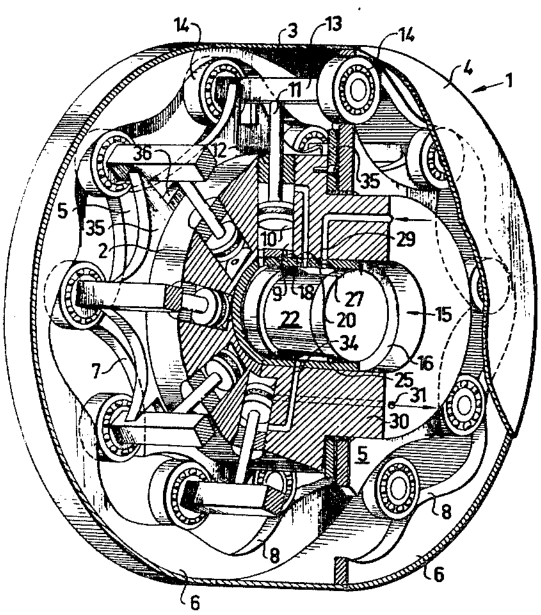
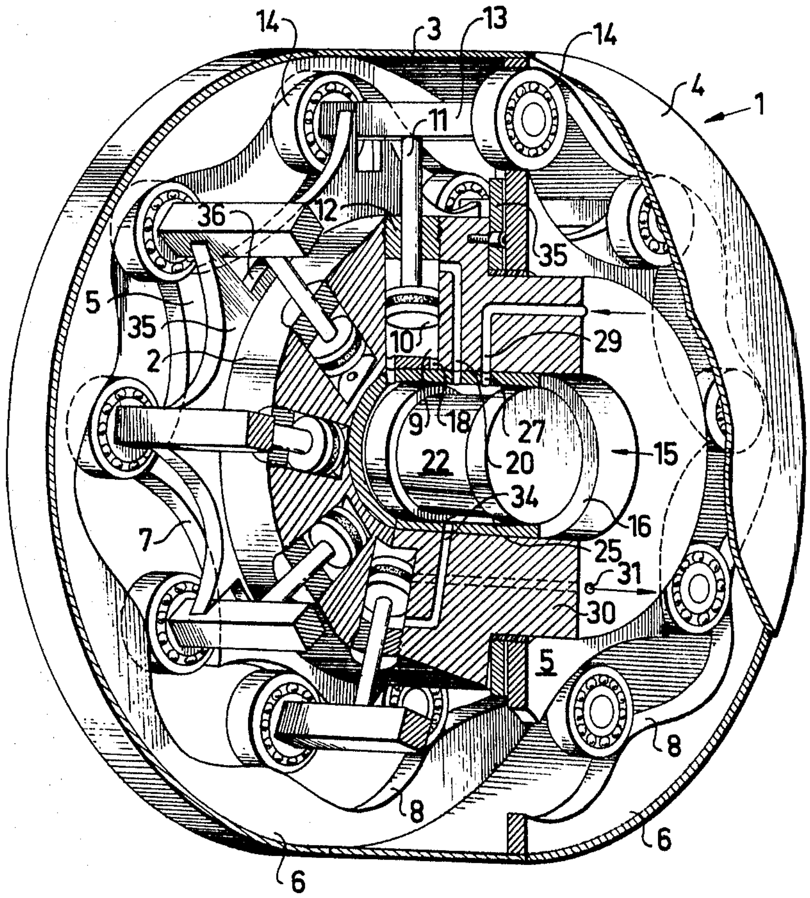


Fig.1



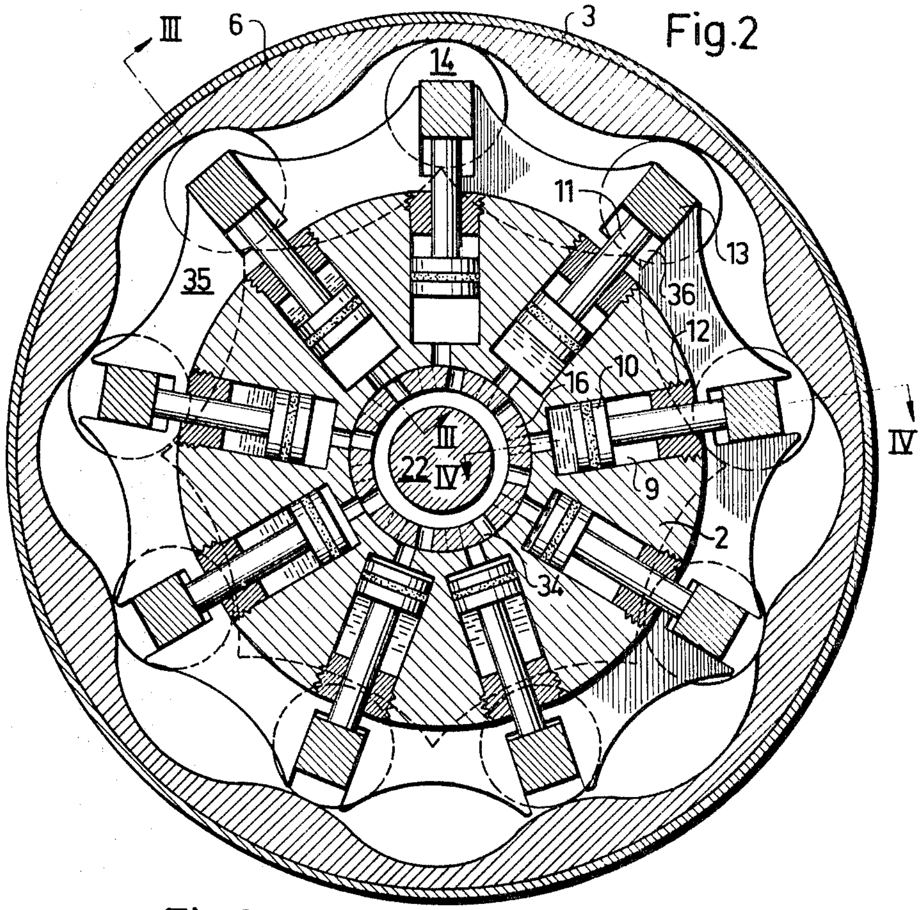


Fig.2

Fig.3

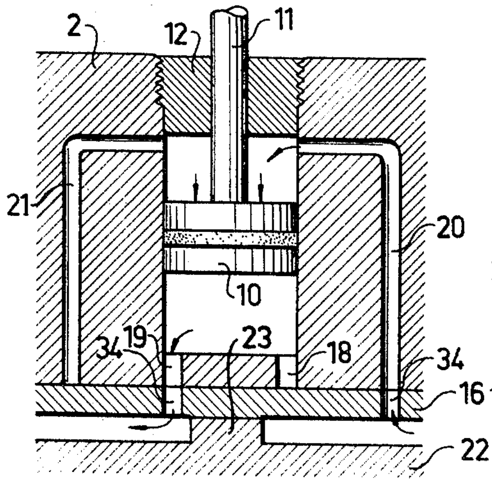


Fig.4

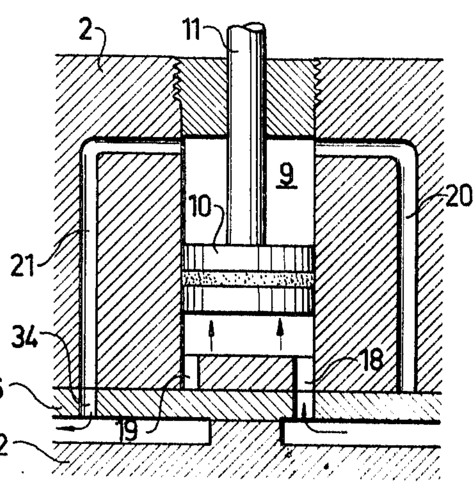


Fig.5

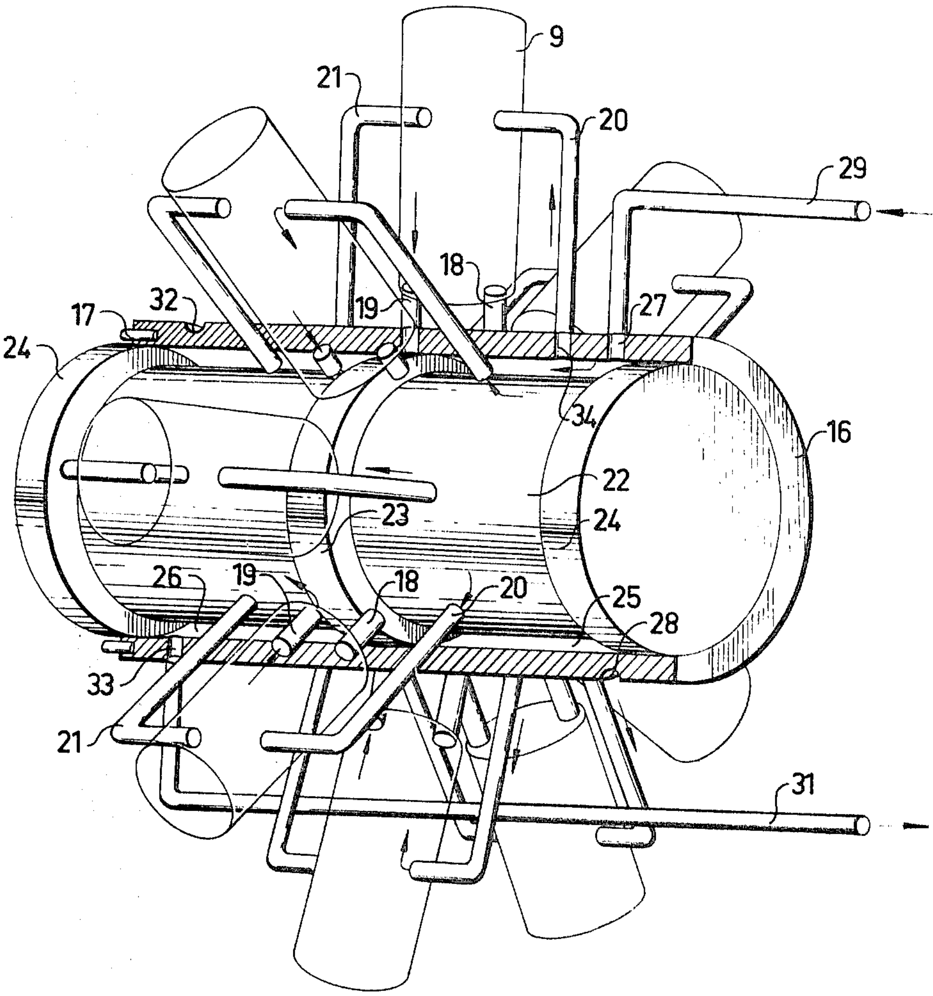
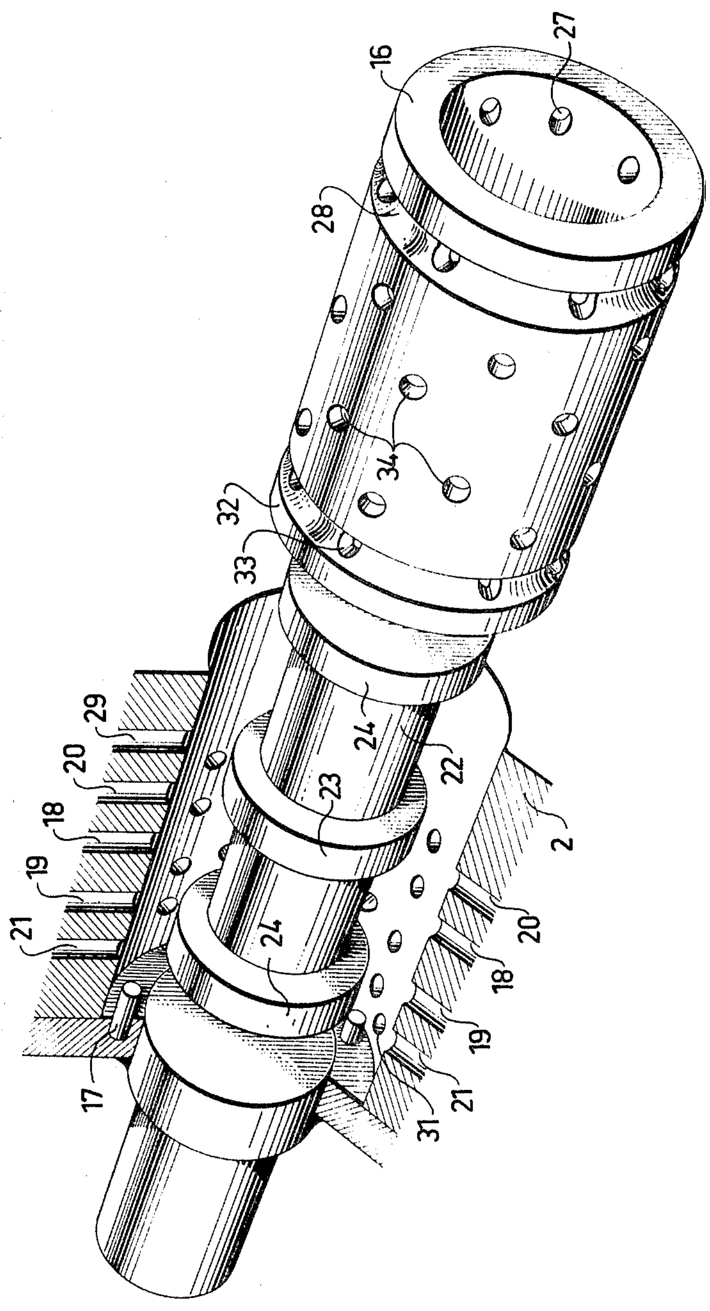


Fig.6



HYDRAULIC RADIAL MOTOR

In prior art hydraulic motors of the type above described only the outwardly directed stroke of each piston has been utilized to cause rotation of the motor, whereas during their return strokes the pistons have been passive. Due the fact that each piston carries out a useful work only during its movement in one of its two opposite directions of movement the power delivered by such a motor amounts to approximately only half the valve that could be attained if the pistons were active during both strokes. Obviously, this disadvantage could be eliminated and the maximum power of the motor be about the double if the motor were made double acting instead of single acting. However, previously it has not been considered possible at reasonable costs to make a double-acting motor satisfying the different requirements which must be fulfilled to make such a motor a commercially interesting product.

The main object of the invention is to offer a solution of the problem of providing a double-acting hydraulic motor of the type above described which is of a simple and robust construction.

Another object of the invention is to provide a double-acting hydraulic motor which can be manufactured at lower costs than a single-acting motor having the same output power.

A further object of the invention is to provide a double-acting hydraulic motor of the kind described which is very reliable in operation.

According to the main characteristic of the invention the cam rollers above referred to are arranged to cooperate also with at least one circumferentially closed cam curve located radially inside said rollers and, like the outer cam curve, rigidly connected to the motor casing, said inner cam curve being actuated by the cam rollers when pressure fluid is supplied to working chambers located outwardly of the pistons, valve means being actuated by the cam rollers when pressure fluid is supplied to working chambers located outwardly of the pistons, valve means being provided to supply alternately the outer and the inner working chamber of each piston cylinder with pressure fluid and simultaneously to discharge the opposite working chamber.

It has been found that an hydraulic motor designed as above described does very well meet the requirements on reliable operation and reasonable manufacturing costs. However, it also has the additional advantage of being more compact than a single-acting motor having the same output power. This is true in respect of radial as well as axial dimensions. Another advantage of an hydraulic motor designed in accordance with the invention is that due to the positive control of the piston movements, obtained by arranging the cam rollers in circumferential grooves defined by the outer and inner cam curves, it is possible to omit the pressure springs which in single-acting motors must be mounted in the working chamber of each piston to make sure that the cam rollers are constantly maintained in contact with the cam curve. A still further advantage is that the axial width of the cam curves can be reduced to half the width required in a corresponding single-acting motor. This reduction is made possible by the decrease in specific pressure exerted by the cam rollers on the cam curves obtained through the invention.

The distribution valve serving to control the flow of pressure fluid to and from the working chambers of the motor may preferably comprise a valve member mounted concentrically in the cylinder block for rotation in unison with the motor casing. Generally, this valve member has the shape of a tube section having a number of orifices in the tube wall which are adapted to cooperate with cylinder block channels communicating with the individual working chambers. In a preferred embodiment of the invention the distribution valve contains two mutually separated chambers radially defined by said tube wall, one of said chambers being in constant communication with the pressure fluid inlet of the motor and the other with the pressure fluid outlet.

In accordance with the invention the orifices in the wall of the tubular valve member may be divided into two groups, namely one group communicating with the outer working chambers and one group for communication with the inner working chambers, each group comprising two series of orifices, within each series equally spaced in the circumferential direction of a circle, the one series communicating with the inlet chamber of the valve and the other with the outlet chamber, the number of orifices within each series being equal to the number of cams on each cam curve.

The channels or bores in the cylinder block can suitably be disposed in one axial row for each piston, the two groups of orifices in the wall of the tubular valve member being mutually displaced by an angle corresponding to half the angular distance between two adjacent orifices in one series.

In addition to the advantages above accounted for a motor designed in accordance with the present invention has the substantial characteristic of being reversible so that switching from the one direction of rotation to the other can be effected simply by interchanging the inlet and outlet pressure fluid connections. It should also be emphasized that while in most practical applications it is preferred to have the motor casing and the cam curves forming the rotor and the cylinder block the stationary part of the motor it is equally possible to mount the casing stationary in which case the cylinder block serves as the rotor.

The invention will now be described in greater detail, reference being had to the accompanying diagrammatical drawings, in which:

FIG. 1 is a partly sectional perspective view showing, by way of example, an hydraulic motor in accordance with one embodiment of the invention;

FIG. 2 shows a section through the motor of FIG. 1 taken along a radial plane;

FIG. 3 and 4 are sections taken along the lines III–III and IV–IV in FIG. 2, respectively;

FIG. 5 is a perspective view diagrammatically illustrating a valve device forming part of the motor shown in FIG. 1 and serving to control the inlet and outlet flow of pressure fluid to the working chambers thereof; and

FIG. 6 is an exploded perspective view showing the valve of FIG. 5 in greater detail.

The motor shown in the drawings is a radial hydraulic motor having nine cylinders with a motor casing **1** serving as a rotor and a cylinder block **2** concentrically located in the casing and forming the stationary part of the motor. The casing **1** consists of a cylindrical mantle **3** and two end walls **4**. Adjacent each front wall **4** there is provided an inner cam curve **5** as well as an outer cam curve **6** both rigidly secured to the motor casing **1** for rotation therewith. The cam curves **5** and **6** have undulated cam surfaces **7** and **8** facing each other and defining between them circumferentially closed grooves the perephery of which corresponds to eight wave lengths. Stated in other words, each cam curve **5** and **6** comprises eight cams.

The cylinder block **2** serving as the stationary part of the motor is formed by a cylindrical body of circular cross section having nine radial bores forming nine cylinders **9** each containing a piston **10**. The pistons **10** have outwardly extending piston rods **11** passing through cylinder plugs **12** at the outer ends of the cylinders **9**. At its outer end each piston rod **11** is connected to an axially oriented yoke **13** carrying at each end thereof a cam roller **14** in the shape of roller bearing. Said cam rollers **14** are mounted with an insignificant clearance in the grooves formed between cam curves **7** and **8**.

Arranged concentrically in the cylinder block **2** is a distribution valve, generally designated **15** and comprising a tubular valve member **16** which by pins **17** is secured to one end wall **4** of the motor casing **1**. Valve member **16** has a number of orifices **34** for cooperation with channels or passages **18, 19 20** and **21** in the cylinder block **2** through which passages the hydraulic pressure fluid can flow to and from the working chambers at opposite sides of each piston **10**. Passages **18** and **19** serve as inlet and outlet conduits, respectively, for the inner working chambers, whereas passages **20** and **21** form inlet and outlet connections, respectively, for the outer working chambers. Disposed inside the tubular valve member 16 there is a solid cylindrical body 22 of circular cross section having a central flange 23 and two end flanges 24. Body 22 is by a force fit maintained in its proper position in valve member 16. As a matter of principle it is, however, insignificant whether or not body 22 is rotatable relatively the valve member 16. The central flange 23 divides the space between member 16 and body 22 into two annular chambers 25 and 26 which are restricted in axial direction by end flanges 24. Chamber 25 forms an inlet chamber and chamber 26 an outlet chamber. Pressure fluid is fed to chamber 25 through a number of radial orifices 27 in valve member 16 which orifices through a circumferential groove 28 in the outer cylindrical surface of member 16 communicate with a supply passage 29 bored in cylinder block 2 and an extension 30 which projects axially to the right as shown in FIG. 1 and has a reduced cross section. Said extension 30 is intended to be mounted in a motor frame not shown.

Correspondingly, in cylinder block 2 and in the extension 30 there is provided a return passage 31 which via an external groove 32 in valve member 16 and orifices 33 communicating therewith is connected to outlet chamber 26. The orifices 34 in valve member 16 adapted to cooperate with the passages 18 to 21 in cylinder block 2 are arranged in four series two of which communicate with the inlet chamber 25 and the remaining two with the outlet chamber 26. Within each series said orifices 34 are uniformly spaced in angular direction and located along a common circle. The angular spacing of orifices 34 within each series corresponds to the angular spacing of the cams on each cam curve 5 and 6, respectively. The orifices 34 in valve member 16 and the passages 18 to 21 in cylinder block 2 are arranged so as to cause the inner and outer working chambers within each cylinder 9 to communicate alternately with the inlet chamber 25 and the outlet chamber 26 of valve 15.

Two plates 35 having radially oriented recesses 36 are arranged to guide the movement of the yokes 13 carrying the cam rollers 14. Said plates 35 serve to protect piston rods 11 and pistons 10 from being affected by any forces not radially directed.

Due to the cooperation between the distribution valve 15 and the passages 18 to 21 in cylinder block 2 there is in each dead center position of the pistons attained a switching between pressure fluid supply to and discharge of pressure fluid from the respective working chamber. Since the motor is double acting the pistons will during each stroke give a contribution to the output power. The output torque is generated by the cam rollers 14 which when cooperating with the cam curves 5 and 6 convert the piston movements into a rotational movement. In order for the motor to operate in the desired manner it is necessary that the number of pistons is different from the number of cams. Moreover, those numbers should be selected in such a way that proper dynamic balance of the motor is attained. Due to the fact that the number of pistons is different from the number of cams only one cylinder can be aligned with a top or bottom portion of the cam curves at a given moment. Hereby a stable unidirectional rotation is secured. When one of the pistons moves radially outwards the related pair of cam rollers are forced against the outer cam curve whereas during an inward piston movement the torque generating force resultant is instead caused by cooperation between the cam rollers and the two inner cam curves. In order to reverse the motor it is only necessary to interchange the inlet and outlet connections of the distribution valve. This could conveniently be done by means of four-way valve connected between the pressure fluid source and the distribution valve.

Practical tests have shown that the invention provides a motor which is superior to prior art motors of the same

general type both as far as weight and dimensions are concerned and which also is more favourable than the single-acting motor also from an operational point of view.

The embodiment of the invention above described and shown in the drawings has been chosen in order to exemplify the general inventive concept and it should be underlined that the various parts and components of the motor may be designed in any suitable manner. This is especially true about the distribution valve and also in respect of the number of cylinders and the choice of which motor part that shall rotate or be stationary in any actual field of use.

I claim:

1. A hydraulic radial piston motor comprising a cylinder block and a motor casing supported for rotation relative to said cylinder block, a plurality of pistons supported for radial movement by said cylinder block, said pistons being connected by piston rods to cam rollers, a first circumferentially closed cam means secured to said casing, said first cam means surrounding and engaging said rollers and being radially aligned therewith, said first cam means including a plurality of cam portions of a number different from the number of pistons, means for supplying fluid pressure to said pistons to urge the pistons outwardly and impart by means of said rollers rotary movement of said first cam means and said casing relative to said cylinder block, a second circumferentially closed cam means secured to said casing, said second cam means being radially aligned with and disposed inwardly of an engaging said rollers, means for supplying fluid pressure to said pistons to urge the pistons inwardly and impart by means of said rollers rotary movement of said second cam means and said casing relative to said cylinder block, and valve means to supply fluid pressure to said pistons to alternately urge said pistons outwardly and inwardly, the means for supplying fluid pressure to the pistons to urge the pistons outwardly and inwardly including an inner and outer working chamber associated with each piston, said cylinder block having passages formed therein and being in communication with said inner and outer working chambers, a distribution valve having a valve member journaled within said cylinder block and connected to said motor casing for rotation therewith relative to the cylinder block, said valve member having a cylindrical wall with orifices therein for communication with said passages in the cylinder block, said valve having two separate valve chambers the radially outer walls of which are defined by said cylindrical wall of the valve member, a pressure fluid inlet in constant communication with one of said chambers and a pressure fluid outlet in constant communication with the other of said chambers.

2. A hydraulic motor as claimed in claim 1 wherein the orifices in the cylindrical wall of the valve member are divided into two groups, the orifices within one group being adapted to be in communication with said outer working chambers and the orifices in the other group being adapted to be in communication with said inner working chambers, each of said groups of orifices comprising two series of orifices uniformally angularly spaced along two axially spaced circles on said valve member, the orifices of one of said series of orifices being in communication with said one chamber of the valve and the orifices of the other series of orifices being in communication with the other chamber of the valve, the number of orifices within each of said series of orifices being equal to the number of said cam portions.

3. A hydraulic motor as claimed in claim 2 wherein the passages formed in said cylinder block for each particular piston are disposed in an axially aligned row, the two groups of orifices in the cylindrical wall of the valve member being angularly displaced by an amount corresponding to half the angular spacing between two adjacent orifices in one series of said orifices.