

July 15, 1969

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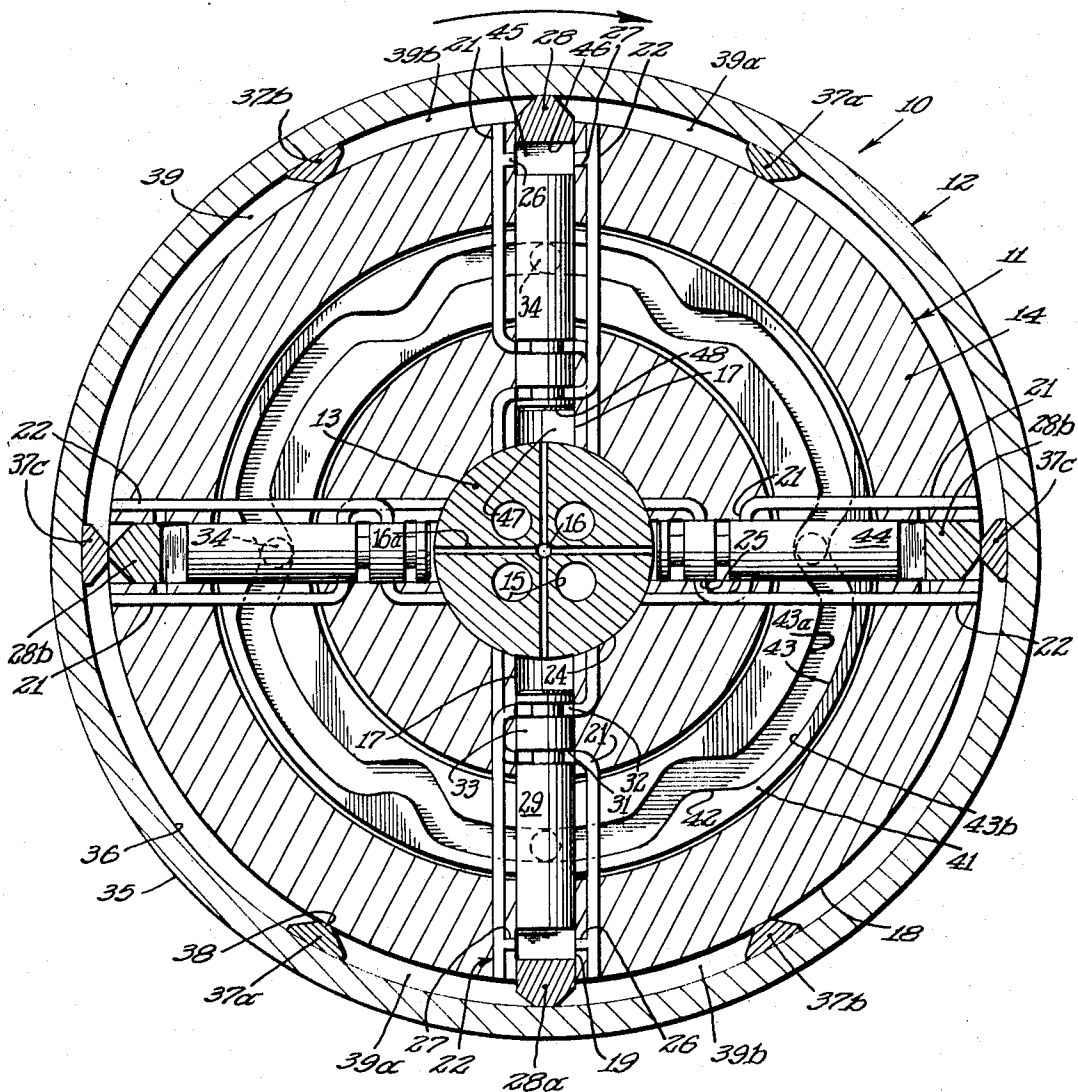
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RETRACTABLE VANE HYDRAULIC MOTOR-PUMP DEVICE

Filed Sept. 12, 1967

4 Sheets-Sheet 1

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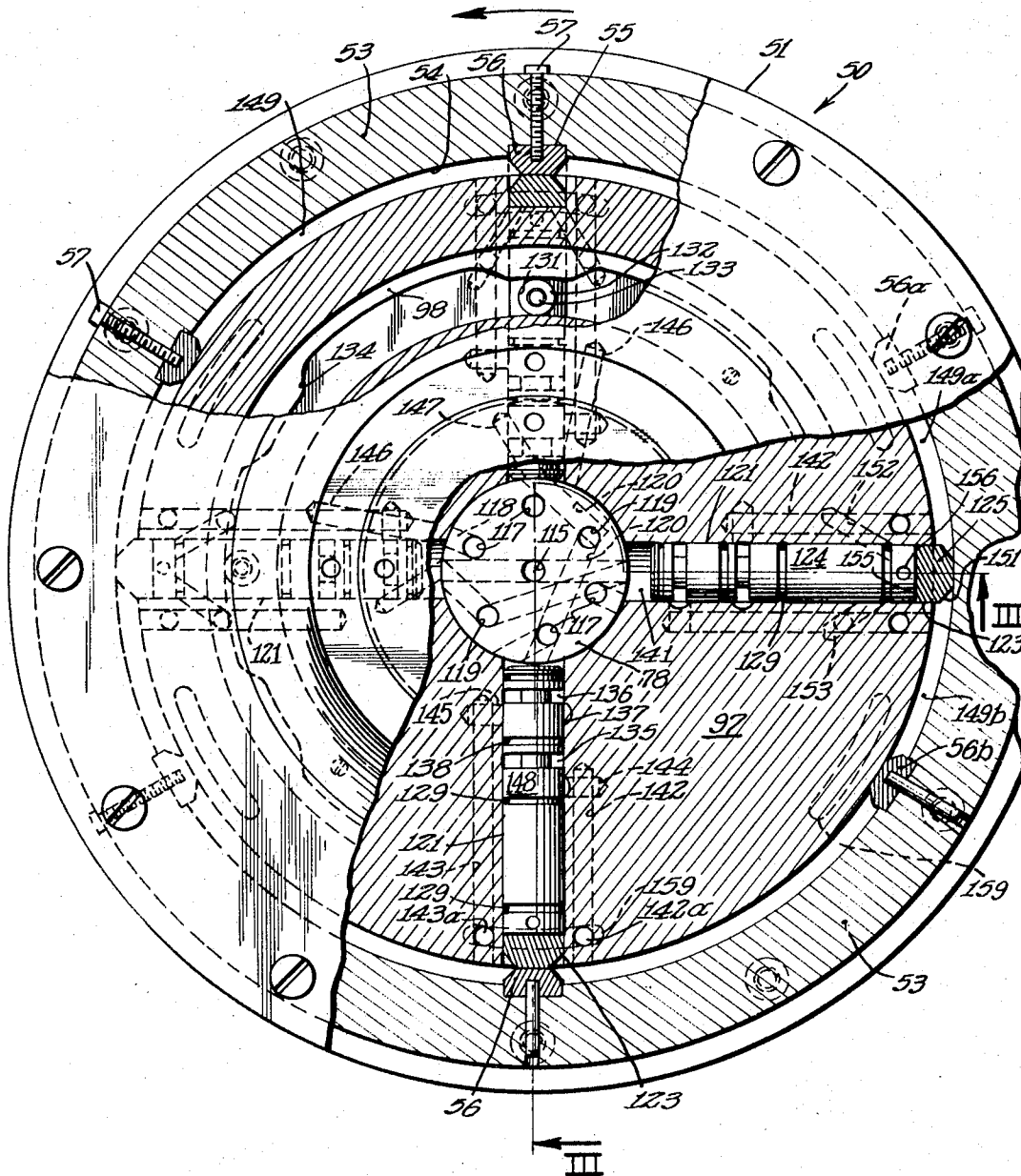
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RETRACTABLE VANE HYDRAULIC MOTOR-PUMP DEVICE

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4 Sheets-Sheet 2

Fig. 2



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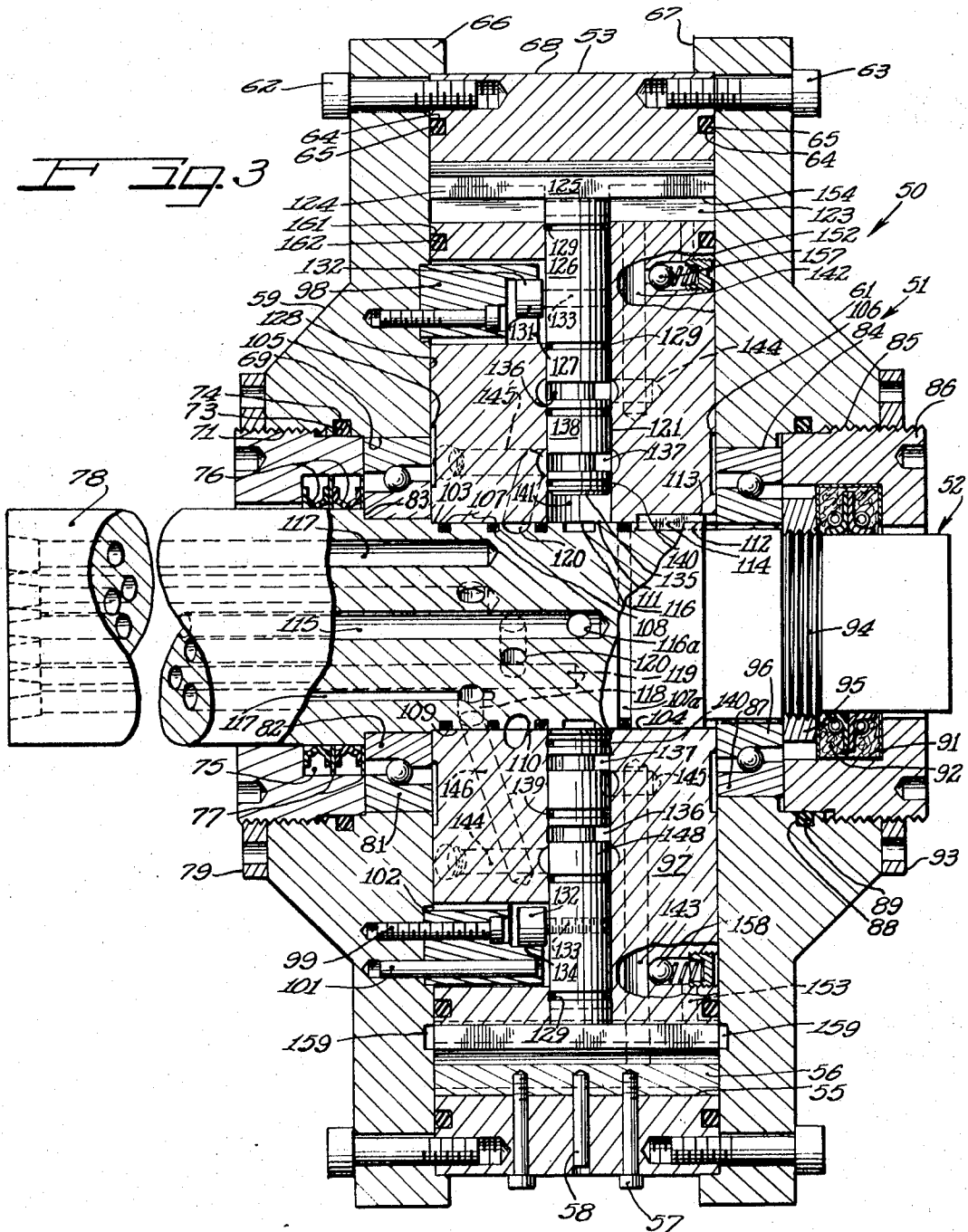
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RETRACTABLE VANE HYDRAULIC MOTOR-PUMP DEVICE

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4 Sheets-Sheet 3



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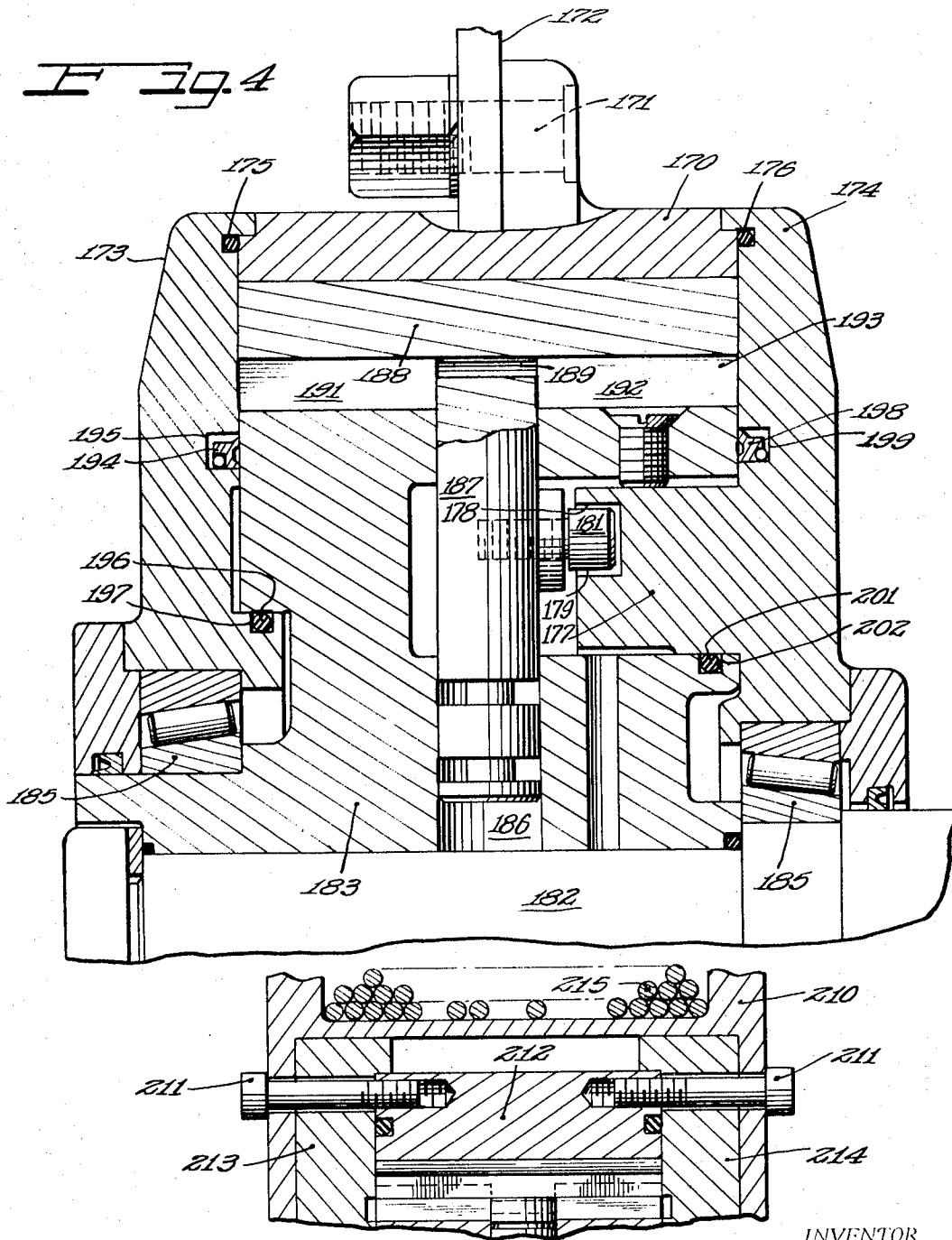
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RETRACTABLE VANE HYDRAULIC MOTOR-PUMP DEVICE

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4 Sheets-Sheet 4



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Fig. 5

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3,455,247

RETRACTABLE VANE HYDRAULIC MOTOR-PUMP DEVICE

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17 Claims

ABSTRACT OF THE DISCLOSURE

A rotary device for hydraulic fluids including a stator which coacts with a rotor having a cylindrical, concentric surface to form an annular space about the stator, divided by a series of abutments on the rotor into a series of segmented working chambers. The stator has a plurality of retractable vanes which move into and out of the chambers. Each of the vanes has an integral spool valve which closes the inlet and outlet passageways associated with the vane when the vane is retracted to allow the passage of the abutment on the rotor. A cam is mounted on the rotor in radial alignment with each abutment to cause the retraction of each vane as the abutment assumes a predetermined position with the vane. The vanes are forced outwardly into contact with the rotor by a control fluid pressure, the removal of which permits the free wheeling of the rotor about the stator and gives the device an additional utility of being used as a hydraulic brake besides being used as a hydraulic pump or motor.

BACKGROUND OF THE INVENTION

Field of the invention

This invention pertains to a retractable vane hydraulic rotor device that is adapted to be used as a motor, pump, clutch or brake.

Prior art

Many of the hydraulic motors and pumps of the prior art rely on an expandable chamber structure in which the rotor moves eccentrically with respect to the stator so that the volume of the chamber formed between the rotor and stator changes as the rotor revolves about the stator. An example of such a device is illustrated in the patent to Stine, U.S. Patent No. 2,097,262.

Hydraulic motors or pumps in which the rotor moves concentric to the stator and in which either the stator or rotor or both have an irregular surface of valley and peaks to form a series of chambers which will decrease or increase in volume as the rotor moves with respect to the stator is illustrated in the patent to Rineer, U.S. Patent No. 3,016,019. The Rineer patent discloses the use of retractable vanes which extend from either or both the rotor and the stator and contact the opposite wall to provide the sweeping seal necessary as the working chamber increases or decreases in volume. Rineer also discloses providing means which will cause the vane to be retracted so that the device may be "free wheeling."

Rineer, U.S. Patent No. 3,016,020, discloses a rotor and stator having substantially cylindrical surfaces instead of the irregular shaped surfaces having valleys and peaks of Rineer, U.S. Patent No. 3,016,019. Rineer also discloses a device which has movable or pivoting vanes and abutments on the stator and rotor respectively; however, the construction of the vanes and abutments allows the rotor to rotate about the stator in one direction only whereas the embodiments using the irregular or non-cylindrical surfaces for the rotors and stators may be rotated in either a clockwise or a counterclockwise direction about the stator.

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SUMMARY OF THE INVENTION

The present invention contemplates a structure for a rotary device which may be used as a pump, motor, or a hydraulic brake utilizing a stator having a cylindrical surface and a rotor having a cylindrical surface which rotates concentrically about the stator. The stator has retractable vanes which coact with abutments provided on the surface of the rotor to provide the tight seal necessary to enclose the working chambers defined therebetween. The device further includes the provision of integral spool valves with each of the retractable vanes, the spool valves closing both the inlet and outlet passageways when the vane is in the retracted position to prevent the pressure in one passageway from being exhausted or lost through the other passageway. The invention also utilizes a control fluid system for biasing the vanes into engagement with the rotor wall and a cam to retract the vanes out of engagement with the rotor wall so that the abutments provided on the wall of the rotor may pass. The fluid control system allows the selective retraction of all the vanes so that the rotor, when desired, may be in a "free wheeling" relationship with the stator.

Accordingly, it is an object of this invention to provide a rotary device and has a "free-wheeling" capability adapted to be used as either a pump, motor, or a braking device.

Another object of the present invention is to provide a rotary device having a rotor with a cylindrical surface and a stator having a concentric cylindrical surface about which the rotor may revolve in either a clockwise or a counterclockwise direction.

A still further object of the present invention is to provide a rotary device having a stator which has a cylindrical surface and a concentric rotor having abutments which cooperate with retractable vanes on the stator to form the fluid pressure chambers, and valve means integral with the retractable vanes to close the fluid passageway of the stator when the vane is retracted to allow passage of the abutment to prevent pressure losses between the passageways.

Yet another object of the present invention is to provide a rotary device having a cam means which retracts a vane and integral valve member of the cylindrical stator out of contact with the concentric cylindrical surface of the rotor to allow the passage of an abutment on the rotor surface.

Yet another object of the present invention is to provide a rotary device having a control fluid system to selectively bias the retractable vanes and their integral valve member carried in the stator into contact with the concentric cylindrical surface of the rotor so that the rotary device may be selectively either "free wheeling" or power converting.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description in the accompanying sheets of drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

Description of the drawings

FIG. 1 is a diagrammatic sectional view illustrating a retractable vane device embodying the principles of the present invention;

FIG. 2 is a plan elevation with portions broken away for purposes of illustrating a structural embodiment of the invention;

FIG. 3 is a sectional view taken along lines III—III of FIG. 2;

FIG. 4 is a partial cross section illustrating the attachment of the rotor to a wheel and a modification of the cam ring; and

FIG. 5 is a partial cross section illustrating the utilization of the rotor device as a brake for a drum of a winch.

As shown on the drawings

The principles of the present invention can be best described by reference to FIG. 1 in which a rotary device of this invention is diagrammatically illustrated and generally indicated at 10. The rotary device 10 consists of a stator generally indicated at 11 and a rotor generally indicated at 12.

The stator 11 consists of a shaft 13 and a core 14 which is mounted on the shaft 13 and is held against rotation therewith. The shaft 13 has a plurality of axially extending bores 15 for conveying hydraulic fluid into and out of the stator and an axially extending bore 16 for conveying a control fluid to the core 14. The bore 16 is in communication with four radially extending bores 16a which extend from the bore 16 to the surface of the shaft 13 and are in communication with four radially extending bores 17 in the core 14.

The core 14 is mounted on the shaft 13 and has a cylindrical surface or periphery 18. The four radially extending bores 17 are formed in the core 14 in equal circumferential spacing which would be approximately 90° between the centers. Each of the bores 17 terminates adjacent the periphery 18 of the core 14 in a slot 19 which extends axially from one side to the other of the core. Adjacent each of the bores 17 and slots 19 are a pair of passageways 21 and 22 which terminates at the periphery 18 of the core 14 with the passageways 21 being on an opposite side of the slot 19 from the passageway 22, and, as illustrated, the passageway 21 is positioned counterclockwise from the passageway 22. The passageway 21 at a point 23 spaced radially inward from the periphery 18 intersects and crosses the bore 19 and then extends to the opening 24 in the core to contact a fluid passageway in the shaft 13 that will interconnect the passageway 21 with one of the fluid passageway bores 15. The passageway 22 intersects and crosses the bore 17 at a point 25 and extends to the central opening 24 to interconnect with the passageways in the shaft 13 which will connect the bore with one of the other fluid bores 15. To control and allow fluid from the passageways into the slots 19, each of the bores or passageways 21 is provided with a means 26 while each of the bores or passageways 22 is provided with a means 27. The purpose of the means 26 and 27 will be discussed hereinafter.

Disposed in the slots 19 is a vane member 28 which extends the full axial length of the slot 19 and is in substantially sealing engagement with the slot 19. Each of the vanes 28 has an integrally attached spool valve means 29 which extends into the bore 17 and is slidable therewith as the vane 28 moves radially in the slot 19. Each of the spool valves 29 has a pair of annular grooves 31 and 32 which cooperate with the fluid passageways 21 and 22, respectively, to allow the fluid to move through the passageways when this valve is in an opened position. The grooves 31 and 32 of each of the spool valves 29 are separated by a land portion 33. Attached to the shaft interconnecting the spool valve 29 to the vane 28 is a cam follower 34 whose function is discussed hereinafter.

The rotor 12 consists of a drive ring 35 having an inner cylindrical surface 36 which, as illustrated, is concentric to the cylindrical periphery 18 of the stator 11. A series of six abutment means 37 are attached in equal spacing about the surface 36 and are of a height to have a wall portion 38 in a sealing engagement with the periphery 18 of the stator 11 to form six annular segment like compartments 39. Attached to the rotor 12 is a cam ring 41 having six cam portions 42 which are in radial alignment with the six abutments 37 on the rotor drive ring 35. The cam

portions 42 which, as illustrated, is formed by a groove 43 coact with the cam followers 34 of each of the combination vanes 28 and spool valves 29 to radially reciprocate the combination inwardly and outwardly as the rotor 12 revolves about the stator 11. As illustrated, the vane 28a which is in an outward position is in contact with the surface 36 of the rotor when the cam follower 34 is between the cam portions 42 on the cam ring 41, and the cam portions 42 will move the vane 28b radially inward to allow the abutment 37c to clear the vane 28b as the abutment passes the vane.

As illustrated in FIG. 1, two of the vanes 28a are in contact with the wall or surface 36 of the rotor 12 and two of the vanes 28b are in the retracted positioned to allow the passing of the abutments 37c. When the vanes 28 are in contact with the surface 36, the grooves 31 and 32 of the spool valves 29 are in alignment with the passageways 21 and 22 to allow the fluid to flow in these passageways between the chamber 39 and the bores 15 in the shaft 13. When the vane 28 is in a retracted position, the land portion 33 blocks or closes the passageway 22 and a solid portion 44 of the valve member 29 adjacent the groove 31 blocks the flow in the passageway 21.

The vane 28 when it engages the surface 36 as illustrated by the vanes 28a divides the chamber 39 into two subchambers 39a and 39b.

The operation of the rotor device 10 will be described as being utilized as a motor in which the rotor 12 rotates in a clockwise direction about the stator 11 as indicated by the arrow of FIG. 1. To operate the device as a motor, a hydraulic fluid under pressure passes through two of the passageway bores 15 which are in communication with the fluid passageways 22 of the core 14 and the remaining two passageways 15 are in communication with the passageways 21 and are connected to an exhaust means. Fluid under pressure flowing in the passageway 22 enters the subchamber 39a and causes the abutment 37a located clockwise from the vane 28a to be forced in a clockwise direction. Fluid which is in the chamber 39b flows or is pumped through the passageway 21 and is returned to the exhaust system. As the rotor 12 revolves, the abutment 37b which is adjacent the vane 28 in a counterclockwise direction approaches the vane 28a, the cam member 42 aligned with the approaching abutment moves the cam follower 34 and, therefore, the vane 28a and its associated spool valve 29 are moved inwardly to a retracted position shown by the vane 28b to allow the passage of the abutment. When the vane 28 and its valve are moved inwardly, the spool valve simultaneously closes both passageways 21 and 22 to prevent the loss of any fluid from flowing over the retracted vane 28b into the other passageway. After the abutment 37 has moved an arcuate distance past the retracted vane 28b, the cam member 41 allows the vane to be moved back into engagement with the wall 36 as illustrated by vane 28a and in so doing opens the passageways 21 and 22 to allow the pressure of the driving hydraulic fluid to flow through the passageway 22 to act against the abutment to continue the rotation of the rotor 12.

As illustrated in FIG. 1, with four vanes spaced 90° apart and with six abutments spaced 60° apart, the cam member or ring 41 allows each vane to have a working stroke of approximately 36° and to be disengaged when the annular distance between the center of the vane and the center of the abutment is approximately 12°. The annular spacing between the vanes 28 in the stator 11 and the abutment 37 of the rotor 12 are such that all four vanes will be in working engagement with the surface 36 of the drive ring 35 for approximately 3° before a pair of the vanes are disengaged by the cam members 41 and move to the position of the two vanes 28b. The disposition of the vane is such that the pressure in the chambers 39a are working on diametrically opposite abutments 37a, 37a, and the surface portions of the rotor and the stator which define the chambers 39a. The diamet-

rically opposite application of the pressure creates a balancing effect which reduces wear on the bearings supporting the rotor 12 on the stator 11.

As illustrated in FIG. 1, the vane is held in contact with the surface 36 by means of a wall 43a of the groove 43 of the cam ring 41. Since the vane has a surface 40 which is subjected to a pressure component of the fluid that is in the chamber 39a, the vane is forced radially inward, and the inward force produces exceptionally high wear on the cam follower 34 and the cam surfaces of the groove 43. To counter this pressure on the surface 40 and to reduce the wear on the surfaces of the cam follower, the means 27 allows fluid from the passageway 22 to enter a chamber 45 behind the vane 28 to act on a back surface 46 of the vane. As noted above both passageways 21 and 22 have a means to allow fluid to enter the chamber 45 and the passageway having the greater fluid pressure determines which means 26 or 27 supplies the fluid to act on surface 46.

As described, the rotary device 10 while operating as a motor will have a continual fluid under pressure applied to the rotor 12 as it rotates about the stator 11. The provision of a spool valve in connection with each of the vanes allows the simultaneous closing and opening of the fluid passageways 21 and 22 as the vane 28 is moved inwardly and outwardly. Therefore, when the vane 22 is moved inwardly, the fluid under pressure in the passageway 22 can not flow around the vane 28 to enter the exhaust passageway 21.

As described, the motor will continue to exhaust fluid out of chamber 39b as the rotor 12 revolves about the stator 11. Thus, if the requirements on the motor are reduced, the continual exhaustion of fluid from the chambers 39b will act as a braking means and will prevent the rotor to "free wheel" about the stator 11. In a modification of the cam ring 41 by removing the cam wall 43a of the groove 42, the cam followers 34 will only be urged in the inward position by the remaining wall 43b of the cam ring 41. Since there would be no force applied to the vanes 28 to force them into engagement with the wall 36, all of the vanes would assume the inward or retracted position 28b and the rotor 12 would then be "free wheeling" with respect to the stator 11.

By application of a fluid under pressure through the control fluid passageway system 16 to a chamber 47 at the base 48 of each of the spool valves 29, the valve and its respective vane 28 will be forced radially outward into engagement with the surface 36. The coaction between the fluid under pressure in the system 16 and the cam portions 42 of the remaining wall 43b of the groove 43 would function in the same manner as if the wall 43a were present. In other words, the fluid under pressure applied through the control fluid system 16 has the same function as the wall 43a of the groove 43 in biasing or forcing the vane 28 into engagement with the surface 36 of the rotor 12. However, by removing the fluid under pressure in the control fluid system 16, the device 10 may be placed in a "free wheeling" operation since the removal of the control fluid would allow the cam portions 42 of the wall 43b to force all of the vanes 28 to their inward position 28b. Thus a single cam member which only acts to move the vane inwardly and the control fluid system 16 provides an added utility of a controllable "free wheeling" for the device 10.

To utilize the device 10 as a pump, the rotor 12 is revolved by mechanical power in a clockwise direction as indicated by the arrow in FIG. 1, and the fluid entrapped in the chamber 39b will be forced or pumped through the passageway 21 to its respective bore 15. The passageway 22 will act as a fluid supply passageway, and the means 26 of the passageway 21 will provide the fluid under pressure necessary in chamber 45 to counter balance the force in the chamber 39b which is applied to the surface 40 of the vane 28.

The device 10 when utilized as a braking device, op-

erates in a manner similar to when it is utilized as a pump. The rotor 12 is rotated about the stator 11 in a clockwise direction as indicated by the arrow in FIG. 1. During the "free wheeling" or non-braking portion of the operation, the fluid under pressure in the control fluid system 16 is reduced or eliminated so that the cam wall 43b of the cam ring 41 will urge or force the vanes 28 and their respective valves 29 into an inward position 28b. While the vanes are in the inward position, the rotor 12 freely revolves about the stator 11 with a minimum amount of power loss due to friction between the various parts of the system.

To apply the brake, a fluid under pressure is applied in the control fluid system 16 which biases the vane 28 into engagement with the surface 36 of the rotor 12 except when the cam portions 42 of the cam ring 41 force the vanes inward to allow the passing of the abutments. With the fluid under pressure applied in the chambers 47 at the base 48 of the spool valves 29, the fluid entrapped in the chamber 39b is forced through the fluid passageways 21 into the respective bores 15 and out to some restricting means that develops the braking force. As the fluid is being forced from the chamber 39b, a replacement fluid under a low pressure is supplied to the expanding chamber 39a so that once the vane 28 has swept between the two abutments 37a and 37b forming the chamber 39, a fresh supply of fluid will be entrapped in the chamber in order that the next vane will have fluid in its respective subchamber 39b to be forced or pumped through the passageway 21.

It should be noted that in the above discussion of utilization of a device 10, the rotor 12 was moving in a clockwise direction about the stator 11; however, the rotor could be moved in a counterclockwise direction around the stator 11 with the appropriate adjustments in the connections of the bores which were in communication with the passageways 21 and 22. The device 10 thus has the advantage of being used as a pump motor or hydraulic brake in either a clockwise or counterclockwise direction.

The device 10 could be modified so that the rotor 12 became the stator and the stator 11 revolved inside the rotor 12; however, it should be noted that it would require some modification in the connections between the lines or bores 15 and 16 and their outside sources.

A preferred structural embodiment of the rotary device is illustrated in FIGS. 2 and 3 and generally indicated at 50, and comprises a rotor indicated at 51, and a stator indicated at 52.

The rotor 51 is made up of a drive ring 53 which has a cylindrical inner surface 54 that has six grooves 55 equally spaced about the surface. Detachably secured in each of the grooves 55 is an abutment 56 which is attached to the drive ring 53 by a pair of bolts 57 and a dowel pin 58.

The rotor 51 is completed by an inside cover plate 59 and an outside cover plate 61 which are each removably secured to the drive ring 53 by means of a plurality of bolts 62, 63 respectively. To insure a sealed joint between the drive ring 53 and each of the cover plates 62, 63, a sealing means is provided between each of the cover plates and the drive ring and is illustrated to be an annular groove 64 on each edge of the drive ring which contains an O-ring 65.

Each of the cover plates 59, 61 are provided with an annular flange 66, 67 respectively, which engages and supports portions of the exterior surface 68 of the drive ring 53. The cover plate 59 has a bore 69 which is threaded at 71 to receive a threaded bearing take up member 72 which is threadedly secured in the threads 71 and has a seal with the bore 69 formed by the O-ring 73 which is disposed in the groove 74. The member 72 has a cavity 75 which contains sealing rings 76 and washers 77 which form a tight seal between the member 72 and the shaft 78 of the stator 52. The housing nut 79 is threaded on the member 72 to lock the member axially in the threads 71 of the bore 69.

To rotatably support the cover 59 on the shaft 78,

a bearing means is provided in the bore 69 and as illustrated consists of a ball bearing 81 which has an inner race 82 disposed in the shaft in tight engagement with a shoulder 83 formed on the shaft 78.

The outer cover plate 61 has a bore 84 which is threaded at 85 to receive a bearing take up member 86 which forces or engages a portion of a ball bearing 87. The take up member 86 is sealed in the bore 84 by a sealing means consisting of a groove 88 containing an O-ring 89. The bearing take up member 86 is substantially similar in structure to the take up member 72 and has a concentric opening 91 in which sealing means 92 are disposed to seal the interior of the member 86 to the shaft 78. A housing nut 93 is engaged on the exterior threads of the bearing take up member to lock it in its position in the bore 84. The shaft 78 is provided with threads 94 for receiving a shaft nut 95 which grips the inner race 96 of the bearing means 87 between the shaft nut 95 and the core 97 of the stator 52. The bearings 81 and 87 rotatably support the rotor 51 on the stator 52.

The inside cover 59 is provided with an annular cam ring 98 which is attached to the cover 59 by a plurality of bolts 99 and pins 101 disposed in a groove 102 which is concentric with the inner surface 54 of the drive ring 53. The cam ring 98 rotates with the rotor 51 about the shaft 78 in the core 97.

The shaft 78 is provided with a shoulder 103 adjacent to the inner surface of the race 82 to receive the bore 104 of the core member 97. The core 97 is provided with a pair of annular depressions 105 and 106 on the opposite side, adjacent the outer races of the bearings 81 and 87 respectively. The depressions 105 and 106 allow the inner races 82 and 96 to be gripped by the sides of the core 97 between the shoulder 83 and the shaft nut 95 but allow the outer race which is rotating with the cover plates to be free from contact with the core 97.

The shafts 78 adjacent the shoulder 103 is provided with four spaced grooves 107 which each have a sealing ring 108 such as an O-ring disposed therein to form a tight seal between the shaft and the bore 104 of the core member 97. The combination grooves and sealing means 107 divide the shaft into three axial spaced portions 109, 110, and 111 which are sealed from each other. Extending inward from the outside cover member is a shaft 78 provided with a pair of opposed key slots 112 which coact with slots 113 in the core 97 which is keyed to the shaft by means of a key 114 disposed in the aligned slots 112, 113.

The shaft 78 is provided with a series of bores. A center bore 115 is in communication with the isolated groove 116 formed in the portion 111. About the center bore 115 are six spaced bores of which four are designated 117 and are of a depth to reach by means of cross bores 118 the isolated portion 109 on the shaft 78. The remaining two bores 119 have a greater depth and by means of cross bores 120 are in communication with the isolated portion 110.

The core 97 is provided with four radially extending bores 121 which are equally spaced 90° apart about the shaft 78. Each of the bores 121 extend toward the periphery 122 of the core 97 and adjacent to the periphery merge with a slot like groove 123 which extends across the width of the core 97. Disposed in each of the combination bores 121 and slots 123 is an integral vane member and spool valve 124 which comprises a vane portion 125 and a shaft having a spool valve portion 126. The vane portion 125 is supported and guided by the slot 123 for reciprocal movement therein. The spool valve 126 is disposed to reciprocate in the bore 121 and moves with said vane 125. The bores 121 are in communication with an annular groove 127 which extends inwardly from the side 128 which is adjacent to the end cover 59 and receives the cam ring 98. To seal the portion of the bore 121 from the groove 127 the shaft 126 is provided with a pair of sealing

means 129 consisting of grooves containing O-rings. Disposed between the seals 129, 129 is a cam follower 131 which as illustrated consists of a roller 132 attached to the shaft 126 by a bolt 133. As best illustrated in FIG. 2, the cam ring 98 has a continuous action surface having a high portion 134 in radial alignment with each of the abutments 56 on the drive ring 53. The high portions 134 forces the cam follower 131 inwardly and therefore moves the combination vane and spool valve 124 inwardly to allow the passing of the abutment 56.

The shaft of the valve portion 126 of the combination vane and valve 124 adjacent an end 135 opposite the vane 125 has a pair of grooves 136 and 137 which are separated by a land 138 containing the sealing means 139. The groove 137 is separated from the end 135 of the valve portion by a sealing means 140 which consists of an O-ring in a groove. The end 135 defines a cavity or a chamber 141 in the bores 121 which is in fluid communication with the groove 116 of the shaft 78.

The core 97 adjacent each of the bores 121 is provided with a bore 142 which is disposed counterclockwise with respect to the bore 121 and a second bore 143 which is disposed clockwise from the bore 121. Each of the bores 142 and 143 may have a plurality of openings extending to the periphery 122, these openings are connected to their respective bores 142 and 143 by cross bores 142a and 143a respectively. The bores 142 and 143 extend radially inwardly from the periphery 122 to cross bores 144 and 145 respectively which are in alignment with their respective annular grooves 136 and 137 of the spool means when the vane 123 is in contact with the inner surface 54 of the drive ring 53 or in the extended position. The cross bore 144 intersects a second bore 146 extending inward from the bore 104 of the core 97. The bore 146 interconnects the cross bore 144 with the cross bore 118 in the shaft 78. The cross bore 145 is intersected by a bore 147 which extends to the bore 104 of the core 97 and is in fluid communication with the cross bores 120 and the shaft 78. Thus, fluid in the bores 117 in the shaft 78 will pass through the outlet or cross bores 118 to the bore 146 through the cross bore 144 and be discharged from the bore 142 in the space between the periphery 122 of the core 97 and the inner surface 54. Likewise fluid forced through the bore 143 will flow through the cross bore 145 to the bore 147 into the cross bores 120 and out through the bores 119 of the shaft 78.

As illustrated in both FIGS. 2 and 3, when the vane 125 of the spool valve combination 124 is in the retracted position, the land 138 blocks the passage formed by the cross bore 145 and a land 148 blocks the passage formed by the cross bore 144. When the vane 125 is in an extended position, the grooves 136 and 137 are in communication with the passages provided by the cross bores 144 and 145 respectively and allow fluid to flow there-through.

The inner surface 54 of the drive ring 53, the abutments 56, the peripheral surface 122 of the core 97 and the vanes 125 coact to define a series of chambers 149 which are subdivided into chambers 149a which extend counterclockwise from the vane 125 to the adjacent abutment 56a and 149b which extends clockwise from the vane 125 to the adjacent abutment 56b. Thus if the rotor 51 is revolved in a counterclockwise direction about the stator, fluid accumulated in the chamber 149b will be forced out through the passageway 143 and eventually through the bores 119 whereas fluid will flow through the bores 117 and eventually through the bores 142 to enter the chamber 149a.

The pressure in the working chamber 149 acting on a chamfered edge 151 of the vane 125 has a reactive force tending to force the vane into an inward position. To counteract the inwardly directed force, each of the passageways 142 and 143 are provided with a bypass 152 and 153 respectively which will bleed the pressure in their respective passageways to the base of the groove 123

to act on a motive surface 154 of the vane 125. The vane has a hole or bore 156 which interconnects the two sides of a pressure control chamber defined by the motive surface 154 and the walls of the slot or groove 123. Each of the bypass means 152 and 153 is provided with a check valve 157 and 158 respectively. Each of the check valves consist of a ball urged in a seat by a spring means, and requires a pressure in either the passageway 142 or the passageway 143 to activate or move the respective ball from its seat. This arrangement allows a high pressure line whether it be 142 or 143 to supply the pressure fluid to the surface 154 of the vane 125.

When the vane 125 is retracted because of the cam portion 134 to allow the passing of the abutment 56, an arcuate groove 159 provided in each of the cover plates 59 and 61 and in radial alignment with the abutments 56 comes into communication with the passageways 142a and 143a. The recesses or grooves 159 allow the balancing of the fluids in both passageways 142 and 143 and their respective bypasses 152 and 153. The balancing allows the bleeding off and removal of the fluid pressure acting on the motive surface 154 and allows the vane to be easily retracted by the cam means 134.

The rotary device 50 may be used as a pump, a motor, clutch, or a brake as explained with respect to the diagrammatic device illustrated in FIG. 1. The control fluid is pumped in the axial bore 115 to the groove 116 to the chambers 141 to act on the bases 135 of the combined valve and vane 124. The pressure in the chambers 141 will urge the vanes 125 into an extended position and into contact with the surface 54 of the drive ring 53 except when the cam follower 131 which moves on the continuous action surface of the cam ring engages the high portion 134 which causes the retraction of the vane 125. By using the pressurized fluid of the control fluid system in the chambers 141 and a single wall cam or an action surface unidirectional cam, the device 50 has a "free wheeling" capability. By removing the pressure of the fluid control system, the vanes 126 will remain in a retracted position and the rotor 51 can rotate around the stator 52 in a "free wheeling" relationship. It should be noted that since the vanes 126 are stationary, there is no centrifugal force to throw or force the vanes into the extended position.

The chambers 149 are isolated by means of the annular sealing ring 65 in the grooves 64 of the drive ring 53. To complete the isolation of the chamber, the core 97 is provided with a groove 162 on each side adjacent the periphery 122 and a sealing ring 161 is positioned in each of the grooves 162.

The utilization of the invention as a brake for a wheel is illustrated in FIG. 4. The rotor which consists of a drive ring 170 is attached by means of studs 171 to a rim of a wheel 172. The drive ring 170 has cover plates 173 and 174 which are sealingly engaged to the drive ring 170 by sealing means 175 and 176 respectively. As illustrated the cover 174 has an integral cam member 177 which has a pair of complementary continuous action surfaces 178 and 179 which are walls of a groove to force the follower 181 in both an inward and outward direction. The drive ring 170 and the side wall cover plates 173 and 174 are rotatably mounted on a shaft 182 and a core 183 of the stator by ball bearings 184 and 185 respectively. The core 183 has the bores 186 for receiving the integral valve and vane member 187 which has a vane 188. At the base of the vane 188 is an opening 189 which interconnects the portion 191 with the portion 192 of the groove 193 in which the vane 188 is reciprocated.

To provide a seal between the cover plate 173 and the core 183 of the stator, sealing rings 194 and 196 are disposed in the grooves 195 and 197, respectively. The other cover plate 174 is provided with grooves 199 and 202 for supporting sealing rings 198 and 201 which provide the seal between the plate and the other edge of the stator core 183.

The partial illustration of FIG. 5 shows a drum 210 of a wench attached by bolts 211 to both the drive ring 212, which is substantially the same as the ring 53, and to the cover plates 213 and 214, which are substantially the same as the plates 59 and 61, respectively. Coiled on the drum 210 is cable 215. The attachment of the drum 210 with the cable 214 wound thereupon to the drive ring 212 is another illustration of using the rotor device as a brake means for a winch or a like device.

The above described rotary device which may function as a hydraulic brake, motor, or a pump can also be operated in either a counterclockwise or a clockwise direction with the only adjustment necessary being the changing of the connections between the inlet and outlet fluid bores and the sources for the inlet and outlet fluids.

The rotary device of the invention has abutments and retractable vanes each having a large and constant working area contacted by the fluid pressure whereas the devices of the above noted prior art have working area that is constantly varying. Therefore, the rotary device of the present invention will develop a constant torque during its operation at any speed. Furthermore, the greater working area allows the development of a fixed amount of torque at a lower fluid pressure than that required by the prior art devices. The lower fluid pressure reduces the forces applied on the various sealing means, and, therefore, reduces the problems associated with sealing a high pressure device.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon, all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A rotary device for a hydraulic fluid comprising in combination:

- (a) a stator having a cylindrical periphery,
- (b) a plurality of retractable vanes carried by said stator and spaced circumferentially about said periphery,

said stator having formed therein a plurality of inlet and outlet ports on said periphery interconnected by passageways to respective inlet and outlet fluid conduit means,

said ports being disposed on said periphery adjacent to said retractable vanes with each of said outlet ports being separated from a corresponding one of said inlet ports by a corresponding one of said vanes,

- (c) a valve means associated with each of said retractable vanes and disposed for movement in said passageways in response to movement of said vanes, said valve means and said passageways having co-operating lands and recesses to open and close said ports,

- (d) a rotor rotatably disposed circumjacent said stator and in sealing engagement therewith,

said rotor having a cylindrical surface concentric with said periphery of said stator and spaced therefrom to form an annular space therebetween,

said rotor having a plurality of abutments disposed in circumferential spaced relationship about said cylindrical surface to partition said annular space into a plurality of working chambers,

said rotor having cam means associated with each of said abutments engageable with said vanes to retract said vanes as said abutments approach said vanes to allow said abutments to pass said vanes whereby relative rotation of said rotor and said stator will occur with corresponding displacement of fluid between said parts.

- 2. A rotary device according to claim 1, in which said stator is provided with a plurality of circumferentially

spaced slots in which said retractable vanes are mounted, thereby to guide and support the vanes for reciprocable movement.

3. A rotary device according to claim 2, in which each of said slots has a radially extending bore portion, and said retractable vane includes a shaft portion extending into said bore portion, said radially extending bore portion intersects said passageways extending to said inlet and outlet fluid conduit means and said shaft includes a portion forming said valve means movable in said bore portion to close said passageways as said vane is retracted.

4. A rotary device according to claim 3, in which said device includes control means to allow the free wheeling of the rotor on said stator.

5. A rotary device according to claim 4, in which said control means comprises a control fluid passageway of a control fluid system being provided in said stator and in communication with each of said radially extending bores whereby a fluid under pressure in said control fluid system biases said vanes into engagement with said rotor and the removal of said fluid under pressure allows said vane to remain in a retracted position.

6. A rotary device according to claim 2 and further characterized by each of said vanes having a motive surface forming one wall of a pressure control chamber in each of said corresponding slots, each of said passageways from said inlet and outlet ports having fluid supply means to provide a fluid from a source at increased pressure to said pressure control chamber, thereby pressure loading said motive surface of said vane to counteract a force in the working chamber tending to move the vane inwardly.

7. A rotary device according to claim 6, in which each of said fluid supply means includes a check valve to prevent fluid under pressure in one passageway from entering the other passageway having fluid at a lesser pressure.

8. A rotary device according to claim 7, in which said rotor includes a bypass means interconnecting the inlet and outlet ports and the respective passageways as the vane is retracted into said slot.

9. A rotary device according to claim 8, in which said bypass means also interconnects said slot of said stator to relieve the pressure acting on the base of said vane.

10. A rotary device according to claim 1, in which said cam means comprises a cam ring having plural spaced camming surfaces and each of said vanes has a cam follower in contact with said ring.

11. A rotary device according to claim 10, in which said cam ring includes a continuous action surface having said cam portions in radial alignment with each of said abutments to move said vane into a retractable position to allow said abutment to pass said vane.

12. A rotary device according to claim 11, in which said cam ring further includes a second action surface complementary to said continuous action surface which forces said vanes into engagement with the periphery of said rotor after the passing of the abutments.

13. A rotary device according to claim 12, in which said first and second action surfaces form walls of a groove in which said follower travels.

14. A motor-pump device comprising:

inner and outer relative rotatable parts together with one another forming a circumferentially continuous annulus having spaced concentric inner and outer walls,

fixed abutment means extending through said annulus radially and spaced circumferentially to partition said annulus into a plurality of working chamber segments of equal size and shape,

movable abutment means for movement through said annulus and in unison with said relative rotation of said inner and outer parts, said movable abutment means comprising a relatively rotatable cam means for reciprocating said movable abutment means radially to clear said fixed abutment means, and control means to selectively retract said movable abutment means for enabling free wheeling between said inner and outer parts.

15. A motor-pump device comprising:

inner and outer relative rotatable parts together with one another forming a circumferentially continuous annulus having spaced concentric inner and outer walls,

fixed abutment means extending through said annulus radially and spaced circumferentially to partition said annulus into a plurality of working chamber segments of equal size and shape, and

movable abutment means for movement through said annulus in unison with said relative rotation of said inner and outer parts, said movable abutment means comprising a relatively rotatable cam means for reciprocating said movable abutment means radially to clear said fixed abutment means, said movable abutment means being spaced circumferentially in one of said concentric walls of said inner and outer parts with the spacing between adjacent movable abutment means being greater than the spacing between fixed abutment means whereby at least one of said movable abutment means is in contact with the other of said concentric walls during relative rotation of the inner and outer parts.

16. A motor-pump device according to claim 15, in which said movable abutment means comprising a spool reciprocatingly movable in a bore formed in said inner part,

said spool and said inner part having lands and recesses to develop a valving action,

and means in said inner part forming an inlet and an outlet with passages controlled by the valving action of said spool,

whereby said parts may be selectively rotated in either direction either as a pump or as a motor.

17. A motor pump device according to claim 15 which includes control means for selectively enabling free wheeling between the said inner and outer parts.

References Cited

UNITED STATES PATENTS

130,300	8/1872	Jungling	91—74
215,314	5/1879	Berger	91—74
560,252	5/1896	Bennett	91—74
693,348	2/1902	Dearing	91—74
1,536,737	5/1925	Williams	91—74

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