

March 9, 1943.

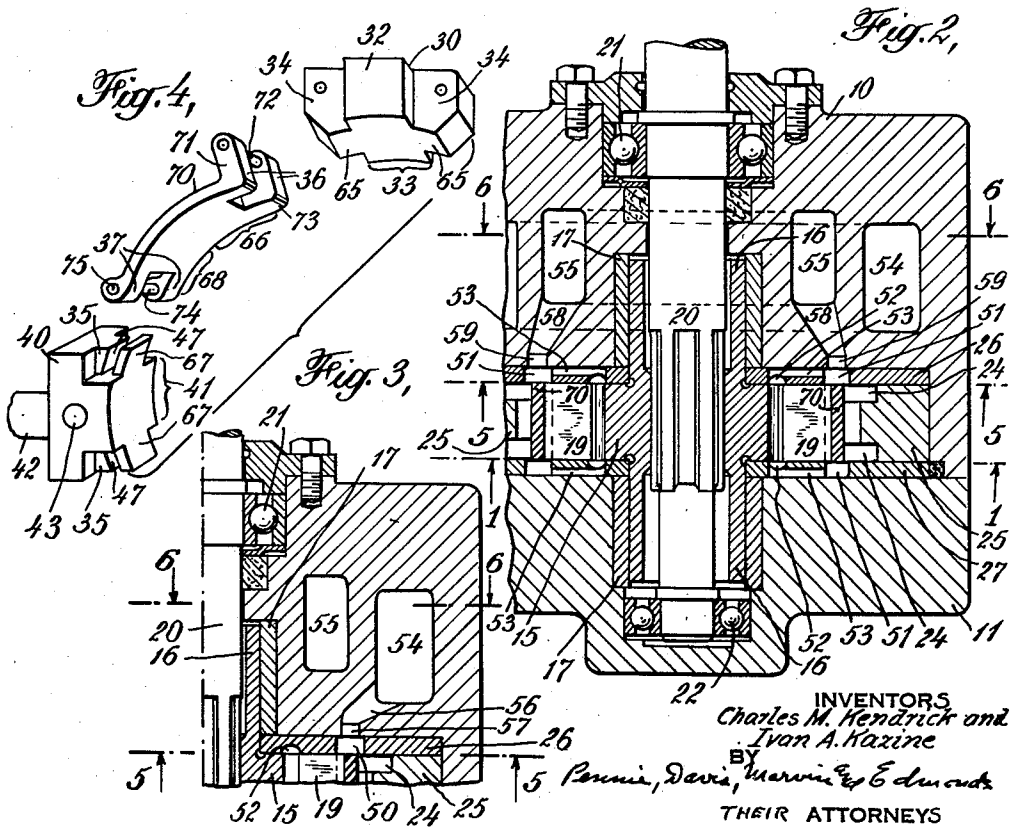
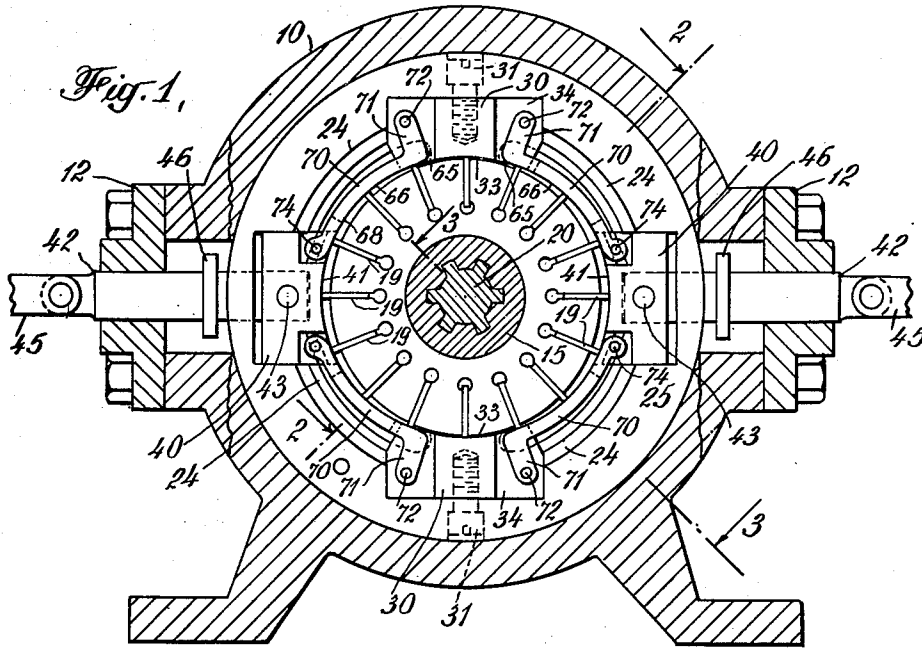
C. M. KENDRICK ET AL

2,313,075

FLUID PRESSURE DEVICE

Filed March 23, 1939

2 Sheets-Sheet 1



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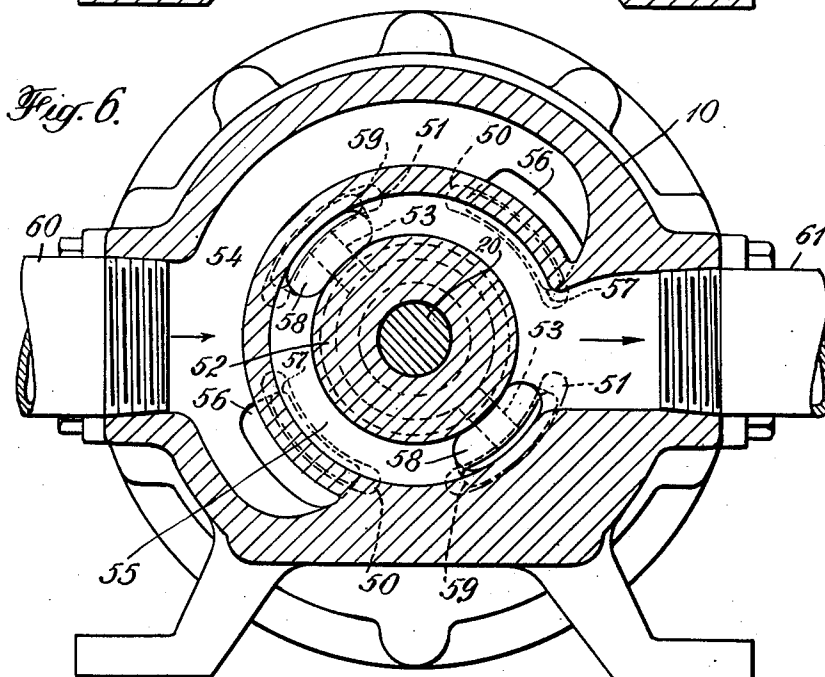
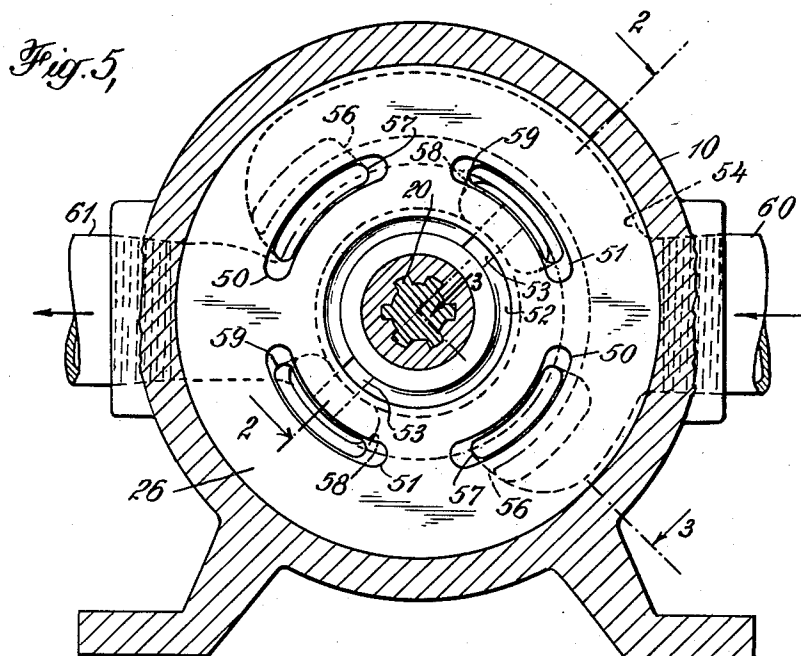
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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FLUID PRESSURE DEVICE

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This invention relates to vane type rotary fluid pressure devices, such, for example, as pumps or fluid motors, the volumetric capacity or output per revolution of which can be regulated or varied, and it relates, more particularly, to improvements in that portion of the fluid pressure device by means of which such variation of capacity or output is obtained.

The widest present use for fluid pressure devices of this general class is as hydraulic devices, that is, devices for handling or whose motive fluid is a liquid, such, for example, as oil, and the fluid pressure device of the present invention will be described in connection with such use. It will be understood, however, that the invention is applicable to fluid pressure devices operating with elastic fluids.

Fluid pressure devices of the type under consideration include a rotor provided with vanes which are movable inwardly and outwardly, for example, in a general radial direction, and arranged to rotate within a chamber having side walls which closely fit the sides of the rotor and the side edges of the vanes. A trackway, which surrounds the outer ends of the vanes and controls their inward and outward movement, comprises one or more pairs of abutments and interconnecting track elements. One abutment of each pair is preferably arranged in fixed position adjacent the circumferential surface of the rotor and the other abutment of each pair is adapted to be adjusted inward and outward with respect to said circumferential rotor surface. With this preferred arrangement the work of the fluid pressure device is done while the vanes move across an arc on the working or movable abutment of each pair, termed the "working" or "pumping arc," which, when the device is at other than zero "stroke," is spaced from the circumferential surface of the rotor, forming a working or fluid transfer chamber. The circulated fluid is received on one circumferential end of this working chamber or pumping arc and discharged on the other.

The volumetric capacity or output per revolution of the fluid pressure device is regulated or varied by adjusting the position of the working or movable abutment of each pair with respect to the surface of the rotor. The interconnecting track element or elements serve to guide and convey the outer ends of the vanes from one abutment to another in all positions of the movable abutment, permitting adjustment of the movable abutment without changing the position of the other abutment of each pair.

The general object of the present invention is to provide an improved variable-capacity vane type fluid pressure device which operates smoothly and quietly, and is substantially free from vibration at hydraulic pressures up to and including 1,000 lbs. per sq. in. A further object is to provide a fluid pressure device of this class having an improved trackway for the vanes in which all trackway members or elements are substantially rigid yet which cooperate to form a substantially smooth and uninterrupted path of travel for the vanes at all outputs of the device. Other and more specific objects will appear from the description which follows.

The invention will be understood from a consideration of the accompanying drawings which illustrate, by way of example, a preferred embodiment of the invention in a fluid pressure device having two working spaces employed as a so-called double-acting pump in which the vanes move inward and outward with respect to the rotor in a substantially radial direction. It will be understood, however, that the invention is also applicable to other fluid pressure devices which may be employed, for example, as fluid motors and that the fluid pressure device can be made a "single" or "single acting" device having only one working chamber and also that more than the two working chambers may be employed, if desired.

In the drawings:

Fig. 1 is a view in vertical transverse section taken on the plane of line 1—1 of Fig. 2.

Fig. 2 is a partial longitudinal sectional view taken along the line 2—2 of Fig. 1 and of Fig. 3.

Fig. 3 is a similar but fragmentary view along the line 3—3 of Fig. 1, showing certain details of the pump's fluid circuit.

Fig. 4 is a perspective view of the elements comprising the improved vane track of the pump separated from but showing their relation to one another.

Fig. 5 is a transverse section taken along the line 5—5 of Figs. 1 and 2 and looking in the direction of the arrows, showing the casing end plate in position and also showing in dotted lines the fluid connections between the ports of this end plate and the inlet and outlet conduits in the pump casing, and

Fig. 6 is a transverse section taken on line 6—6 of Figs. 2 and 3, looking in a direction opposite to that of Fig. 5 as indicated by the arrows.

Referring now to the drawings, as shown in Fig. 2, the pump includes a casing 10 and a head or cover 11 which cooperate to form a cavity for

the rotor 15 and associated parts. The rotor 15 is rotatably supported by its hubs 16 which extend into bushings 17 carried by the casing 10 and cover 11 respectively and said rotor is also provided with substantially radial vane slots in each of which is a vane 19 adapted to be moved radially inward and outward therein.

The pump's driving shaft 20 is revolvably supported upon a pair of bearing members 21 and 22 carried by the casing 10 and cover 11 respectively and shaft 20 passes through the central bore of the rotor 15 with which it has a slidable splined connection as clearly shown in Figs. 1, 2 and 4.

A substantially annular spacer block or ring 25 surrounds the rotor and vane assembly (Fig. 1) and separates a pair of disk-shaped end plates 26 and 27 which are provided with holes at their centers through which pass the hubs 16 of the rotor 15, as best shown in Fig. 2. The outer faces of the end plates 26 and 27 fit snugly against the adjacent wall surfaces of the casing 10 and cover 11 respectively and form substantially fluid tight fits with the several ports and passages to be presently described. The inner or opposing faces of the end plates 26 and 27 form fluid tight fits with the sides of the spacer ring 25 by which they are axially positioned with respect to the rotor 15 in such manner that the rotor is permitted to turn freely while its sides and the side edges of the vanes form substantially fluid tight running fits with the adjacent faces of said end plates 26 and 27.

The space within the chamber formed between the end plates 26 and 27 and which surrounds the rotor 15 is divided into a plurality of pumping sections, preferably two, each consisting of a working or pumping chamber flanked by an inlet area and an outlet area. In the embodiment illustrated this space surrounding the rotor is divided into two pumping sections by a pair of diametrically positioned fixed abutments 30 (Fig. 1) which extend inward from the spacer ring 25 and are positioned above and below the rotor 15. Each fixed abutment is received within an appropriate recess formed in the spacer ring 25 and is held in place by a screw 31, as shown by dotted lines in Fig. 1, so that each fixed abutment 30 forms a substantially fluid tight seal with the bottom of its corresponding recess. As best shown in the perspective view of Fig. 4, each fixed abutment 30 includes a central section 32 which is of the same width or thickness as that of the spacer ring 25 and thus forms a substantially fluid tight seal with the faces of the end plates 26 and 27. The interior surface of each fixed abutment 30 includes an arcuate surface 33, for convenience termed a "sealing arc," preferably concentric with the rotor 15, which is adapted to form a substantially fluid tight sliding fit with the ends of the vanes 19 and which has an angular length equal to or slightly greater than the distance between a pair of adjacent vanes 19. The fixed abutments 30 thus cooperate with the rotor 15 and vanes 19 to form the divisions between the pump's two pumping sections.

The working or pumping chambers of the two pumping sections are formed by means of two diametrically positioned movable abutments 40, acting in conjunction with the rotor and vanes. Abutments 40 are shown in side elevation in Fig. 1, and one is shown in perspective in Fig. 4. The pumping chambers are comprised by the spaces bounded by the rotor surface and the inner ends of abutments 40 and extend in a

circumferential direction for an arcuate distance substantially equal to the distance between the two adjacent vanes which at any given instant are moving in contact with the arcs 41 (Fig. 4) on the inner ends of these movable abutments 40; the arcs 41 will be referred to as the "pumping arcs." The center line of each pumping arc 41 is preferably in line with the horizontal center line of its corresponding movable abutment 40, and the two pumping arcs and pumping chambers are thus diametrically opposite one another. The size of the pumping chambers, and hence the volume of fluid delivered per revolution of the rotor 15, is determined by the distance of the pumping arcs 41 from the circumferential surface of the rotor 15.

The movable abutments 40 are arranged to be adjusted in a substantially radial direction to permit regulation or variation in the size of the pumping chambers and hence in the output of the pump. The movable abutments 40 are accordingly supported by and form substantially fluid tight fits with a pair of parallel slideways formed in the spacer ring 25 as shown in Fig. 1. The width of the movable abutments 40 is substantially the same as that of the spacer ring 25 and the arrangement is such that said movable abutments 40 likewise form substantially fluid tight sliding fits with the adjacent faces of the end plates 26 and 27. In this manner the movable abutments 40, in cooperation with the rotor 15 and the vanes 19, separate the inlet and outlet areas of each of the two pumping sections while permitting adjustment or variation in the size of the pumping chambers.

The movable abutments 40 are adapted to be moved inwardly and outwardly, in order to regulate the output of the pump, by means of a pair of adjusting rods 42 (Figs. 1 and 4), the inner ends of which are received within suitable holes drilled in the movable abutments 40, as indicated by dotted lines in Fig. 1, and the parts are fastened together by pins 43. The adjusting rods 42 extend through suitable holes in the spacer ring 25 and in the side covers 12 which close the horizontal adjusting rod bores formed in the casing 10. Movement or adjustment of the adjusting rods 42 and movable abutments 40 may be effected by any suitable means, not shown, which may be conveniently connected with the links 45 on the outer ends of the adjusting rods. Maximum outward movement of the movable abutments 40 is limited by the ends of the parallel slideways of the spacer ring by which said movable abutments are supported, and their maximum inward movement is limited by stop collars 46 formed on the adjusting rods 42.

Fluid is admitted to the pumping chambers at the sides of the vanes as they approach each pumping chamber, and fluid is discharged from the pumping chambers in like manner as the vanes recede therefrom. This admission and discharge is accomplished through a pair of diametrically opposite arcuate inlet ports 50 and a similar pair of outlet ports 51 formed in the end plate 26 as shown in full lines in Fig. 5 and in dotted lines in Fig. 6; the ports 51 are also shown in the sectional view of Fig. 2. The end plate 27 is likewise provided with a pair of similar inlet ports 50 (Fig. 2) and a pair of outlet ports 51 which serve as "balance ports" to contain fluid under the same pressure as that in the corresponding ports in the end plate 26 in order to substantially balance the hydraulic forces acting on the sides or axial ends of the

vanes to prevent binding thereof. Fluid is also admitted and discharged, however, through the ports in the end plate 27 as fluid is free to pass to or from said ports through the clearance spaces intermediate the link members 70, to be later described, and the spacer ring 25.

Each of the end plates 26 and 27 contain an annular groove 52, termed a "vane slot port," which registers with the radially inner ends of the vane slots of the rotor 15. The vane slot ports 52 are connected with the discharge ports 51 of their respective end plates by the grooves 53 formed on the outer faces of said end plates; the vane slot ports 52 and grooves 53 are shown in full line in Figs. 2 and 5 and are also shown by the dotted lines of Fig. 6. With this arrangement pressure fluid from the outlet areas, that is to say from the outlet ports 51, is continuously supplied to the inner ends of all the vane slots where it acts upon the ends of the vanes 19 to urge them radially outward.

The fluid circuit also includes a branched inlet conduit 54 and an annular outlet conduit 55 as best shown in Figs. 2 and 5. The inlet conduit 54 is connected by sloping passages 56 with arcuate ports 57 formed in the wall of the casing 10, as shown in Figs. 3, 5 and 6, the ports 57 registering with the inlet ports 51 of the end plate 26. The outlet channel 55 is similarly connected with the output ports 51 of the end plate 26, this connection being through sloping passages 58 and arcuate ports 59 in the wall of the casing 10 as best shown in Fig. 2. Fluid is supplied to the pump from a suitable reservoir, not shown, through the inlet pipe 60 and pressure fluid is discharged by the pump into the outlet pipe 61 which may be connected with any suitable hydraulic device which is to be operated thereby.

When the rotor 15 revolves in a counterclockwise direction as viewed in Fig. 1 fluid enters through the inlet ports 50 of the end plate 26 and passes into the inlet area of each of the two pumping sections of the pump. Pumping is accomplished by the vanes 19 as they move across the pumping arcs 41 and the vanes 19 thus force fluid into the outlet areas of each of the two pumping sections from which it passes out through the outlet ports 51 of the end plate 26 and into the outlet conduit 55. As already stated the size of the pumping chambers and the volume of fluid delivered by the pump are determined by the distance of the pumping arcs 41 from the rotor 15; as this distance may be varied in infinitely small increments from minimum to maximum, the size of the pumping chambers and the volume of fluid delivered by the pump may likewise be varied from minimum to maximum.

The present invention is directed especially to the construction of the trackway by means of which the ends of the vanes are guided in their in-and-out movement as the rotor revolves. This trackway comprises the inner surfaces of the fixed abutments 30 and movable abutments 40, and the inner surfaces of articulated interconnecting track elements which extend in a generally circumferential direction between these abutments to guide the vanes as they move from one abutment to another as the rotor revolves. In the present embodiment the interconnecting track elements, as shown in Figs. 1 and 4, take the form of rigid (that is to say, not readily bendable) links 70 the entire vane-contacting surfaces of which are of fixed curvature

or configuration. Two of these track links 70 are employed in each of the two pumping sections in the present embodiment and serve to connect the movable abutments 40 thereof with the two fixed abutments 30 as shown in Fig. 1. All four of the links 70 of the present embodiment are preferably identical and each of them is forked at each end, as indicated at 36 and 37 in Fig. 4, in order to form sliding fits with the correspondingly reduced end portions 34 and 35 of the fixed and movable abutments, respectively, which it connects. These reduced end portions 34 and 35 of the abutments extend into the slots or forks 36 and 37, respectively, of the links in such manner that the vane-contacting surfaces of each link overlap the vane-contacting surfaces of the abutments, as will be understood from Figs. 1 and 4.

Each link 70 is pivotally positioned with respect to one of its abutments, preferably its fixed abutment 30 in this embodiment. As shown in Figs. 1 and 4 each link 70 is pivotally supported at a point near the outer end of an arm 71 which extends outward in a substantially radial direction at the end of link 70 adjacent fixed abutment 30. In this manner the point of pivotal support is appreciably removed in a generally radial direction from the overlapping vane-contacting surfaces of the link 70 and its fixed abutment 30, for a purpose to be presently explained. The pivotal support of the link 70 comprises a pin 72 which in turn may be supported upon any suitable member such, for example, as the spacer ring 25, but is preferably carried by the corresponding reduced end portion 34 of fixed abutment 30 in order that the two parts may be substantially self-aligning and thus facilitate and assure proper relationship between the portion of the overlapping vane track surface carried by each of them.

It is essential that the vane-contacting surfaces of links 70 be maintained in vane-transferring relation with the vane-contacting surfaces of the abutments which they connect in order that the vanes may pass smoothly from one of these members to another. It is also necessary that such alignment be provided at all positions of adjustment of the movable abutments 40 from zero to full stroke. The importance of this will be understood from the fact that the rotor 15 is frequently driven at a speed of 1200 R. P. M. or more and that each vane 19 passes to and from each of the track elements during each revolution of the rotor.

The point of transfer between each link 70 and its fixed abutment 30 is preferably located upon the radius of curvature of the interior or vane-contacting surface of fixed abutment 30 which passes through the center of the corresponding pivot 72, or conversely, each pivot 72 may be said to be preferably located upon the extension of the radius of curvature passing through the corresponding point of transfer on the fixed abutment 30. The vane-contacting surface of each link 70 on its end adjacent its corresponding fixed abutment 30 is formed with an arc 73 having the same center as that of the corresponding pivot pin 72 and having a radius equal to the distance from the center of the pivot pin to the point of transfer on the vane-contacting surface of the fixed abutment 30. This arc 73 extends on to the link 70 for a distance sufficient to engage or register with the point of transfer on the fixed abutment 30 throughout the range of swinging or rocking of

said link 70 about the pivot 72 incident to adjustment of the corresponding movable abutment from its extreme outward to its extreme inward position. This arrangement provides smooth transfer of the vanes from the vane-contacting surface of the fixed abutment 30 to the vane-contacting surface of the link 70, and vice versa, in all positions of adjustment of the vane track elements, and this smooth and uninterrupted transfer is not affected by movement of the links. The location of the pivot points 72 at points appreciably removed from the vane-contacting surfaces contributes to the smooth transfer thus obtained and permits swinging or rocking movement of the links relative to the fixed abutments without angularity between the vane-contacting surfaces of these members at the points of vane transfer which would produce an excessively abrupt change in the rate of radially inward and outward movement of the vanes. The portion of each arc 73 which is contacted by the ends of the vanes changes conformably with the amount of swinging of the links, so that the circumferential length of the vane trackway adjacent the transfer point on the fixed abutments is increased as the links swing outward, upon outward adjustment of the movable abutments, and vice versa.

In this connection it may be stated that in the particular embodiment illustrated the points of transfer on the fixed abutments 30 (Fig. 1) are preferably spaced, in a circumferential direction, a distance from the arcs 33 which is somewhat greater than that necessary to permit swinging of the links 70 into their extreme inward position toward the rotor 15. The vane-contacting surfaces 65 of reduced end portions 34 of the fixed abutments 30 intermediate the arcs 33 and the transfer points are preferably given a curvature of slightly but gradually increasing radius so that the transfer points are radially separated from the circumferential rotor surface for a distance slightly greater than that between the rotor surface and the arcs 33. The vane-contacting surface 66 on each link 70 extending from the arc 73 toward the corresponding movable abutment 40 may be given any suitable curvature and considerable latitude in contour is permissible, particularly when all of the vanes are continuously urged outward by action of pressure fluid from the discharge area upon the inner ends thereof as in the present embodiment. For example, this vane-contacting surface 66 may include an arc (not designated by a reference numeral) which is concentric with the rotor 15 when the link 70 is in its extreme inward position and it may be joined with the arc 73 in any suitable manner, as by a common tangent therewith or by an intermediate portion the curvature of which gradually increases as it approaches the arc 73; this "concentric" arc does not extend, however, across the entire length of the link's vane contacting surface but to an intermediate point which in the present instance is approximately midway between the ends of the link where it is smoothly joined with the contiguous portions of the link's vane-contacting surface which will be presently described. This arrangement of transfer point and of curvature of the vane-contacting surfaces adjacent thereto permits use of a relatively small clearance between the surface of the rotor 15 and the arcs 33 without danger of any binding of the rotor by the links 70 and provides satisfactory radially inward and outward movement of the vanes

throughout the range of swinging movement of the links. The small amount of radial movement of the vane occurring adjacent the transfer point when the link is in its extreme inward position (corresponding to zero output of the pump) is negligible and does not adversely affect the pump's operation.

It is also necessary, as previously stated, to provide smooth transfer of the vanes as they pass from the vane-contacting surfaces of the links 70 onto the vane-contacting surfaces of the movable abutments 40, and vice versa. Moreover this smooth and uninterrupted transfer must be provided in all positions of the movable abutment and the arrangements must also be such that relative motion is permitted between the links 70 and the movable abutments 40 in order that said movable abutments may be freely adjusted inward and outward to alter the pump's output. In the preferred embodiment the adjacent end of each link 70 is adapted to have an extensible connection with its contiguous movable abutment 40. This extensible connection is provided by means of a pin 74 (Fig. 1) closely fitted in holes 75 (Fig. 4) in the ends of link 70 and slidably fitted into a slot 47 which is formed in the reduced end portion 35 of the movable abutment 40 that extends into fork 37 in the adjacent end of said link 70. In this manner the vane-contacting surfaces on the movable abutment 40 overlap those on the link 70 and relative sliding and rocking movements between the two parts are permitted simultaneously.

The links 70 swing outward, about the pivots 72, when the movable abutments 40 are moved in an outward direction and at the same time the pins 74 slide in the slots 47 in a direction away from the horizontal center line so that the length of the overlapping portions of the vane-contacting surfaces on the links and movable abutments is reduced and the circumferential length of the vane trackway is increased. The reverse is of course the case when the movable abutments 40 are moved in an inward direction. The slots 47 are so positioned and their configuration is such that a point on the portion of the vane-contacting surfaces on the fork 37 of the link 70 is maintained substantially even with the overlapping vane-contacting surface 67 on the end portion 35 of the corresponding movable abutment 40; or in other words each slot 47 may be said to be positioned along the line generated by movement of the pin 74 when the vane-contacting surface of the link 70 is kept in proper relation to the vane-contacting surface of the movable abutment 40 and said movable abutment 40 is adjusted from its extreme outward to its extreme inward position. A line so generated has, theoretically, a slight curvature but this curvature is so extremely small that in practice it often may be neglected and the slot 47 may be straight as in the present embodiment.

As shown in Figs. 1 and 2, the flat side surfaces of the spacer ring 25 are cut away to form arcuate recesses 24 extending intermediate the fixed and movable abutments and positioned adjacent the inner circumference of spacer ring 25. The purposes of these recesses 24 is to provide clearance for the ends of the links 70 adjacent the movable abutments 40 as said movable abutments are adjusted toward their extreme outward positions. Only a relatively small part of each recess 24 is needed for this purpose but

they are extended for convenience in manufacture.

The entire vane-contacting surface of each movable abutment 40 is, in the present embodiment, a single arc which is concentric with the rotor 15 when said movable abutment is in its "half stroke" position; that is, when said abutment is midway between its extreme inward and outward positions of adjustment. In other words, the vane-contacting surfaces 67 of end portions 35 on each movable abutment have the same curvature as that of the pumping arc 41. The vane contacting surfaces 68 on the adjacent ends of the links 70 in this preferred embodiment have a contour approximating a segment of a parabola which smoothly joins the vane-contacting surface 67 of the movable abutment 40 when said abutment is in its half stroke position. This approximate parabolic contour 68 extends to about the middle of the link and to a point near the end of the previously described arc 66 which is formed on the end of the link adjacent the fixed abutment 30, the two curves being smoothly joined.

The above described arrangement provides smooth transfer of the vanes as they pass onto and away from the movable abutments 40, and the vane-contacting surfaces of the links merge so smoothly with the vane-contacting surfaces of the movable abutments that in practice a considerable part of their overlapping portions appears to be substantially coincident.

The links 70 are moved conformably with the extent of inward and outward adjustment of the movable abutments 40 and the relative positions of the links are accurately controlled throughout the entire range of adjustment. The links 70 move relative to both the fixed abutments 30 and the movable abutments 40 and have their movement coordinated with the movement of the movable abutments 40. The track surface has extensible connections at the ends of the links 70 with both their corresponding fixed and movable abutments, whereby an increase or decrease in circumferential length of the vane trackway takes place at each end of the link incident to outward or inward adjustment of the movable abutments. The relative amount of change in circumferential length of the vane trackway taking place at each end of the links is determined by its pivot 72 and may be distributed between the ends of each link in varying proportions by changing the positions of said pivot 72. For example, when the pivot 72 of any link is positioned immediately adjacent the vane-contacting surface at the transfer point on the fixed abutment substantially all of the change in circumferential length of the vane track will occur adjacent the movable abutment 40 and relatively little such change will occur adjacent the fixed abutment 30. Substantially all of the change in circumferential length may be made to occur adjacent the fixed abutment, however, with relatively little such change adjacent the movable abutment, by moving the pivot points outward in a substantially radial direction until they occupy positions in which a line drawn through the centers of the two pivots in each pumping section (which is a vertical line in the present embodiment) extends through the regions of vane transfer on the corresponding movable abutment. The distribution of this change in trackway length between opposite ends of a link may therefore, as already stated, be altered to provide numerous ratios by change in

location of the pivot. It is preferable, however, to remove the pivot point as far outward as possible from the point of transfer on the fixed abutment and to position said pivot upon an extension of the radius of curvature passing through said transfer point, as this arrangement will provide smoothest vane transfer between the vane-contacting surfaces of the link and the fixed abutment. Practical considerations such as size of the casing 10, the spacer ring 25, etc. usually impose certain limitations upon the location of the pivot points and the approximate locations as illustrated in connection with the present embodiment will be preferable for practical reasons in many instances. Pivot points located in the approximate relative positions shown in the accompanying drawings produce somewhat greater change in circumferential track length at the ends of the links adjacent the movable abutments than at the ends thereof adjacent the fixed abutments.

A vane track embodying the construction above described provides smooth transfer at all points of connection between the several vane track elements and at all positions of adjustment of the movable abutments. This transfer of the vanes makes possible quiet and steady operation of the pump, and the terms "smooth vane transferring relation," "vane transferring relation" and other forms of these general expressions refer to transfer of the vanes with which pump operation of this character may be obtained. Numerous variations in this arrangement may be made, however, such, for example, as change in location of the pivot points or change in contours of the vane-contacting surfaces, etc. The arrangement described has, however, been found to function satisfactorily.

The construction and arrangement of the vane track elements and associated mechanism are important features of this invention and have numerous advantages. For example, the vane track consists entirely of rigid elements, that is to say, no flexing or bending of any of them is required to provide smooth transition and it is accordingly possible to heat-treat all parts to have any desired degree of hardness. The track presents substantially no resistance to adjustment and the movable abutment may be moved inward and outward with very little effort. This is important particularly in instances where it is desired to use hydraulic adjusting mechanism which is actuated by pressure fluid delivered by the pump itself as it permits such hydraulic adjustment at low pressures of the discharged fluid.

The present construction also makes it possible to provide pumps of small capacity having rotors of relatively small diameter as the link construction allows free movement of the several coordinated track members throughout a wide range of sizes. The present construction also makes it possible to use a relatively wide rotor as the tracks of the present construction impose no limitation on rotor width. The manufacturing is facilitated by the fact that there are only three different elements in the track, that is to say, the fixed abutments, the links and the movable abutments respectively, so that these parts may be made in quantities. A still further advantage is that the parts are readily interchangeable which also facilitates production.

The vane track elements are also easy to assemble. The links 70 are first mounted upon their pivots 72 on the fixed abutments 30 and

the pins 74 are then inserted into the slots 47 of the movable abutments 40. The entire vane track is then put into place in the spacer ring 25 and the fixed abutments are fastened in position by the screws 31. The pins 72 which form the pivots for the links require no fastening as they are held in position by the end plates 26 and 27. The pins 74 pass across the ports 50 and 51 respectively as the position of the movable abutments is altered and it is therefore preferable to fasten these pins in place in the holes 75 as by riveting the ends of the pins or assembling the parts when the temperature of the pins is appreciably below that of the links.

While the device has been described as a pump it may also be employed for other purposes; for example, it will also function as a fluid motor if supplied with pressure fluid for its operation but the cycle of operation will of course be reversed. When employed as a motor it is necessary to introduce means tending to hold the vanes 19 radially outward, particularly if the motor is to be operated at low rotative speeds.

It is to be understood that the foregoing is merely an exemplifying disclosure and that changes may be made in the apparatus without departing from the invention which is defined in the appended claims.

We claim:

1. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor, and a trackway for the vanes comprising a stationary track element, a track element movable to vary simultaneously the capacity of the device and the length of the trackway, and a link member pivoted nearer one of said track elements than the other and having an extensible connection with the other of said track elements, the entire vane-contacting surface of said link being of fixed curvature.

2. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inwardly and outwardly thereof, a trackway for the vanes comprising a stationary track element, a track element movable to vary simultaneously the capacity of the device and the length of the trackway, and a link member having at each end an extensible connection of its track surface with the track surface of one of the track elements, the entire track surface of said link member being of fixed configuration, and pivot means for maintaining the track surface of one end of the link member in vane-transferring relation with the track surface of the track element contiguous thereto.

3. In a vane fluid pressure device of the class described, a vane trackway comprising a fixed abutment, a movable abutment and an interconnecting track member having at each end a joint with one of said abutments including overlapping track surfaces, pivot means for maintaining the track surface of one end of the interconnecting track member in smooth vane-transferring relation with the surface of one of the abutments at all positions of adjustment of the movable abutment, and sliding means for maintaining the track surface of the opposite end of said member in smooth vane-transferring relation with the surface of the other abutment.

4. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor, a trackway for the vanes comprising a stationary track element, a track element movable to vary simulta-

neously the capacity of the device and the length of the trackway, and a link member whose entire vane-contacting inner surface is of fixed curvature interconnecting the stationary and movable track elements, said link member having the inner surface of one end pivotally maintained in even relation with the face of one of the track elements, and at its opposite end having a slidable connection with the other of the track elements, said slidable connection including sliding means for maintaining the inner surface of the link member even with the contiguous track element.

5. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor, and a trackway for the vanes comprising a stationary track element, a track element movable to vary simultaneously the capacity of the device and the length of the trackway, and a link member arranged to connect said track elements in all positions of said movable track element and having at each end an extensible connection of its track surface with the track surface of the adjacent track element.

6. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor, a trackway for the vanes comprising a stationary track element, a track element movable to vary simultaneously the capacity of the device and the length of the trackway, and an interconnecting track member extending in a generally circumferential direction of the rotor and having at each end an extensible connection of the track surface thereon with the track surface of one of the track elements, said extensible connections each including a track surface on the interconnecting member overlapping a track surface on the corresponding track element, the entire track surface of said interconnecting track member being of fixed contour, and means for maintaining the said overlapping track surfaces in smooth vane-transferring relation with one another in all positions of adjustment of the movable track element.

7. In a rotary fluid pressure device of variable capacity, a rotary assembly including a rotor and a plurality of vanes movable inwardly and outwardly thereof, a casing therefor including a stationary abutment coacting with a portion of the peripheral surface of the rotary assembly, a movable abutment coacting with another portion of the peripheral surface of that assembly, and a trackway for guiding the outer ends of the vanes in their in and out movement, means for adjusting the movable abutment radially to vary simultaneously the capacity of the device and the circumferential length of the trackway, said trackway comprising the faces of the abutments and an interconnecting track member, one of the abutments having an end portion provided with a track surface gradually receding from the rotor, the interconnecting track member having a sliding connection on at least one of its ends with the end portion of the abutment contiguous thereto, and pivot means directly connected with said interconnecting track member for controlling the interconnecting track member as the movable abutment is adjusted, said pivot means being disposed towards that end of the interconnecting track member which coacts with the abutment having an end portion provided with said gradually receding track surface.

8. In a rotary fluid pressure device of variable capacity, a rotary assembly including a rotor and

a plurality of vanes movable inwardly and outwardly thereof, a casing therefor including a pair of stationary abutments coacting with opposite sides of the peripheral surface of the rotary assembly, a pair of movable abutments coacting with the opposite sides of the peripheral surface of that assembly intermediate the stationary abutments, link members for guiding the outer ends of the vanes in their in and out movement as they rotate from one to another of the abutments, the faces of said abutments and of said link members comprising a trackway of variable circumferential length for said vanes, and means for adjusting the movable abutments radially to vary simultaneously the capacity of the device and the circumferential length of the trackway, each link member being pivoted at one of its ends adjacent an abutment of one of said pairs and at its opposite end having an extensible connection with an abutment of the other of said pairs, the entire face of each link member having a fixed curvature.

9. In a rotary fluid pressure device of variable capacity, a rotary assembly including a rotor and a plurality of vanes movable inwardly and outwardly thereof, a casing therefor including a pair of stationary abutments coacting with opposite sides of the peripheral surface of the rotary assembly, a pair of movable abutments coacting with opposite sides of the peripheral surface of that assembly intermediate the stationary abutments, and link-track members for guiding the outer ends of the vanes in their in and out movement as they rotate from one to another of the abutments, the vane-contacting surfaces of said abutments and of said link track members forming a trackway of variable circumferential length for said vanes, means for adjusting the movable abutments radially to vary simultaneously the capacity of the pump device and the circumferential length of the trackway, the vane-contacting surface adjacent both ends of each link track member having extensible connections with the vane-contacting surfaces of the contiguous abutments, pivot means for maintaining the track surface of one end of each link member in vane-transferring relation with the surface of its contiguous abutment, and rockable means at the opposite end of each link member for maintaining the track surface thereof in vane-transferring relation with the surface of its contiguous abutment.

10. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly in slots of the rotor, a trackway of variable circumferential length having a surface for guiding the ends of the vanes in their in and out movement, means for simultaneously varying the circumferential length of the trackway and the capacity of the device, said trackway including two rigid track elements and a rigid interconnecting track member rockable with respect to said track elements and extending in a generally circumferential direction of the rotor, said interconnecting track member having on each end thereof a track surface that decreasingly overlaps the track surface on the contiguous element as the capacity of the device and circumferential length of the trackway are increased, and means for maintaining the overlapping track surfaces in smooth vane-transferring relation with one another to produce a smooth guiding of the vanes at any given capacity of the device.

11. In a rotary fluid pressure device of variable

capacity, a rotor, a plurality of vanes movable inward and outward of said rotor in a substantially radial direction, a trackway of variable length for said vanes having two contiguous parts both of which are provided with track surfaces of fixed contour throughout which overlap one another near their adjacent ends in all positions of relative movement between said parts, one of said parts being mounted upon a pivot of fixed location and being movable in its entirety thereon in a path of varying angularity with respect to the other part as the length of the trackway is varied, and means for varying simultaneously the length of said trackway and the capacity of the device.

12. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly in slots of the rotor, a trackway of variable circumferential length having a surface for guiding the ends of the vanes in their in and out movement, means for simultaneously varying the circumferential length of the trackway and the capacity of the device, said trackway including two rigid track elements and a rigid interconnecting track member extending in a generally circumferential direction of the rotor and having at each end a track surface that overlaps in varying amounts the track surface on the contiguous elements as the circumferential length of the trackway is varied, sliding means for maintaining the track surface of one end of the interconnecting track member in smooth vane-transferring relation with the track surface of one of the track elements to produce a smooth guiding of the vanes at any given capacity of the device, and pivot means for maintaining the track surface of the opposite end of the interconnecting member in smooth vane-transferring relation with the track surface of the other track element, said pivot means being disposed radially outward from substantially the point of transfer of the vanes between the track surface of that track element and the interconnecting track member.

13. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inward and outward thereof, and a trackway of variable circumferential length for said vanes, the length of said trackway increasing as the capacity of said device is increased, said trackway including a first abutment, a second abutment, at least one of said abutments being movable with respect to the other to simultaneously vary the capacity of the device and the circumferential length of said trackway, and an intermediate track member movable with respect to both of said abutments and adapted to connect said abutments in all positions of relative movement therebetween, the entire vane-contacting surface of said intermediate track member having a fixed curvature.

14. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inward and outward thereof, a trackway of variable circumferential length for said vanes, said trackway including a first abutment, a second abutment, at least one of said abutments being movable with respect to the other to simultaneously vary the capacity of the device and the circumferential length of said trackway, the length of said trackway increasing as the capacity of said device is increased, an intermediate track member movable with respect to both of said abutments and adapted to connect said abut-

ments in all positions of relative movement therebetween, the track surface of said intermediate track member having a fixed contour throughout the circumferential length thereof, and means operative simultaneously with movement of one abutment with respect to the other to move said intermediate track member conformably with the relative movement between said abutments.

15. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inward and outward thereof, a trackway of variable circumferential length for said vanes, said trackway consisting of a plurality of elements the entire track surfaces of all of which have fixed configurations and including a first abutment, a second abutment and an intermediate track member angularly movable with respect to both of said abutments, means for effecting relative motion between said abutments to alter the circumferential length of the trackway and the capacity of the device, and means functioning simultaneously therewith for altering the angular position of said intermediate track member with respect to both of said abutments.

16. In a vane fluid pressure device of the class described, a vane trackway comprising a fixed abutment, a movable abutment and an interconnecting track member having at each end thereof a joint with one of said abutments, each joint including overlapping track surfaces of said track member and the corresponding abutment, the entire track surface of said track member having a fixed contour, and means for maintaining the track surfaces on the ends of said interconnecting track member in vane transferring relation with the overlapping track surfaces on said abutments in all positions of said movable abutment.

17. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inward and outward of said rotor in a substantially radial direction, a trackway of variable length for said vanes having two contiguous parts both of which are provided with track surfaces of fixed contour throughout which overlap one another near their adjacent ends in all positions of relative movement between said parts, and means for varying the length of said trackway as the capacity of the device is varied, the length of said trackway increasing as the capacity is increased, one of said two parts being movable in its entirety in a path of varying angularity with respect to the other part as the length of the trackway is varied.

18. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inward and outward of said rotor in a substantially radial direction, and a trackway for said vanes surrounding the rotor and vane assembly, said trackway consisting of elements in linked relation one to the other to form a substantially continuous vane track surface for said vanes, the entire vane-contacting surface of each element being of fixed configuration and at least one of said elements being movable to simultaneously alter the capacity of the device and the circumferential length of said trackway, the length of said trackway increasing as the capacity of said device is increased.

19. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inward and outward thereof in a substantially radial direction, a trackway of variable circumferential length for said vanes surrounding the rotor and vane assembly, said trackway com-

prising a plurality of elements disposed in a generally circumferential arrangement with respect to the rotor and vane assembly, the entire vane-contacting surface of each element having a fixed contour, each of said elements having on each of its ends a jointed connection with the element contiguous thereto, at least one of said jointed connections also providing an extensible connection between the contiguous elements connected thereby, at least one of said elements having a pivotal mounting about which it is movable relative to an element contiguous thereto, and means for moving at least one of said elements to simultaneously vary the circumferential length of the trackway and the capacity of the device, the circumferential length of said trackway increasing as the capacity of the device is increased.

20. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor in a substantially radial direction, a trackway for the vanes comprising a stationary abutment, a movable abutment and track means disposed in articulated relation with respect to both of said abutments and connecting said abutments in all positions of said movable abutment.

21. In a rotary fluid pressure device of variable capacity, a rotor having a plurality of vanes movable inwardly and outwardly thereof, a trackway for said vanes having a track surface of variable circumferential length, said trackway including a first abutment, a second abutment and intermediate track means connecting said abutments in all positions of relative movement therebetween, means for moving one of said abutments to simultaneously alter the capacity of the device and the length of the track surface, and means operative simultaneously with movement of one abutment with respect to the other for moving said track means to increase the length of said track surface adjacent both abutments as the capacity of the device is increased and to decrease the length thereof adjacent both abutments as the capacity of the device is decreased.

22. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor and a trackway for said vanes having a track surface of variable circumferential length, said trackway comprising a stationary abutment, an abutment movable to alter simultaneously the capacity of the device and the length of the circumferential track surface and means for connecting the portions of the track surface on said abutments in all positions of said movable abutment including at least one track member disposed intermediate said abutments and arranged to simultaneously alter the circumferential length of the track surface adjacent both of its ends as the capacity of the device is varied.

23. In a multi-section rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor in a substantially radial direction, a trackway for said vanes, said trackway comprising oppositely positioned pairs of movable and fixed abutments and track means movable relative to and connecting said fixed and movable abutments in all positions of said movable abutments, the track surface carried by said track means being of fixed contour, and means coordinating the movement of said track means with movement of said movable abutments.

24. In a rotary fluid pressure device of vari-

able capacity, a rotor and vane assembly comprising a rotor having a plurality of vanes movable inward and outward thereof in a substantially radial direction, a trackway for said vanes surrounding the rotor and vane assembly, said trackway comprising a plurality of elements disposed in a generally circumferential arrangement with respect to the rotor and vane assembly, each of said elements having a track surface of fixed contour and also having on each of its ends a connection with the element contiguous thereto including pivot mounting means, at least one of said elements being stationary, and means for moving at least one of said elements to vary the capacity of the device.

25. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inwardly and outwardly of the rotor in a substantially radial direction, a trackway for said vanes comprising a fixed abutment, a movable abutment and track means movable relative to and connecting said fixed and movable abutments in all positions of said movable abutment, the track surface carried by said means being of fixed contour, means for moving said movable abutment to vary the capacity of the device and means coordinating the movement of said track means with movement of said movable abutment.

26. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inward and outward of the rotor in a substantially radial direction, a trackway for said vanes comprising a plurality of abutments including at least one abutment movable to vary

simultaneously the capacity of the device and the circumferential length of said trackway, the length of said trackway increasing as the capacity of the device is increased, and track means connecting the abutments in all positions of said movable abutment, said track means comprising a plurality of track elements arranged for movement with respect to said movable abutment as the position of said movable abutment is altered, the entire track surface carried by each of said track elements being of fixed contour, means for moving said movable abutment and means operative simultaneously with movement of said movable abutment for moving said track elements correspondingly with the extent and direction of the movement of said movable abutment.

27. In a rotary fluid pressure device of variable capacity, a rotor, a plurality of vanes movable inward and outward of the rotor in a substantially radial direction, a trackway for said vanes, said trackway comprising at least two movable abutments and at least two stationary abutments and track elements movable relative to and connecting said movable and stationary abutments in all positions of said movable abutments, the track surface carried by each of said track elements being of fixed contour, means for moving said movable abutments to alter the capacity of the device and means operative simultaneously with movement of said movable abutments for moving said track elements to correspond to the positions to which said movable abutments are adjusted.

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IVAN A. KAZINE.

CERTIFICATE OF CORRECTION.

Patent No. 2,313,075.

March 9, 1943.

CHARLES M. KENDRICK, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 30, for "output" read --outlet--; page 4, second column, line 4, for "it" read --is--; line 69, for "purposes" read --purpose--; page 6, second column, line 12, after "with" insert --that of--; page 7, first column, line 40, strike out "pump"; line 48, after "rockable" insert --sliding--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of April, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.