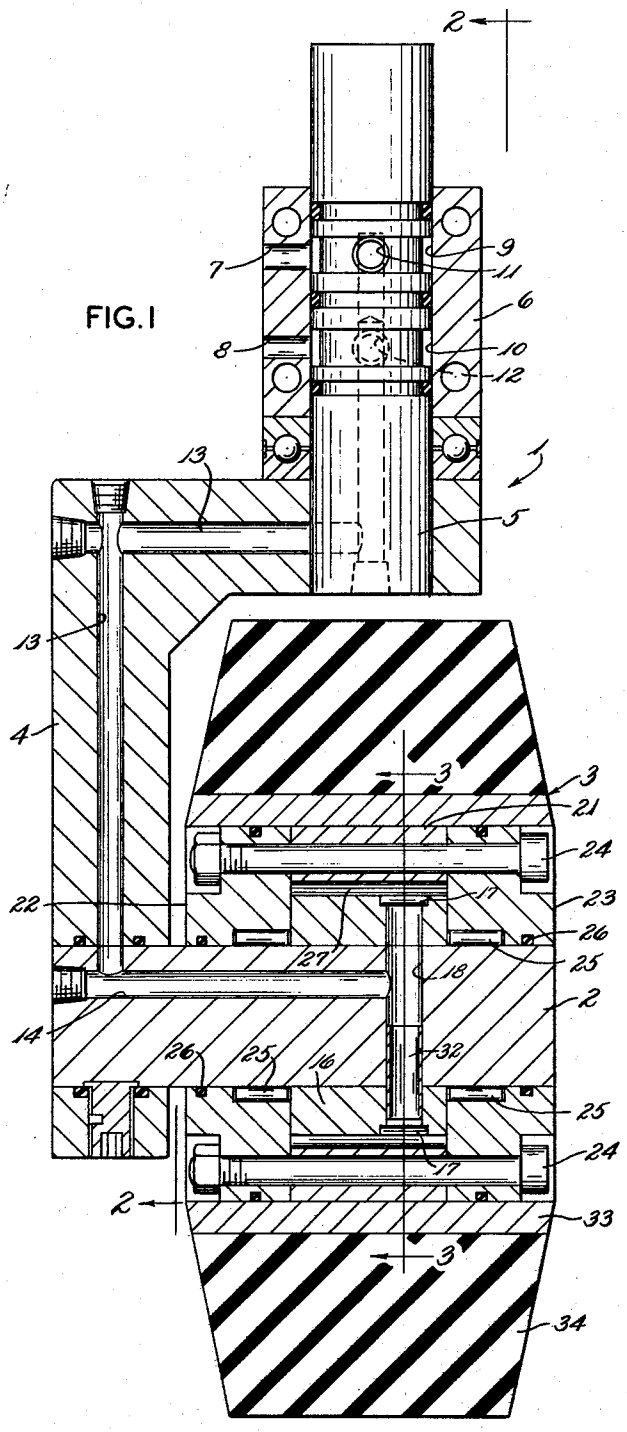
Nov. 14, 1961 D. L. ROTH 3,008,424

HYDRAULIC WHEEL

Filed March 7, 1958 3 Sheets-Sheet 1

FIG. 1



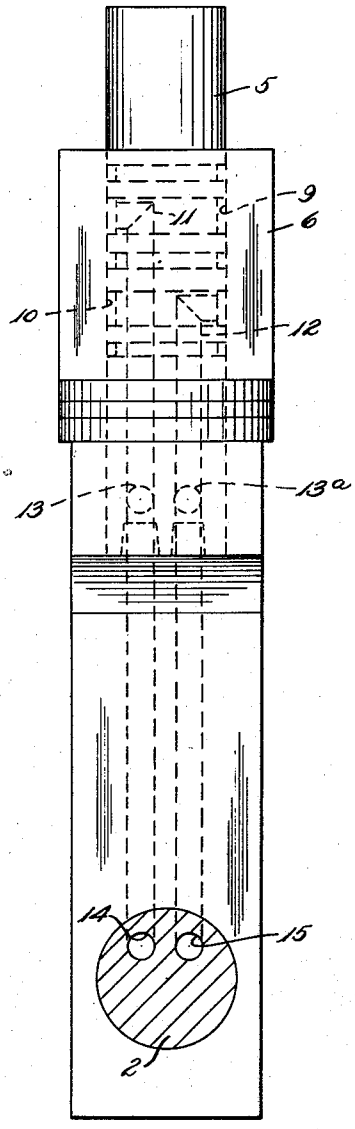


FIG. 2

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Nov. 14, 1961 D. L. ROTH 3,008,424

HYDRAULIC WHEEL

Filed March 7, 1958 3 Sheets-Sheet 2

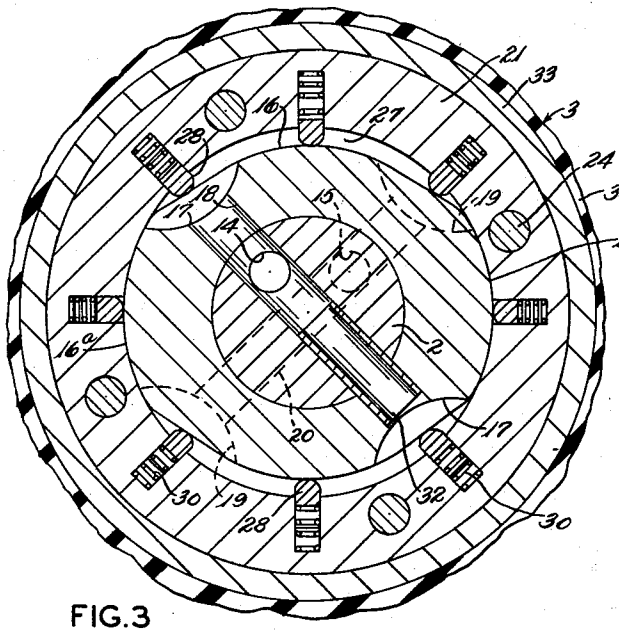


FIG.3

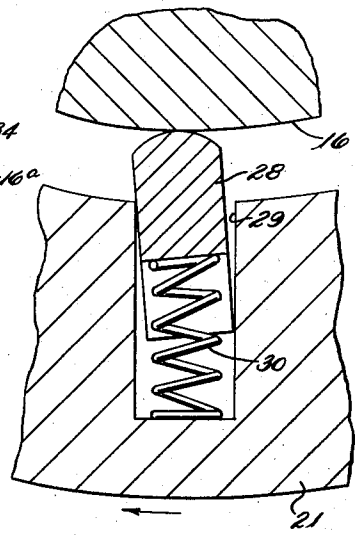


FIG.4

FIG.5

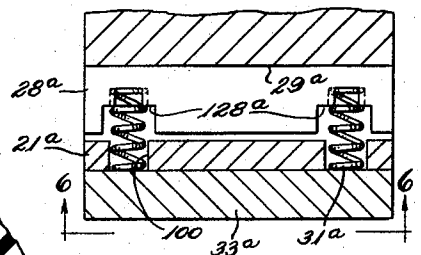
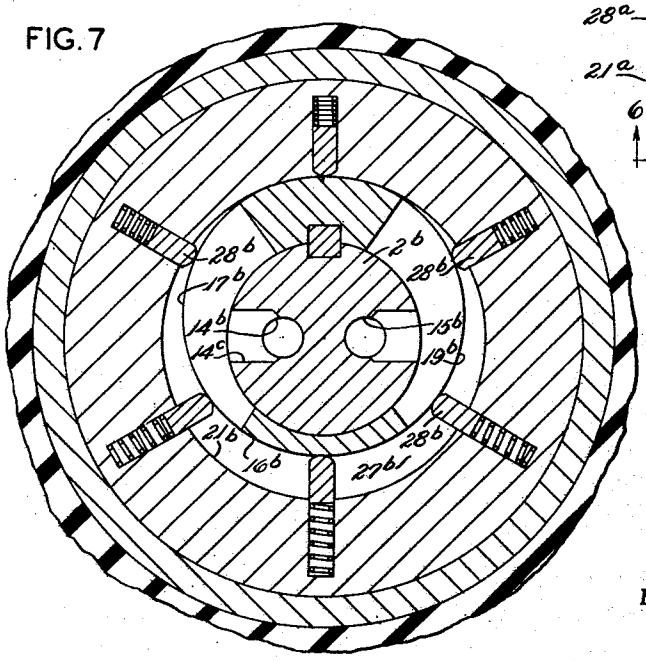


FIG.7



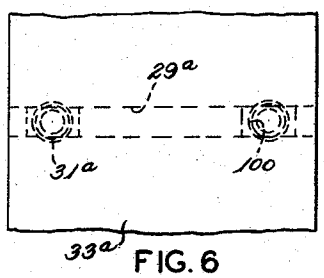


FIG.6

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Nov. 14, 1961 D. L. ROTH 3,008,424

HYDRAULIC WHEEL

Filed March 7, 1958 3 Sheets-Sheet 3

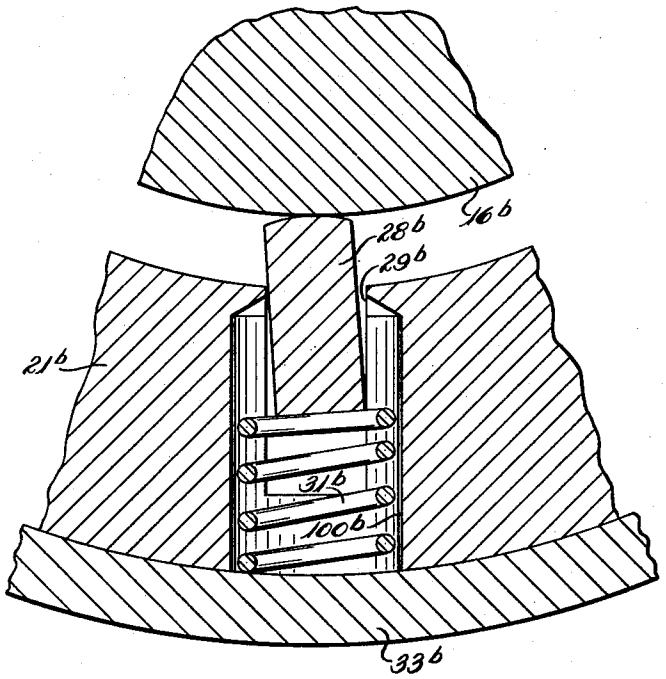

FIG. 8

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3,008,424

HYDRAULIC WHEEL

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8 Claims. (Cl. 103—121)

This invention relates to hydraulic wheels, and especially to a wheel having a hydraulic transducer built therein for action as either a hydraulic pump or motor depending upon the operating conditions.

Heretofore there have been many different types of hydraulic pumps or motors built wherein a stationary housing is provided that has a shaft member journalled therein for rotation by forces applied thereto by liquids supplied to the housing and flowing through sections of the housing to provide desired rotary movement for the shaft and associated means carried thereby. These prior types of hydraulic pumps or motors have had wide commercial use and have been provided in many different forms. However, there are uses for small hydraulic motors today wherein it would be desirable to have a stationary shaft with a rotor member journalled on the shaft and operated by hydraulic fluid supplied to the stationary shaft.

In some lift or carrier trucks used in industry today, there are small steering wheels which are driven by a motor connected thereto by an endless chain. Thus the wheel and drive motor must turn as a unit and require quite a bit of space for installation and operative clearance.

The general object of the present invention is to provide a novel hydraulic wheel with a hydraulic transducer built as a portion thereof and characterized by the use of a non-rotatable positioning shaft and a rotor housing in the hydraulic transducer.

Another object of the invention is to provide a hydraulic wheel of relatively small overall diameter wherein a hydraulic motor or pump is built within the wheel construction and does not project from the wheel.

Another object of the invention is to provide a hydraulic transducer wherein a plurality of radially extending vanes are carried by a rotor sleeve and are resiliently urged radially inwardly of the rotor sleeve for sealing engagement with an eccentric member fixedly carried by the positioning shaft on which the rotor is journalled.

A further object of the invention is to provide a hydraulic transducer of the class described wherein coil springs of greater diameter than the width of vane receiving slots are provided in the rotor for urging the vanes in the pump radially inwardly thereof.

Another object of the invention is to provide a support shaft in a transducer of the type described wherein two oil or other liquid passage bores are provided in the shaft so that fluid ports can be provided therein by diametrically extending holes connecting to the shaft bores and axially offset from each other but with each diametrically extending hole providing two discharge or inlet ports for the oil passage bore to which it connects.

Further objects of the invention are to provide a control cam on a stationary shaft and with bore means being provided in the stationary shaft and control cam for flow of liquids therethrough and wherein the control cam is secured to the stationary shaft means by longitudinally split spring sleeves which lock the cam to the shaft and at the same time provide center bores for liquid transmission or flow therethrough; to provide a hydraulic wheel wherein the wheel can be turned through 360° without any limitation on the rotary movement thereof by fluid connector lines or the like; to provide fluid receiving and distributing bores in parallel relationship to each other

in a stationary shaft but offset from the center thereof to permit the provision of diametrically positioned distributing bores in the stationary shaft and corresponding diametrically opposed pressure zones in the pump or motor; to provide radially movable vanes extending radially inwardly of the rotor in a hydraulic transducer and wherein the high pressure liquid in the pump exerts a radially inwardly directed force against the vanes; and to provide a hydraulic transducer built into a small wheel.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

When referring to corresponding parts shown in the drawings and referred to in the specification, corresponding numerals are used to facilitate comparison between such corresponding parts.

A currently preferred embodiment of the present invention is shown in the accompanying drawings, wherein:

FIG. 1 is a vertical section through a hydraulic, or transducer wheel embodying the principles of the invention;

FIGS. 2 and 3 are vertical sections taken on lines 2—2 and 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary section showing the sealing action of a vane in the pumping chamber of the hydraulic wheel of the invention;

FIG. 5 is a fragmentary section showing the construction and positioning of a slightly modified vane assembly in the hydraulic wheel of the invention;

FIG. 6 is a plan of a portion of the hydraulic wheel of the invention taken on line 6—6 of FIG. 5;

FIG. 7 is a vertical section, like FIG. 2, taken of a modified transducer of the invention and

FIG. 8 is a fragmentary section, similar to FIG. 5, of a further modification of the invention.

The invention generally relates to a hydraulic transducer comprising a positioning shaft having a pair of parallel bores therein offset from the center axis thereof, support means connected to the shaft to position it, which support means have a pair of bores therein connected to the bores in the shaft for flow of liquid to and from the shaft, a cam secured to and carried by the shaft, which cam has circumferentially extending fluid distributing recesses provided in the periphery thereof at circumferentially spaced portions thereof and individually connected to one of the bores in the positioning shaft, a rotor journalled on the shaft and encompassing the cam, a plurality of vanes received in slots in the rotor for sliding engagement with the cam, and spring means between the rotor and the vanes to urge the vanes radially inwardly against said cam and provide a rotatable unit on a stationary shaft coupled by hydraulic chamber means.

The improved hydraulic transducer of the invention is adapted for use either as a motor when hydraulic pressure liquid is supplied thereto in order to drive a hydraulic wheel into which the transducer is built, or else the transducer could be used as a pump to force liquid therefrom should the wheel, or vehicle on which the wheel is positioned be driven by another power source.

In this currently preferred embodiment of the invention, it is illustrated in a hydraulic wheel, indicated as a whole by the numeral 1. Such hydraulic wheel 1 includes a positioning, or support shaft 2 on which a wheel 3 is suitably journalled for rotary action. The shaft 2 is secured to and positioned by an elbow 4 at one end thereof and with the elbow 4 extending to and being secured to a swivel stem 5. A swivel sleeve 6 is secured around the swivel stem 5. The swivel stem 5 is suitably journalled in this swivel sleeve 6 and such sleeve 6 is secured to any desired member for positioning the hydraulic wheel and associated means of the invention on a lift truck or other vehicle, as desired.

Means are provided for a controlled flow of pressure liquid to and from the wheel 3 and to this end, a pair of separate conduits or bores 7 and 8 are provided in the sleeve 6 and with each such bore 7 or 8 being connected to an individual annular connection groove 9 or 10, respectively, provided in axially spaced portions of the periphery of the swivel stem 5. The swivel stem 5 likewise has a pair of axially extending bores 11 and 12 connecting, respectively to the grooves 9 and 10 for flow of pressure liquid to and from the swivel stem 5 and to the elbow 4 connected thereto. Such elbow 4 likewise has a pair of parallel, but individual, bores 13 and 13*a* provided therein and permanently connecting to the bores 11 and 12, respectively, and the stem 5 for transmitting pressure fluid to a pair of parallel bores, or passages 14 and 15, respectively, provided in the shaft 2. The bores 14 and 15 preferably are spaced radially from the center axis of the shaft 2 and are spaced circumferentially from each other as best shown in FIG. 2.

The shaft 2 has a cam or eccentric 16 suitably secured thereto and this cam 16 has a plurality of liquid distributing recesses 17 extending along portions of the periphery thereof and with a pair of such recesses 17, 17 being shown formed in diametrically opposed portions of the cam 16. A diametrically extending bore 18 is provided in the shaft 2 and connects the recesses 17 to the bore 14 in the shaft 2. The bore 18 extends through both the shaft 2 and the cam 16 and a similar, but circumferentially spaced series of recesses 19 is provided in an axially spaced portion of the cam 16 from that at which the section shown in FIG. 3 is taken. The recesses 19 are connected by a diametrically extending bore 20 provided in a portion of the shaft 2 and cam 16 spaced axially from the bore 18. Such bore 20 connects to the other axial bore 15 in the shaft 2. Portions of the periphery of the cam 16 indicated at 16*a* are of arcuate contour and are snugly received within a rotor 21 for no flow of liquid in that portion of the cam, and for no pumping action therein. The portions of the bores 18 and 20 formed in the shaft 2 form extension bores that connect the passages, or bores 14 and 15 to the periphery of the shaft 2. The recesses 17 and 19 are formed in peripheral portions of the cam 16 intermediate the arcuate sections 16*a* of the cam surface.

It is an important feature of the invention that the rotor 21 encompasses and encloses the surfaces of the cam 16 and with the rotor 21 being positioned on the shaft 2 for rotation with relation thereto. Thus a pair of end plates 22 and 23 are secured to the rotor 21, as by means of bolts 24, to provide an integral unit for rotary action on the shaft 2 as by means of bearings 25. Suitable O-rings, or similar packing means 26, are carried by the end plates 22 and 23 to seal the rotor 21 with relation to the shaft 2 and associated means. Thus a pumping or pressure chamber 27 is provided intermediate the surfaces of the cam 16 and associated rotor 21 and end plates 22 and 23.

For the actual pumping or hydraulic motor action in this chamber 27, a plurality of axially extending vane means 28 are positioned in recesses 29 provided in the rotor 21. Such vanes 28 preferably are of the length of the cam 16, as shown in FIG. 4 of the drawings. Normally such vanes 28 each have at least a pair of recesses 28*a* extending radially thereinto from the radially outer end thereof. Such recesses, as shown in FIGS. 4 and 5, are adapted to receive suitable spring means, such as coil springs 30, to compress such coil springs against the inner periphery of the rotor 21 whereby the vanes 28 are resiliently urged radially inwardly of the hydraulic wheel 1 of the invention by the springs to bear against the periphery of the cam 16. Normally the radially inner surfaces of these vanes 28 are of arcuate shape to provide a smooth bearing engagement between the vane and cam surface.

It should be noted that the recesses 29 provided in the rotor 21 are slightly larger in a circumferential direction than the width of the vanes 28 so that the vanes are loosely positioned. Such looseness of the vanes in their receiving recesses permits them to tilt or cant slightly in the recess by the pressures exerted thereon by liquid being pumped, for example through the supply bores to the chamber 27. FIG. 4 of the drawings clearly brings out the fact that the high pressure supplied to the chamber 27 can flow into and through the recesses 29 to exert high pressure against one side and the radially outer surface of the vanes 28 and urge such vanes radially inwardly of the hydraulic transducer. This aids in effecting a tight seal of the vanes against the cam and the opposite or low pressure wall of the recess 29 in which the vanes 28 are positioned.

FIG. 3 of the drawings clearly brings out the fact that the vanes 28 are more closely spaced circumferentially of the rotor 21 than the distance intermediate the adjacent sets of fluid distributing or receiving recesses 17 and 19 provided in the cam 16. Thus at least a pair of closed, but movable, pressure chambers are made within a part of the chamber 27 at all times and with such pressure being exerted upon two or more of the vanes 28 to urge the rotor 21 to rotate sufficiently as to permit fluid in such pressure chambers to reach the next set of recesses, such as the recesses 19, for flow of the pressure liquid from the chamber 27 after the driving action, for example, has been effected.

Referring now to the structure shown in FIG. 3 of the drawings, it should be noted that a longitudinally split sleeve 32 is used for securing the cam 16 to the shaft 2. One of the split sleeves 32 is received in each of the diametrically extending bores 18 and 20 provided in the shaft 2 and with the sleeve extending into the portion of the bore provided in the cam 16. Thus the split sleeve holds the cam to the shaft but at the same time has a hollow bore for transmission of pressure fluid therethrough. Hence, no key or other member is required to secure the cam 16 to its positioning shaft and this simplifies and improves the construction of the transducer of the invention.

The hydraulic wheel of the invention is completed by use of conventional members and a suitable felloe or rim 33 is secured to the rotor 21 and forms an integral unit therewith. Any desired type of tread member 34, usually made from rubber or similar material, is secured to the rim 33.

The drawing clearly shows that the tread member 34 and rim 33 are centered on the cam 16 and that this wheel 3 is of relatively small diameter but has effective pumping or transducing members provided within the periphery of the rim 33.

FIGS. 5 and 6 of the drawings show that, if desired, holes 100 are formed in the rotor 21*a* in which coil springs 31*a* are positioned can be wider in circumferential length than the widths of vanes 28*a* so that such coil springs 31*a* are received in recesses 128*a* in the vanes 28*a*. The holes 100 have sections that extend into the adjacent faces of the walls defining recesses 29*a* in the rotor 21. Hence, the effective diameter of the coil springs 31*a* is not limited to the circumferential width of the vanes 28*a* or the recesses 29*a*. The springs 31*a* can be positioned before the rotor 21*a* is pressed into its rim 33*a*, or they can be tilted and be fed into the holes 100 through the recesses 29*a*.

A modified type of a hydraulic transducer of the invention is shown in FIG. 7 of the drawings and in this instance, a stationary shaft 2*b* is shown which has a pair of axially extending bores 14*b* and 15*b* provided therein. These bores 14*b* and 15*b* connect to diametrically opposed distributing grooves or recesses 17*b* and 19*b* provided in a cam or eccentric 16*b* suitably secured to the shaft 2*b*. Such distributing recesses 17*b* and 19*b* can be of relatively long circumferential extent and define only one pumping chamber or section adjacent the periphery of

the cam 16*b*. Suitable vanes 28*b* are positioned in a rotor 21*b* like that shown in the other figures of the drawings so that in this embodiment of the invention, fluid can flow out of the bore 14*b* through the distributing recess 17*b* and associated discharge port 14*c* of the bore 14*b* for pressure action against the vanes 28*b* to urge them to rotate in counter clockwise direction and carry the rotor 21*b* therewith. When any individual vane 28*b* reaches the first circumferential portion of the recess 19*b*, then fluid starts to flow from the actual pumping chamber towards the discharge bore 15*b* through the connecting section 15*c* provided in the shaft 2*b* and connecting to the recess 19*b*.

It thus will be seen that in the embodiment of the invention shown in FIG. 7, the pressure fluid flows into the pumping chamber 27*b* along one relatively long circumferential portion thereof, and that only one exhaust port is provided for flow of pressure liquid from this pumping chamber.

FIG. 8 shows a further modification of the invention wherein a rotor 21*b* has several spaced holes 100*b* formed therein aligned with each slot 29*b* provided in the radially inner edge of the rotor. These holes are of larger diameter than the width of the slot 29*b* which receives a vane 28*b* therein for operative engagement with the cam 16*b*. Springs 31*b* are received in these holes 100*b* to urge the vane 28*b* out for operative engagement with the cam 16*b*. The outer ends of the holes 100*b* are closed by means of the rim member 33*b* provided in this embodiment of the invention. It will be noted that the slot 29*b* provides a continuous edge surface for sealing action with the vane 28*b* as tilted by pressure liquid flowing into engagement with the radially outer end of the vane 28*b* and urging it into tight engagement with the cam 16*b*.

Transducers or hydraulic wheels of the invention have been constructed and have given very satisfactory action. Any suitable supply of pressure liquid can be connected to the swivel sleeve 6 to drive the wheel 3 by use of the transducer as a motor, or if the wheel 3 is otherwise driven, the transducer functions as a pump to provide pressure liquid at the swivel sleeve 6.

The wheel 3 is compact and functions effectively for the purposes stated. The rotor 21 can be driven by the pressure liquid supplied by the stationary shaft on which it is journalled so that the objects of the invention are thought to be achieved.

While several complete embodiments of the invention have been disclosed herein, it will be appreciated that modification of these particular embodiments of the invention may be resorted to without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A hydraulic transducer comprising a positioning shaft having a pair of parallel bores therein offset from the center axis thereof, a cam carried by said shaft, said cam having circumferentially extending fluid distributing recesses provided in the periphery thereof at circumferentially spaced portions thereof and individually connected to one of said bores in said positioning shaft, said cam and shaft having a pair of diametrically extending bores therein individually connecting said parallel bores to different ones of said fluid distributing recesses, a longitudinally split sleeve positioned in each of said diametrically extending bores to secure said cam to said shaft but to permit pressure liquid flow therethrough, a rotor journalled on said shaft and encompassing said cam, said rotor having slots in a radially inner surface thereof, a plurality of vanes received in said slots in said rotor for sliding engagement with said cam, and spring means between said rotor and said vanes to urge said vanes radially inwardly against said cam.

2. A hydraulic transducer comprising a positioning shaft having a pair of parallel bores therein offset from the center axis thereof, a cam stationarily carried by said shaft, said cam having circumferentially extending fluid distributing recesses provided in the periphery thereof at circumferentially spaced portions thereof and individually connected to one of said bores in said positioning shaft, said cam and shaft having a pair of diametrically extending bores therein individually connecting said parallel bores to different ones of said fluid distributing recesses, a longitudinally split sleeve positioned in each of said diametrically extending bores to secure said cam to said shaft but to permit pressure liquid flow therethrough, a slotted rotor journalled on said shaft and encompassing said cam, a plurality of vanes received in said slots in said rotor and protruding therefrom for sliding engagement with said cam, said vanes having slots extending thereinto from the radially outer ends thereof and being loosely received in but contacting both walls of said rotor slots for flow of pressure liquid against one side face and the radially outer end of said vanes, and spring means between said rotor and said vanes to urge said vanes radially inwardly against said cam.

3. A hydraulic transducer comprising a stationary axle having two axially extending fluid passages therein and connecting to the axle periphery by passage extensions, a tubular lobed cam having two peripheral circumferentially spaced porting recesses per lobe stationarily secured to said axle and substantially radially extending bores formed therein and connecting said recesses respectively to said passage extensions in said axle for hydraulic flow to and from said cam, a ring rotor journalled on said axle, vanes carried by said ring rotor, and resilient means operatively carried by said ring rotor urging said vanes inward against the periphery of said cam for continuous sealing engagement therewith, the circumferential distance between adjacent vanes being less than the circumferential distance between porting recesses in said cam, said rotor having individual closed radially outer end vane receiving slots therein in its radially inner surface, said vanes being loosely received in said slots and being tilted in said slots by hydraulic pressure applied thereto to seal against an edge of said slot remote from the source of pressure liquid, said vanes and said slots being correlated in size so that said vanes contact both walls of said slots when tilted, said vanes having uniform size recesses extending into the radially outer ends thereof the entire circumferential width thereof for uniform flow of pressure liquid at full pressure into said slot and past a said vane through the said recesses therein to contact the radially outer end of said vanes regardless of the radial position of a said vane in a said slot.

4. A hydraulic transducer as in claim 3 in which said cam has two lobes and the two fluid passages in said axle are eccentrically located with relation to the axis of said axle so that each pair of porting recesses in the cam is inter-connected and is connected to its respective fluid passage by a straight radially extending hole at a different axial location in said axle.

5. A hydraulic transducer comprising a stationary axle having two axially extending fluid passages therein and connecting to the axle periphery by passage extensions, a tubular lobed cam having two peripheral circumferentially spaced porting recesses per lobe stationarily secured to said axle and having radially extending bores connecting said recesses individually to said passages in said axle, a ring rotor journalled on said axle, vanes carried by said ring rotor, and coil springs operatively carried by said ring rotor urging said vanes radially inwardly against the periphery of said cam for continuous sealing engagement therewith, the circumferential distance between adjacent vanes being less than the circumferential distance between porting recesses in said cam, said rotor having individual closed radially outer end vane receiving slots therein in its radially inner surface, said vanes being loosely received in said slots and being tilted in said slots by hydraulic pressure applied thereto to seal against an edge of said slot remote from the source of pressure liquid, said vanes and said slots being correlated in size

so that said vanes contact both walls of said slots when tilted, said ring rotor having coil spring receiving means provided therein wider than the circumferential width of said slots extending thereinto from the radially outer end portion thereof and extending radially inwardly of the radially outer ends of said vanes for uniform flow of pressure liquid at full pressure into said slot and past a said vane through the coil spring receiving means to contact the radially outer end of said vanes regardless of the radial position of a said vane in a said slot.

6. A hydraulic transducer comprising a stationary axle having two axially extending fluid passages therein and radially extending extension bores connecting such fluid passageways to the periphery of said axle, an eccentric sleeve having two lobes thereon rigidly and stationarily supported on said axle and provided with two pairs of circumferentially spaced porting recesses in its outer periphery, said eccentric having radially extending bores therein extending to its inner periphery to connect each of said pairs of recesses to one of said extension bores of said two fluid passages in said axle, a ring rotor journalled on said axle, vanes carried by said ring rotor, and resilient means engaging said vanes and urging said vanes inwardly against the periphery of said eccentric sleeve, the circumferential distance between adjacent vanes being less than the circumferential distance between said porting recesses in said eccentric sleeve, each of said bores being radially aligned with one of said extension bores, said extension bores being at different axial locations in said axle, and a hollow pin positioned in at least one of said bores and its aligned extension bore to permit fluid flow therethrough and to secure said eccentric sleeve to said axle.

7. A hydraulic transducer comprising a stationary axle having a pair of axially extending passages therein and having extension bores therein connecting said passages to the periphery of said axle, a tubular eccentric having at least one cam lobe thereon rigidly and stationarily supported on said axle and provided with two peripheral circumferentially spaced porting recesses per cam lobe therein, said eccentric having individual bores therein extending from said porting recesses to the inner periphery of said eccentric to connect to said extension bores, a ring rotor journalled on said axle and having slots in its inner surface, vanes carried in said slots in said ring rotor and slidably engaging said eccentric, said vanes being parallel with the axis of said axle and being smaller in circumferential width than said slots, said ring rotor having apertures therein of greater diameter than the circumferential width of said slots and extending from the radially outer periphery of said ring rotor to connect to said slots but terminating spaced from the radially inner ends thereof, a rim engaging the periphery of said ring rotor and sealing the outer ends of said apertures, said apertures extending a distance past the radially outer ends of said vanes to provide passageways for hydraulic fluid into said slots for application of full transducer fluid pressure to the radially outer ends of said vanes, and resilient means engaging said vanes and said rim to urge said vanes inwardly against the periphery of said eccentric, the circumferential distance between adjacent vanes being less than the circumferential distance between said porting recesses in said eccentric.

8. A hydraulic transducer comprising a stationary axle having two axially extending fluid passages therein, an eccentric sleeve rigidly and stationarily supported on said axle and provided with at least two peripheral circumferentially spaced porting recesses therein, said eccentric sleeve having individual bores therein connecting said porting recesses to the inner periphery of said sleeve, said axle having bore extensions therein connecting said fluid passages to the periphery of said axle, said bores connecting respectively to said bore extensions of said two fluid passages in said axle, a ring rotor journalled on said axle to form a pressure chamber around said eccentric sleeve and having axially extending slots in its inner surface, vanes carried in but being circumferentially narrower than said slots in said ring rotor and slidably engaging said eccentric sleeve, said vanes being parallel with the axis of said axle and being tilted in use by the hydraulic fluid in the transducer to engage both walls of the said slot in which it is positioned, said ring rotor having at least an aperture therein located at each said slot and of greater diameter than the circumferential width of said slots and extending from the radially outer periphery of said ring rotor nearly to the radially inner ends of said slots, said apertures extending a distance past the radially outer ends of said vanes to provide passageways for hydraulic fluid into said slots for application of full transducer fluid pressure to the radially outer ends of said vanes, a rim engaging the periphery of and carried by said ring rotor to seal the radially outer ends of said apertures, and a coil spring positioned in each of said apertures and engaging said vanes and said rim to urge said vanes inwardly against the periphery of said eccentric sleeve, the circumferential distance between the adjacent vanes being less than the circumferential distance between said porting recesses in said eccentric sleeve, said apertures aiding the flow of liquid from the pressure chamber to the radially outer surfaces of said vanes.

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