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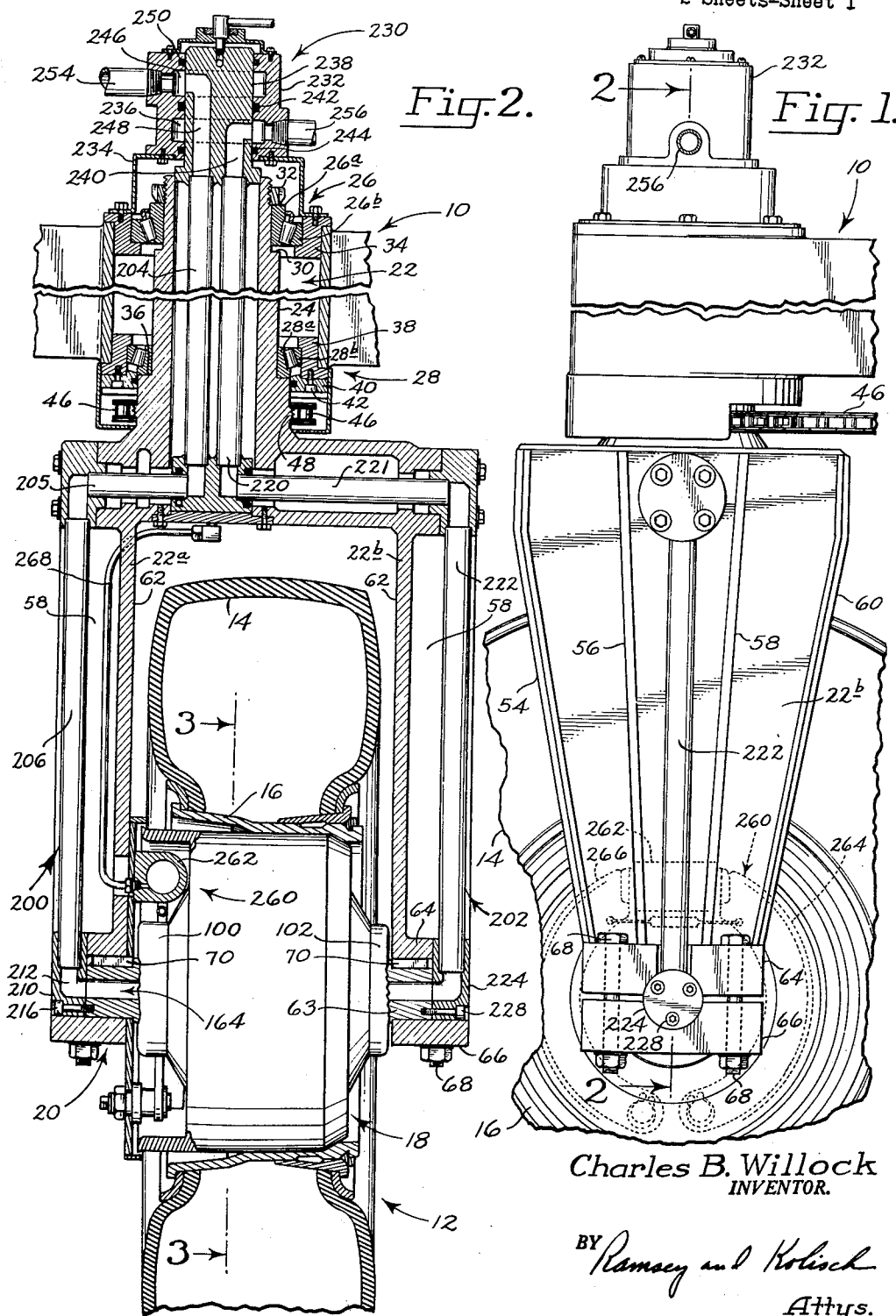
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HYDRAULICALLY DRIVEN MOTORIZED WHEEL

Filed Aug. 15, 1960

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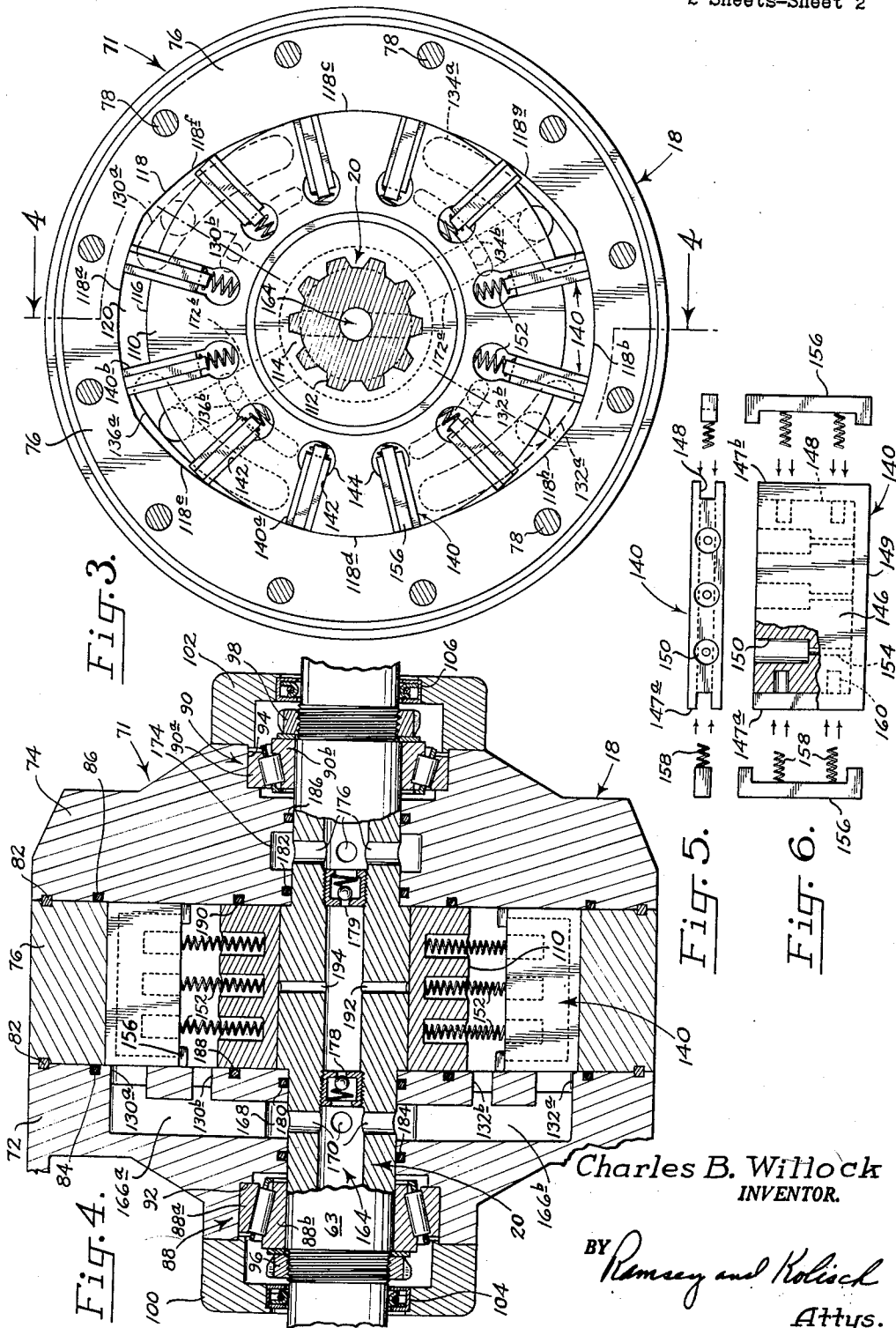
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HYDRAULICALLY DRIVEN MOTORIZED WHEEL
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4 Claims. (Cl. 180-66)

This invention relates to a novel construction for a hydraulically driven, motorized wheel. The invention is characterized by a number of novel features that make the wheel practical to manufacture and use. The wheel is constructed to handle actuating fluid energizing the motor of the wheel at relatively high pressures, which is advantageous, since it has the effect of minimizing the volume of fluid that must be circulated to the wheel motor to obtain a given amount of work therefrom.

The wheel of the invention is disclosed herein as a dirigible wheel of a wheel-supported vehicle, and the wheel has particular utility in such a construction. With heavy, wheel-supported, earth-handling equipment, it is often convenient to have a separate motor drive for each driven wheel, as this simplifies problems of transmitting power to the wheels and promotes flexible operation. According to this invention, a dead axle is mounted adjacent the lower end of an upright steering post. Joined to the axle is a stator portion, and a casing structure that mounts the vehicle wheel surrounds the stator portion and is journaled on the axle. The casing structure includes a portion that functions as a rotor portion, and the rotor and stator portions together form part of a positive-displacement hydraulic motor. Actuating fluid is pumped to the motor, and the motor is designed so that the fluid can be fed to the motor in either of opposite directions. Thus, the motor is reversible. The steering post is mounted on the vehicle frame so that it can be turned about a vertical axis through an angle of 360°. The driven speed of the wheel is varied through control of the volume of fluid pumped to the motor. The vehicle described is extremely maneuverable, and the hydraulic motor within the wheel provides an efficient and practical means for powering the wheel.

A general object of the invention is to provide an improved construction for a hydraulically driven, motorized wheel that features a fixed axle and a stator portion joined thereto, and a casing journaled on the axle and supporting the wheel and forming the rotor portion of a positive-displacement motor.

A more specific object is to provide an improved construction for a hydraulically driven, motorized wheel of the above description that includes novel means for feeding and exhausting actuating fluid to and from the motor of the wheel, and novel means for taking care of any leaking fluid within the motor. Fluid at relatively high pressure may be used, with leakage effectively controlled. Where leakage of fluid does occur, a novel means is provided for returning the fluid to the hydraulic system supplying the motor. Stresses in the wheel, such as might result from leaking fluid captured within the motor, are effectively minimized. This makes possible reduction in the size and mass of the parts used.

Another object is to provide an improved construction for a hydraulically driven, motorized wheel, having a driving motor that includes novel means sealing the ends of motor vanes present in the construction to hub portions of the casing structure disposed at either end of the stator portion. The result is a more efficient operation over longer operating periods without maintenance required.

A still further object of the invention is to provide, in a vehicle, a novel form of dirigible wheel that may be turned entirely about a 360° angle, lending maximum maneuverability to the vehicle.

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Other objects and advantages of the invention will become apparent as the following description is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevation of portions of a dirigible wheel in a vehicle, showing a vertical steering post journaled in part of a vehicle frame, such steering post rotatably supporting at its lower end a hydraulically driven, motorized wheel as contemplated by the invention;

FIG. 2 is a cross-sectional view, taken along the line 2-2 in FIG. 1, and illustrating details of construction;

FIG. 3 is a cross-sectional view, slightly enlarged, taken along the line 3-3 in FIG. 2, and illustrating a positive-displacement motor which drives the wheel;

FIG. 4 is a cross-sectional view, taken along the line 4-4 in FIG. 3, illustrating further details of the positive-displacement motor;

FIG. 5 is an exploded view looking at an edge of a vane employed in the motor of FIGS. 3 and 4; and

FIG. 6 is an exploded side view of one of the faces of the vane illustrated in FIG. 5.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, 10 indicates generally portions of a vehicle frame, of the type that may be employed in mobile, heavy, earth-handling equipment. The frame is supported for movement over the ground by a dirigible support wheel 12. The support wheel in the embodiment illustrated comprises a tire 14 mounted on conventional rim structure 16. Rim structure 16 is secured to casing structure, generally indicated at 18. As will be described in more detail hereinbelow, casing structure 18 is journaled on axle mechanism 20, and the axle mechanism extends in a horizontal direction between forks 22a, 22b, provided at the lower end of a vertically disposed steering post 22. Also, as will be more specifically described, the steering post is journaled in frame 10 for movement about a vertical axis through an angle of 360°. Thus, the wheel may be turned in all directions for steering purposes.

Further considering the construction of the steering post and its mounting in frame 10, steering post 22 includes a vertical spindle portion 24, journaled on the frame through bearing assemblies 26, 28. Inner race 26a of the upper bearing assembly 26 is confined on spindle portion 24 between an annular shoulder 30 of the spindle and a nut 32 screwed onto a threaded upper-end portion of the spindle. The outer race 26b is supported on a collar 34 joined to frame 10. With respect to the lower bearing assembly 28, inner race 28a seats on a shoulder 36 of the spindle 24, and outer race 28b is fixed in place on the frame 10 by means of collar 38 joined to the frame and ring member 40 joined to collar 38 by screws 42.

Steering of wheel 12 is done by turning the steering post using a chain 46. The chain is trained over teeth 48 of a sprocket that forms part of spindle portion 24. Important is the fact that there is no limit to the turning angle of the steering post, as it can be turned through an angle of 360° by suitable shifting of chain 46.

Continuing with a description of the steering post, as already indicated the lower end of the post terminates in forks 22a, 22b, and these straddle wheel 12. In the embodiment of the invention shown, each fork comprises substantially upright flanges, such as flanges 54, 56, 58, and 60, integral with a vertical plate portion 62. The flanges are included, as they make the plate portion rigid without substantially increasing its mass.

Axle mechanism 20 comprises an axle shaft 63 secured in fixed position adjacent the bottom ends of legs 22a, 22b by clamping each end of the axle shaft between a pair of clamp portions 64, 66. Each upper clamp portion 64 is joined to a plate portion 62. Each lower clamp portion 66 is fastened to an upper clamp portion using nut and bolt assemblies 68 extending through the two

clamp portions. A key 70 keys the axle shaft to each upper clamp portion 64. Thus, the axle shaft constitutes a dead axle shaft in the construction.

Support wheel 12 is a hydraulically driven, motorized wheel. Means is provided forming a positive-displacement motor of casing structure 18 and axle mechanism 20. Details of the motor will now be discussed, with particular reference to FIGS. 3, 4, 5, and 6, where the motor is indicated generally at 71. On actuation of the motor, the casing structure rotates relative to the dead axle shaft 63 to produce wheel movement.

Referring to the figures mentioned, casing structure 18 comprises a pair of oppositely disposed hub portions or members 72, 74 axially spaced on axle shaft 63, and an annular ring or rotor member 76 between the hub members and secured at opposite axial ends to the hub members. In the form of the invention shown, the hub and rotor members are secured together by elongated screws 78. Annular keys 82, one for each end of member 76, extend from the ring member into the adjacent hub member, and fit within accommodating grooves provided the two members. The rotor member is sealed to the hub members at either end by means of O rings 84, 86. The hub and rotor members rotate as a unit, and thus there is no tendency for their rings to wear because of relative movement of parts sliding thereagainst.

Casing structure 18 comprising hub members 72, 74 and ring member 76 is journaled on the axle shaft through bearing assemblies 88, 90. These have outer races 88a, 90a that seat in steps 92, 94 provided the hub members. Inner races 88b, 90b of the assemblies directly encircle the axle shaft, and are confined from outward axial shifting on the axle shaft by nuts 96, 98. Outwardly on the axle shaft of the bearing assemblies are bearing caps 100, 102 and oil seals, indicated at 104, 106.

Forming part of axle mechanism 20 and mounted on axle shaft 63 between the hub members and within the ring member is a stator member or portion 110. The ends of the stator portion are snugly adjacent the hub members on either end. The axle shaft is splined, as at 112, and the stator portion has key portions 114 complementing the splines of the shaft that fit within the splines. Thus, the stator member is fixed in place on the axle shaft. The stator member or portion, and with reference to FIG. 3, has an outer wall indicated at 116 which is cylindrical in outline. Ring member 76 has an inner wall surrounding the stator portion, indicated at 118. The inner and outer walls of these two members define a motor chamber 120 for motor 71.

Considering the shape of wall 118, portions 118a, 118b are portions of the wall that curve about a relatively large radius, and portions 118c and 118d are portions that curve about a smaller radius. Between these portions and joining them are smoothly curving portions 118e, 118f, 118g, and 118h. Portions 118c and 118d that curve about the smaller radius are snugly adjacent wall 116 of the stator portion.

A fluid supply and exhaust means is provided the motor, and this will now be described. As can be seen with reference to FIG. 4, ports or openings 130a, 130b connect with the left end of the motor chamber, at the top of the motor chamber as shown in FIG. 4. Ports 132a, 132b connect with the same end of the motor chamber, at the bottom of the chamber in FIG. 4. The ports are shown in dashed outlines in FIG. 3, as the hub member containing them has been removed in FIG. 3. It will be seen with reference to dashed outlines that the ports are on diametrically opposite sides of the axle shaft. The larger of the ports 130a, 132a are adjacent outer margins of the pump chamber, and the smaller of the ports 130b, 132b are spaced radially inwardly. The ports connect with motor chamber where the chamber is bounded by curving portions 118f, 118h.

Connecting with the opposite end of the motor chamber, or right end as viewed in FIGS. 2 and 4, are ports or

openings 134a, 134b and 136a, 136b (refer to FIG. 3). These are similar in shape to the first-described set of ports, and they also are on diametrically opposite sides of the axle shaft. These ports are located adjacent curving wall portions 118g, 118e. During running of the motor in one direction, ports 130a, 130b, and 132a, 132b, function as inlet ports, and ports 136a, 136b and 134a, 134b function as outlet ports, and during running of the motor in the opposite direction this is reversed.

Considering again the construction of motor 71, a series of radially shiftable and radially extending vanes 140 are mounted on the stator portion, and divide the motor chamber into sections. The vanes are mounted in slots 142 indented inwardly from the periphery of the stator portion, and are spaced apart approximately the distance separating adjacent ends of consecutive sets of ports. Axially extending bores 144 connect along their sides with the slots extending along the inner ends of slots 142. On rotation of the casing structure relative to the stator, the ends of these bores ride over the smaller ports 130b, 132b, 134b, 136b.

A vane 140, is shown removed and exploded in FIGS. 5 and 6. Each comprises a plate-like body 146, with a groove 148 extending around two end edges 147a, 147b and a side edge 149. Enlarged bores 150 extend inwardly from the side edge opposite edge 149. These seat the ends of coil springs 152 (see FIG. 3). Connecting with the ends of bores 150 are smaller bores 154, that extend to edge 149 and communicate with groove 148. Assembled, end edges 147a, 147b ride adjacent the hub members. Providing a seal at these end edges and bearing on the hub members are shoes 156, made of suitable bearing material. The shoes have generally a channel-shaped outline in plan, and are urged outwardly of the end edges of the vanes and against the hub members by coil springs 158. These springs have inner ends that seat in bores 160.

With the vanes mounted on the stator, as shown in FIGS. 3 and 4, coil springs 152 urge the vanes radially outwardly and into abutting contact with surface 118 of the ring member. The shoes, as discussed, seal the end edges of the vanes to the hub members.

Explaining the operation of motor 71, and assuming casing structure 18 to be rotating in a counterclockwise direction relative to the stator portion in FIG. 3, for this direction of rotation, ports 136a, 136b and ports 134a, 134b supply fluid under pressure, and ports 130a, 130b, 132a, 132b are exhaust ports. With reference to vane 140a in FIG. 3, as ports 136a, 136b swing downwardly with respect to the vane 140a, fluid under pressure is introduced against the under face of the vane. Fluid also flows into bore 144, to balance hydraulically the vane. By the time the vane reaches the portion of vane 140b relative to the casing structure in FIG. 3, the vane is fully extended, and the maximum possible area of its under or left face has pressure fluid bearing thereagainst. As soon as the vane just in front of vane 140b reaches the position where its left face in FIG. 3 is over ports 130a, 130b, pressure fluid may escape from the space to the right of vane 140b, and a force results producing relative rotation of the casing structure in a counterclockwise direction with respect to the stator portion. On reaching a position over ports 130a, 130b, pressure fluid may escape from the space behind the vane. The operation repeats on the vane reaching supply ports 134a, 134b, where fluid under pressure enters the motor chamber, such fluid being exhausted when the vane reaches ports 132a, 132b. To reverse the running direction of the motor, pressure fluid is supplied to ports 130a, 130b, 132a, 132b and exhausted from ports 134a, 134b, 136a, 136b.

An axle passage 164 is provided for the supply and exhaust of fluid to and from the various ports. The passage, as can be seen in FIG. 4, extends longitudinally along axle shaft 63. In hub member 72, passages 166a,

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166b connect with ports 130a, 130b, 132a, 132b, and these ports and passages constitute a first passage means in the construction. Passages 166a, 166b communicate with axle passage 164, in all positions of the hub member, through annular passage 168 encircling the axle shaft, and bores 170. In hub member 74, passages 172a, 172b, similar to passages 166a, 166b, are provided, that connect with ports 134a, 134b, 136a, 136b, and these ports and passages constitute a second passage means. Passages 172a, 172b communicate with the axle passage in all positions of hub member 74 through annular passage 174 and bores 176. Check valves or means 178, 179 block the flow of fluid straight through the axle shaft so that fluid must pass through the motor chamber and actuate the motor.

Motor 71, just described, is adapted to handle fluid at relatively high pressures. By using fluid at relatively high pressures, the volume of fluid that has to be circulated to obtain a given amount of work from the motor may be minimized. This is an important consideration in a wheeled vehicle, where weight and other factors limit volume of fluid available. Where fluid at high pressures is used, leakage in the motor may be a problem. According to this invention, relief passage means is provided the motor that feeds back to the hydraulic system supplying the motor any fluid that may leak between the hub and stator members, and between the stator member and axle shaft. The relief passage means has the effect of reducing stresses on the motor parts.

Explaining the relief passage means and seals used in the motor, encircling the axle shaft and between annular passages 168, 174 and sealing the hub members to the axle shaft are O rings 180, 182. Outwardly on the axle shaft of the annular passages and also sealing the hub members to the axle shaft are O rings 184, 186. Thus, O rings bound that side of passages 168, 174. Sealing the hub members to the ends of the stator member are O rings 188, 190.

While O rings 84, 86 between the ends of ring member 76 and hub members 72, 74 seal parts that have a fixed relative position, O rings 180, 182, 188, 190 seal together parts that are relatively movable. Thus, they are more prone to wear than the first-mentioned set of O rings, and leakage past the O rings may occur. Fluid leaking past rings 180, 182, 188, 190 is returned to the hydraulic system for the motor through relief passages 192, 194 that have their outer set of ends connecting with the outside of the axle shaft between the ends of the stator member. The inner set of ends of passages 192, 194 connect with axle passage 164 at a location bounded on either side by check valves 178, 179. Check valves 178, 179 accommodate one-way flow of fluid through the axle passage away from passages 192, 194. During operation of the motor, flow is to the end of the axle passage that handles exhaust fluid from motor 71. Assuming that passages 166a, 166b are operating as supply passages for the motor, then passages 172a, 172b are operating as exhaust passages, and leaking fluid flowing in relief passages 192, 194 is returned through check valve 179 and the right end of the axle passage in FIG. 4. With the motor running in the opposite direction, fluid return is through check valve 178 and the left end of the axle passage.

Referring now again to FIGS. 1 and 2, flow of fluid to and from the axle passage is by means of first and second conduits 200, 202. First conduit 200 comprises conduit sections 204, 205, and 206, extending downwardly through the center of spindle portion 24, outwardly above the support wheel 12, and downwardly along fork 22a to the left end of the axle shaft, respectively. A fitting 210 having a passage 212 therein connects the bottom of conduit section 206 with the left end of axle passage 164. The fitting is secured to the end of the axle shaft by screws 216. In a similar manner, second conduit 202 comprises conduit sections 220, 221, 222. Bottom conduit section 222 connects to the right end of axle passage

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164 through a fitting 224. The latter is secured in place by screws 228. Note that flanges 56, 58 protect bottom conduit sections 206, 222, as each section has a flange extending up and down along each side thereof.

Adjacent the top of the steering post is a rotary coupling mechanism 230. This includes a casing portion 232, secured to the vehicle frame through a mounting 234, which is fastened to the collar 34. Within the casing portion and secured to the steering post is a core portion 238. An annular groove 236 in casing portion 232 is connected by a passage 240 formed in core portion 238 with conduit section 220 of the second conduit 202. On either side of groove 236 and sealing the core and casing portions are O rings 242, 244. Similarly, an annular groove 246 in the casing portion above groove 236 is connected by a passage 248 with upper conduit section 204 of the first conduit 200. Sealing the core and casing portions above groove 246 is an O ring 250. O ring 242 (already described) seals the core and casing portions below groove 246. Pipes 254, 256 have hollow interiors connecting with grooves 246, 236, respectively. The pipes are connected to a conventional hydraulic system including a pump, reservoir, and reversing valve mechanism (not shown), constructed to enable fluid under pressure to be introduced to coupling mechanism 230 through either one of the pipes, and discharged from the coupling mechanism through the other of the pipes. The coupling mechanism thus constitutes a means for connecting pipes or lines that are fixed in position with passages that may be swung in a 360° angle about a vertical axis.

Completing the description of the vehicle wheel and its mounting, a brake mechanism is indicated at 260. The brake mechanism includes a brake cylinder 262 for actuating the mechanism, and shoes 264, 266. A supply line for the delivery of fluid to motor 262 is indicated at 268.

It should be apparent that a vehicle equipped with the motorized wheel described has several advantages. For one thing, the vehicle is highly maneuverable, as the wheel can be turned during steering through an angle of 360°, by proper manipulation of chain 46. In all positions of the wheel, there is no interruption in the supply and exhaust of fluid to and from the motor driving the wheel. The positive displacement motor disclosed is relatively efficient in operation, easy to service, and when properly constructed can develop considerable horsepower. The motor is particularly suited for handling fluid at high pressure. Any leakage of fluid in the motor is taken care of by the relief passage means described, with such fluid returning to the hydraulic system supplying the motor.

It is claimed and desired to secure by Letters Patent:

1. A hydraulically driven wheel comprising a dead axle shaft; a wheel; means supporting the wheel on the axle shaft; the latter means comprising a pair of oppositely disposed and rotatable hub members journaled on said axle shaft and spaced axially from each other, and an annular rotor member between the hub members and sealed to and rotatable with the hub members at each of its ends; a stator member nonrotatably secured to the axle shaft and within the rotor member; a motor chamber bounded at its ends by said hub members and between the rotor and stator members; radially shiftable vanes mounted on said stator member and dividing the motor chamber into sections with said vanes and motor chamber forming a positive-displacement motor; and fluid supply and exhaust means for the motor comprising first passage means in one of said hub members connecting at one end with one end of said motor chamber, second passage means in the other of said hub members connecting with the other end of said motor chamber and circumferentially spaced from said one end of said first passage means, an elongated axle passage extending longitudinally of the axle shaft, first connecting means adjacent said one hub member connecting said axle passage and said first passage means in all positions of said one hub member,

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second connecting means adjacent said other hub member connecting said axle passage and said second passage means in all positions of said other hub member, fluid relief passage means connecting the axle passage at a location between the two connecting means with the exterior of said axle shaft, and a check valve in said axle passage on each side of where the relief passage means connects with the axle passage and intermediate said first and second connecting means accommodating one-way flow of fluid away from the relief passage means.

2. In a wheel mechanism having a wheel and hydraulic means for driving it, axle mechanism including a dead axle shaft and a stator portion fixedly joined thereto, casing structure journaled on said axle shaft having hub portions adjacent each end of said stator portion and a ring portion surrounding the stator portion, a motor chamber bounded at its ends by said hub portions and between the ring and stator portions, radially shiftable vanes mounted on said stator portion and dividing the motor chamber into sections with said vanes and motor chamber forming a positive-displacement motor, and fluid supply and exhaust means for the motor comprising first passage means in one of said hub portions connecting at one end with one end of said motor chamber, second passage means in the other of said hub portions connecting with the other end of said motor chamber and circumferentially spaced from said one end of said first passage means, an elongated axle passage extending longitudinally of the axle shaft connected adjacent said one hub portion to said first passage means and adjacent said other hub portion to said second passage means, sealing means sealing the casing structure to the axle mechanism adjacent each end of the stator portion and inwardly on the axle mechanism of the connections of the axle passage with said first and second passage means, fluid relief passage means for the relief of any fluid that may leak past said sealing means connecting with said axle passage intermediate its connections with said first and second passage means, and check valve means in said axle passage on each side of where the relief passage means connects with said axle passage and intermediate where the axle passage connects with said first and second passage means accommodating one-way flow of fluid away from the relief passage means.

3. A hydraulically driven wheel comprising a dead axle shaft, a stator portion spline-connected to the axle shaft, a wheel, and casing structure carrying the wheel journaled on said axle shaft, said casing structure having hub portions outwardly of and abutting ends of the stator portion and a ring portion surrounding the stator portion, a motor chamber bounded at its ends by said hub portions and between the ring and stator portions, radially shiftable vanes mounted on said stator portion and dividing the motor chamber into sections with the vanes and motor chamber forming a positive-displacement motor, and fluid supply and exhaust means for the motor, said fluid supply and exhaust means including an axle passage extending longitudinally of said axle shaft and means ad-

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jacent each hub portion connecting the axle passage to an end of the motor chamber at circumferentially spaced locations, means sealing each hub portion to an adjacent end of the stator portion, means sealing each hub portion to the axle shaft, relief passage means connecting at one end with the exterior of the axle at a location disposed between the ends of the stator portion and at its other end with said axle passage between the means connecting the axle passage with the ends of the motor chamber, and check valve means in said axle passage on each side of the connection of said relief passage means with the axle passage and between the means connecting the axle passage with the ends of the motor chamber accommodating one-way flow of fluid away from said relief passage means.

4. A hydraulically driven wheel construction comprising a dead axle shaft, a stator portion fixedly joined to said axle shaft intermediate its ends, wheel-carrying casing structure journaled on said axle shaft and surrounding said stator portion and including hub portions adjacent the ends of said stator portion, sealing means sealing said casing structure to said axle shaft adjacent each end of said stator portion, a motor chamber between said casing structure and stator portion and bounded at its ends by said hub portions, means forming a positive displacement motor of said motor chamber, an axle passage extending longitudinally of said axle shaft, first passage means in one of said hub portions connecting said axle passage with one end of said motor chamber, second passage means in the other of said hub portions connecting said axle passage with the other end of said motor chamber at a point circumferentially spaced from the connection of said first passage means with said motor chamber, relief passage means for the relief of any fluid that may leak past said sealing means connecting with said axle passage between the connections of said first and second passage means with said axle passage, and check valve means in said axle passage on each side of the connection of said relief passage means with said axle passage and between the passage means connecting the axle passage with the ends of said motor chamber, said check valve means accommodating the one-way flow of fluid away from said relief passage means.

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