July 14, 1953 F. E. HAWKINS ET AL 2,645,298

HYDRAULIC FLUID MOTOR-IN-WHEEL

Filed July 22, 1950 6 Sheets-Sheet 1

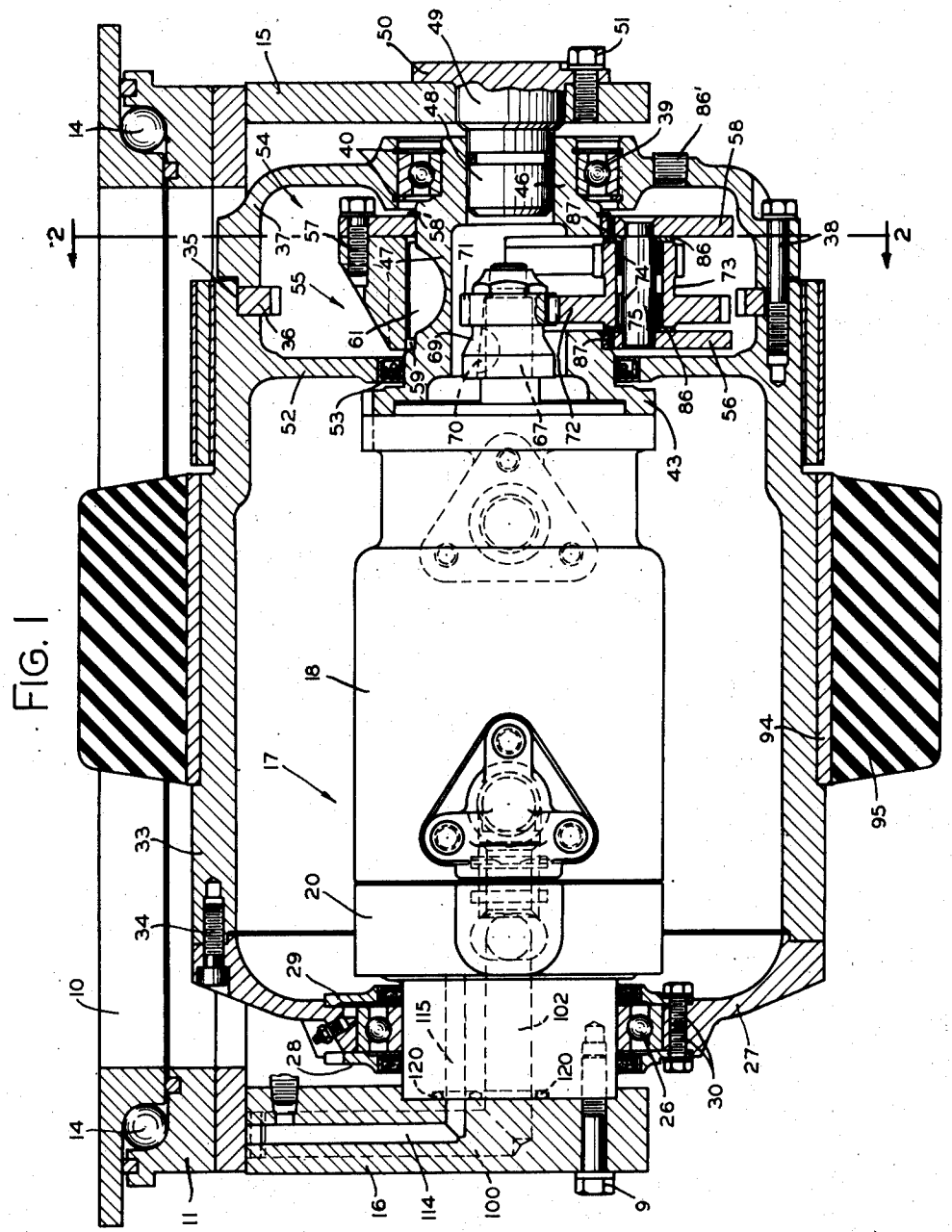

FIG. 1

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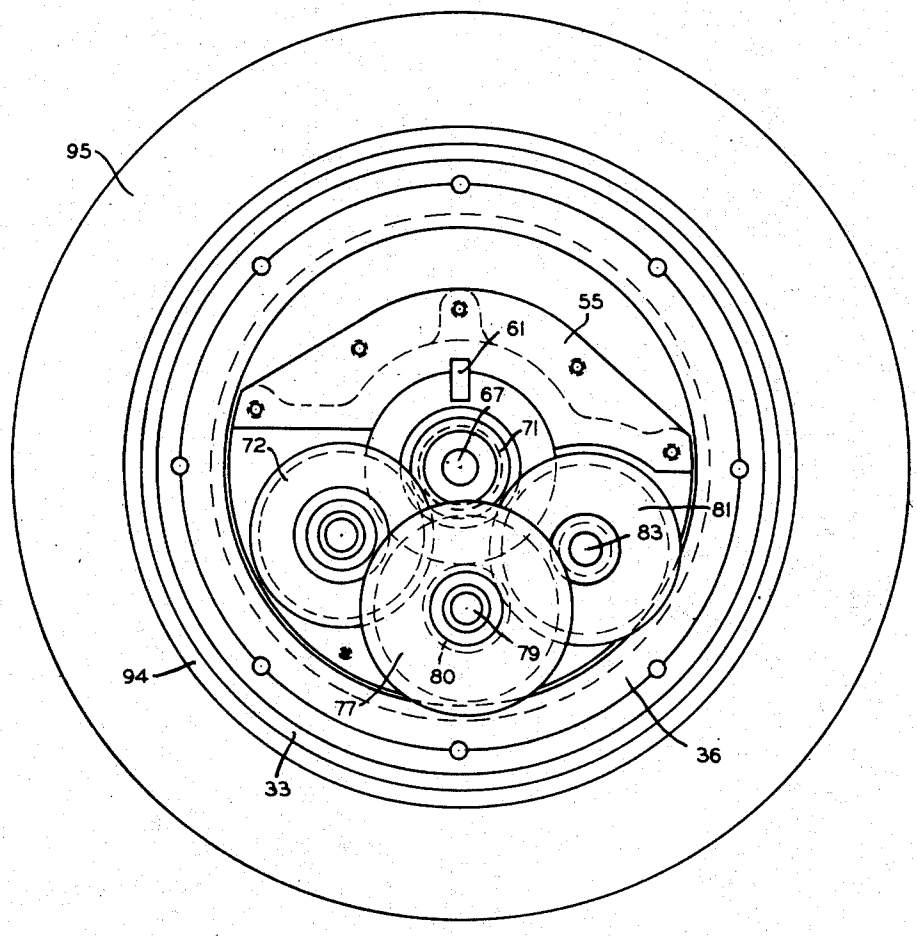
FIG. 2



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HYDRAULIC FLUID MOTOR-IN-WHEEL

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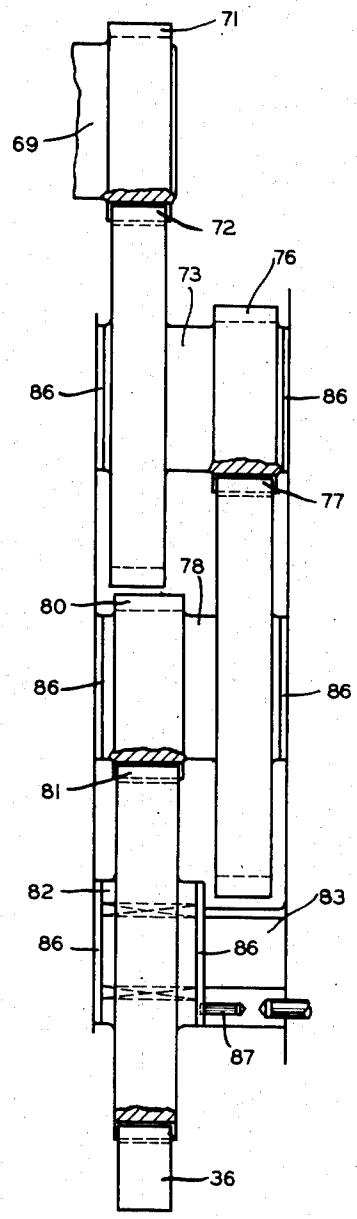
FIG. 3



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HYDRAULIC FLUID MOTOR-IN-WHEEL

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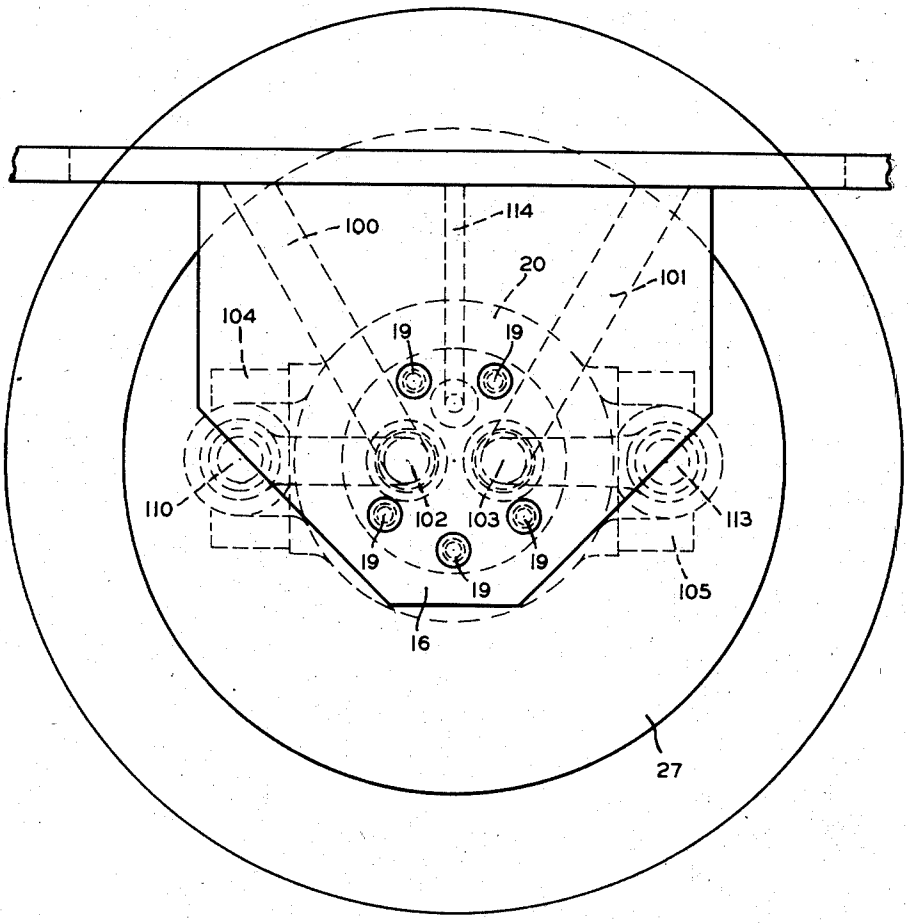
FIG. 4



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HYDRAULIC FLUID MOTOR-IN-WHEEL

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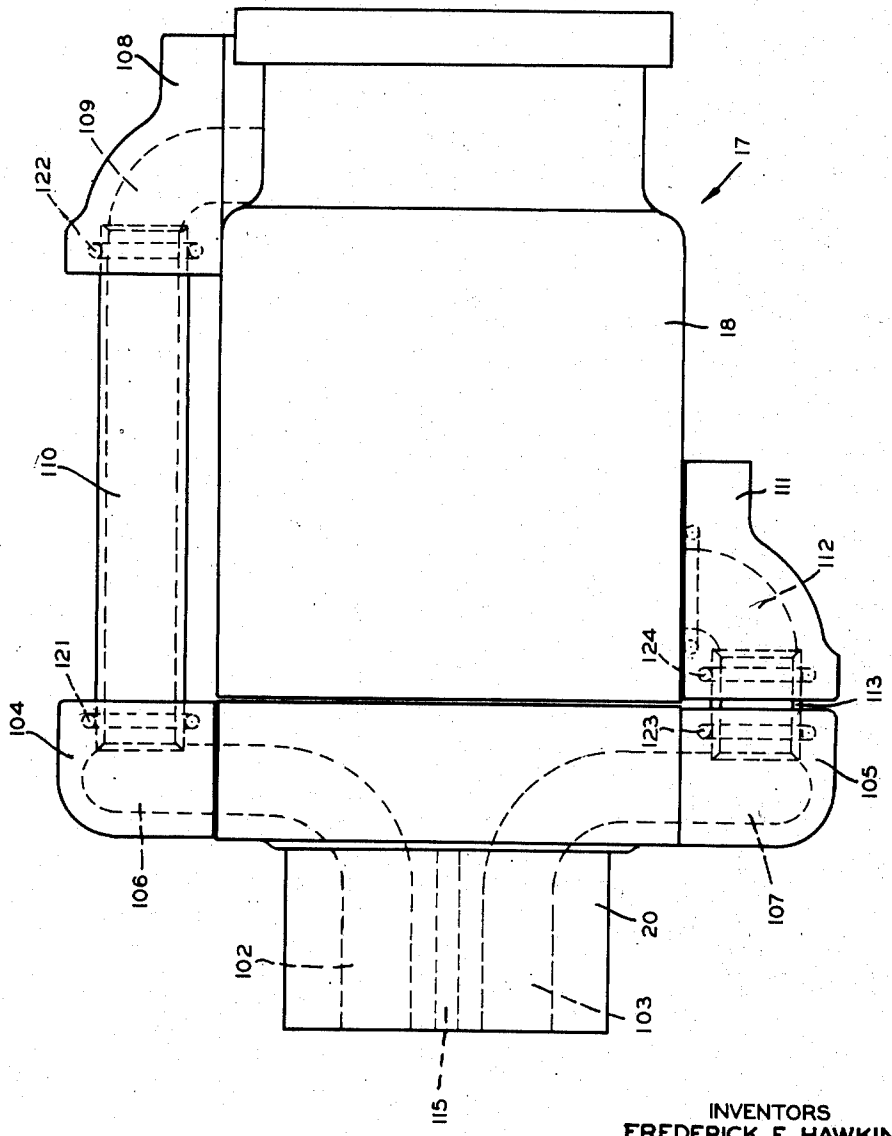
FIG. 5



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HYDRAULIC FLUID MOTOR-IN-WHEEL

Filed July 22, 1950 6 Sheets-Sheet 6

FIG. 7

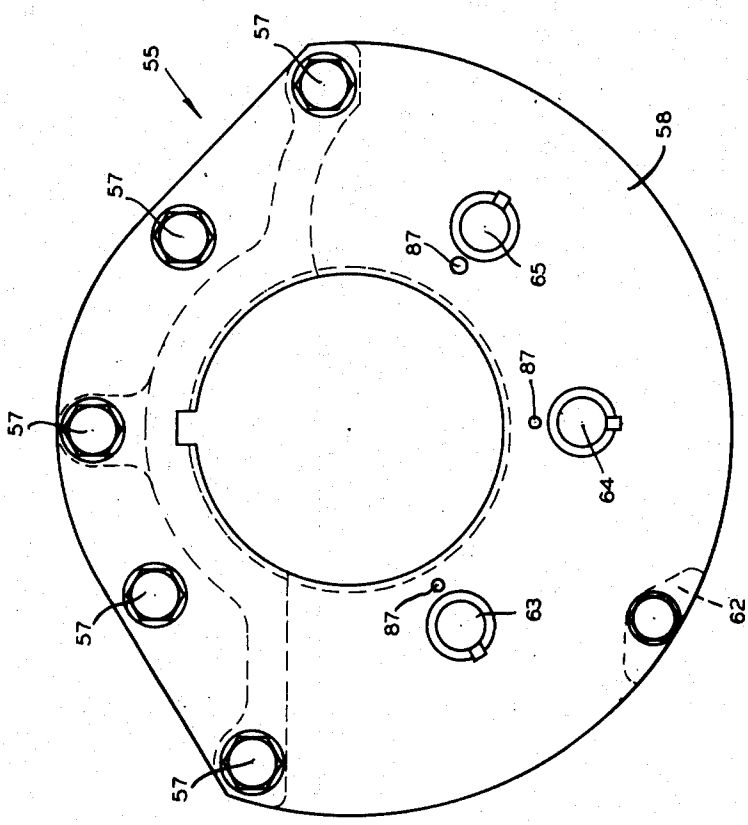
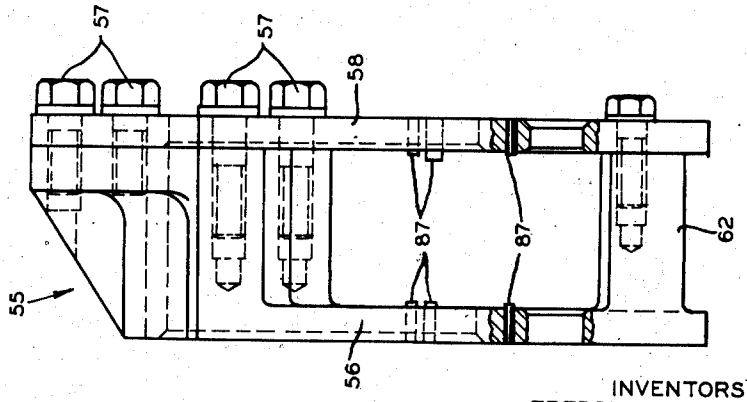


FIG. 6



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Patented July 14, 1953 2,645,298

UNITED STATES PATENT OFFICE

2,645,298

HYDRAULIC FLUID MOTOR-IN-WHEEL

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Application July 22, 1950, Serial No. 175,377

5 Claims. (Cl. 180—66)

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Our invention relates to a combination motor and drive means disposed within a wheel for driving the latter.

It is an object of our present invention to provide a compact combination hydraulic fluid motor and drive means which may be disposed within a wheel for driving the latter.

We propose to provide a hydraulic fluid motor having an outer casing to which is secured a pair of end cap members, one at each end thereof, and each having portions extending axially of the drive shaft of the motor. Disposed about the casing of the hydraulic fluid motor, in concentric relation thereto, is a wheel housing having end closure members which are rotatably journaled on the axially extending portions of the cap members at the ends of the motor casing. The drive shaft extending axially outwardly of the casing of the hydraulic fluid motor serves as an output shaft which, through suitable drive means, is adapted to effect rotation of the rotatable wheel housing when the end cap members of the motor casing are held rigid. Mounted to the outer periphery of the rotatable wheel housing, intermediate of the ends thereof, is a tire assembly through which drive is adapted to be effected to the ground. Our present invention is an improvement over the motor-in-wheel disclosed and claimed in our copending application, Serial No. 175,376, filed July 22, 1950, now Patent No. 2,608,598.

It is another object of our present invention to provide an end cap member adjacent one end of the hydraulic fluid motor casing through which fluid is adapted to be transmitted for supplying power to the hydraulic fluid motor.

We have formed a pair of cavities within the one end cap member, which cavities open inwardly of the rotatable wheel housing. The ends of the cavities within the wheel housing have suitable connection with the one ends of a pair of tubing members, which, in turn, at their other ends, are suitably connected to the ends of the hydraulic fluid motor. When driving the hydraulic fluid motor in one direction fluid under pressure is admitted through one of the cavities and the associated tubing member, while fluid is bled from the other cavity and associated tubing member. If the hydraulic fluid motor is to be driven in the opposite direction the reverse procedure is followed. That is, fluid is bled from the first cavity and associated tubing member, while fluid under pressure is admitted to the other cavity and associated tubing member.

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It is still another object of our present invention to provide support means for the end cap members of the hydraulic fluid motor of a character which will permit the combination hydraulic fluid motor and drive means to be removed easily from the support means for servicing.

Now, in order to acquaint those skilled in the art with the manner of constructing and using devices in accordance with the principles of our present invention, we shall describe, in connection with the accompanying drawings, a preferred embodiment of our invention.

In the drawings:

Figure 1 is a vertical sectional view taken along the lengthwise extending median plane of the motor-in-wheel construction of our present invention, with the hydraulic fluid motor shown in elevation;

Figure 2 is a vertical transverse sectional view taken along the line 2—2 of Figure 1, looking in the direction indicated by the arrows, showing the drive means for our present invention;

Figure 3 is a schematic view of the drive means of Figure 2;

Figure 4 is an end elevational view of the motor-in-wheel construction of Figure 1;

Figure 5 is a plan view of the hydraulic fluid motor of Figure 1;

Figure 6 is a side elevational view of the substantially U-shaped inverted frame member provided for supporting the drive means; and

Figure 7 is a front view of the frame member of Figure 6.

Referring now to Figure 1, there is shown the motor-in-wheel construction of our present invention which may, for example, be adapted to rotatably support a horizontally extending frame member 10 of an industrial truck. The horizontally extending frame member 10 is adapted to be rotatably supported upon a horizontally extending circular ring member 11, which comprises a portion of the support means of the motor-in-wheel. Anti-friction balls 14 are provided between the frame members 10 and 11 for permitting relative rotation therebetween. Secured to the underside of the frame member 11, adjacent opposite edges thereof, are a pair of vertically downwardly extending plate members 15 and 16.

Disposed intermediate the plate members 15 and 16 is a hydraulic fluid motor, indicated generally by the reference numeral 17. The hydraulic fluid motor 17 has a cylindrical casing 18 to which, at the left end thereof, as viewed

in Figure 1, is secured, as by a plurality of circumferentially spaced bolts 19, an end cap member 20 having a portion extending axially of the drive shaft of the motor. The outer end of the axially extending portion of the end cap member 20 is adapted to seat within an opening formed within the adjacent plate member 16 and is secured thereto by bolts 9.

Mounted on the outer periphery of the axially extending portion of the end cap member 20 is a ball bearing assembly 26 which is adapted to rotatably support an end closure member 27. The hub of the end closure member 27 is maintained in concentric relation with respect to the ball bearing assembly 26, by means of circular retaining members 28 and 29 which are disposed one on each side of the ball bearing assembly 26 and are secured, as by a plurality of circumferentially spaced bolts 30, to the end closure member 27.

The end closure member 27 is adapted to provide a support for a lengthwise extending cylindrical wheel housing or casing 33, the cylindrical housing 33 being suitably secured to the outer peripheral edge of the end closure member 27, by means of a plurality of circumferentially spaced bolts 34. The cylindrical housing 33 is disposed about the motor 17 in concentric relation thereto. The wheel housing 33, at its opposite end, is formed with an annular inwardly facing groove 35 which is adapted to receive an internal ring gear 36, which is held in position by an end closure member 37 secured to the cylindrical housing 33, as by means of a plurality of circumferentially spaced bolts 38. The ring gear member 36 is provided with circumferentially spaced semispherical notches at the outer periphery thereof, which notches are adapted to align with the bolts 38 for preventing rotation of the ring gear 36, with respect to the housing 33. The end closure member 37 is journaled on a ball bearing assembly 39 and is held against axial movement with respect thereto, by means of the spaced retaining rings 40.

Suitably secured to the casing 18 of the motor 17 is an end cap member 43 having a portion extending axially of the drive shaft of the motor. The axially extending portion of the end cap member 43 comprises a pair of coaxially aligned spaced apart cylindrical portions 45 and 46 which are interconnected adjacent their upper ends by means of an integrally formed web portion 47. The outer cylindrical portion 46 of the end cap member 43 is adapted to support the ball bearing assembly 39. Disposed within the outer cylindrical portion 46 is the reduced end portion of a pilot shaft 48. The pilot shaft 48 has an intermediate enlarged portion 49 which is adapted to be disposed within an opening formed in the plate member 15. The pilot shaft 48 has formed at its outer end an enlarged flange portion 50 which is adapted to be suitably secured to the outer surface of the plate member 15, by means of bolts 51.

It will also be observed that the above-described support means permits the motor 17 and drive means to be removed easily for servicing. That is, by removing the pilot shaft 48 from the end cap member 43, and the bolts 9 which secure the end cap member 20 to the plate member 16, the motor and drive means may be shifted axially, permitting the outer end of the end cap member 20 to be withdrawn from the opening in the plate member 16. The motor and drive means may then be withdrawn from between the plate members 15 and 16.

Formed integrally with the cylindrical wheel housing 33, adjacent the right end of motor 17, as viewed in Figure 1, is a radially inwardly extending flange portion 52. A central opening is formed in the flange member 52 and an oil seal ring 53 is disposed between the inner periphery of the flange member 52 and the outer periphery of the inner cylindrical portion 45 of the axially extending portion of the end cap member 43. It will thus be observed that the inwardly extending flange member 52 and the end closure member 37 define a chamber 54 in which is disposed the drive means of our present invention.

Disposed within the cavity 54 is a substantially U-shaped inverted frame member 55 which, as best shown in Figures 6 and 7, comprises a vertical plate member 56 having a laterally extending web portion adjacent the upper end thereof, to which is secured, as by bolts 57, a vertically extending plate member 58. The plate members 56 and 58 are spaced at their lower ends by means of a spacer member 62 formed integrally with plate member 56 and bolted to plate member 58. The frame member 55 is adapted to be disposed over the web portion 47 of the axially extending portion of the end cap member 43 secured to the casing 18 of the motor 17. The frame member 55 is held against rotation, with respect to the end cap member 43, by means of a woodruff key 61. The frame member 55 is held against axial movement in one direction by means of a shoulder 59 formed in the periphery of the inner cylindrical portion 45 of the end cap member 43, and in the other direction by means of a retaining ring 58' which is disposed within an annular groove formed in the outer cylindrical portion 46 of the end cap member 43. Extending outwardly of the end of the casing 18, of the hydraulic fluid motor 17, is a rotatable output shaft 67.

As shown in Figure 7, three pair of circumferentially spaced openings 63, 64, and 65 are formed in the plate members 56 and 58 of the frame member 55. When the frame member 55 is assembled in position in the motor-in-wheel construction of our present invention, the openings 63 lie below a horizontal median plane passing through the output shaft 67, at one side of a vertical median plane passing through the output shaft 67; the openings 64 lie below the horizontal median plane in the vertical median plane; and the openings 65 lie below the horizontal median plane at the opposite side of the vertical median plane, as the openings 63. The openings 63, 64, and 65 are provided for a purpose to be hereinafter described.

The output shaft 67, at its outer end, has secured thereon, as by a key 70, a pinion member 69. Referring now to Figure 3, there is shown the drive means of our present invention comprising a meshing gear train which, for the sake of clarity, is shown with the axes of the gears in one plane. The pinion member 69 has at its outer end a gear portion 71 which is adapted to have meshing engagement with the first gear portion 72 of a first compound gear member 73, rotatably journaled by means of needle bearings 74 on a lay shaft 75. The ends of the lay shaft 75 are disposed within the openings 63 formed in the frame member 55.

The first compound gear 73 has a second gear portion 76 which is adapted to have meshing engagement with the first gear portion 77 of a sec-

ond compound gear member 78, which is rotatably journaled, as by means of needle bearings (not shown), on a lay shaft 79. The ends of the lay shaft 79 are disposed within the openings 64 in the frame member 55.

The second compound gear 78 has a second gear portion 80 which is adapted to have meshing engagement with a gear portion 81 of a gear member 82, which is rotatably journaled, as by means of needle bearings (not shown), on a lay shaft 83. The lay shaft 83 has its ends disposed within the opening 65 in the frame member 55. The gear portion 81 of the gear member 82 is adapted to have meshing engagement with the aforedescribed ring gear member 36, secured within the rotatable wheel housing 33.

It will thus be observed that drive is effected from the rotatable output shaft 67 of the motor 17 to the ring gear 36 of the rotatable wheel housing 33, by means of the pinion 71, gear portion 72, gear portion 76, gear portion 77, gear portion 80, and gear portion 81.

The gear members 73, 78, and 82 are axially spaced between plate members 56 and 58 of the frame member 55, by means of thrust washers 86, secured to the inner faces of the plate members 56 and 58, by means of pin members 87.

Since the chamber 54, defined by end closure member 37 and radially inwardly directed flange member 52, is substantially sealed against oil leakage, it will be understood that the gears disposed within the chamber 54 may be run continuously in an oil bath. A suitable drain plug member 86' is provided adjacent the lower end of the end closure member 37.

Secured to the outer periphery of the rotatable wheel housing 33 is a tire construction comprising a cylindrical sleeve 94 and a tire 95 for effecting drive from the rotatable wheel housing 33 to the ground.

Referring now to Figures 4 and 5, there is shown a pair of radially extending openings 100 and 101 formed in the depending plate member 16. The fluid openings 100 and 101, adjacent their inner ends, have connection, respectively, with a pair of substantially L-shaped cavities 102 and 103 formed in the end cap member 20. Suitably secured to the outer periphery of the end cap member 20, within the rotatable wheel housing 33, are a pair of elbow members 104 and 105 which have openings 106 and 107 formed respectively therein. The elbow members 104 and 105 are mounted 180 degrees apart. Suitably mounted to the outer periphery of the casing 18, of the hydraulic fluid motor 17, adjacent the right end thereof, as viewed in Figure 5, is an elbow member 108 having an opening 109 formed therein. The opening 109, adjacent its one end, has suitable connection with the interior of the hydraulic fluid motor 17. The other end of the opening 109 has suitable connection, through a tube member 110, with the aforementioned opening 106 formed in the elbow member 104. Also secured to the outer periphery of the casing 18, of the hydraulic fluid motor 17, is an elbow member 111 having an opening 112 formed therein. The elbow member 111 is mounted adjacent the left side of the casing 18, as viewed in Figure 5, 180 degrees from the elbow member 108. The one end of the opening 112 has suitable connection with the interior of the hydraulic fluid motor 17. The other end of the opening 112 communicates, through a tube member 113, with the aforementioned opening 107 formed in the elbow member 105.

A vertical pressure relief opening 114 is formed in the depending plate member 16 and, at its inner end, opens into an axially extending opening 115 formed in the end cap member 20. The other end of the opening 115 has suitable connection with the hydraulic fluid motor 17, for a purpose well known in the art.

Oil seals 120 are disposed about the outer ends of openings 102, 103, and 115 for sealing the junction of the openings 102, 103, and 115 in the end cap member 20 with the openings 100, 101, and 114 formed in the depending plate member 16, when the hydraulic fluid motor 17 is in mounted position. Oil seals 121 and 122 are also disposed in the elbow members 104 and 108, respectively, for preventing oil leakage past the tube member 110. Oil seals 123 and 124 are disposed within the elbow members 105 and 111, respectively, for preventing oil leakage past the tube member 113.

When fluid under pressure is admitted through the opening 100 in plate member 16, cavity 102 in end cap member 20, elbow member 104, tube member 110, and elbow member 108, into the hydraulic fluid motor 17, the latter is driven in one direction. When fluid is bled from the opening 100, cavity 102, elbow member 104, tube 110, and elbow member 108, and fluid under pressure is admitted through opening 101 in plate member 16, cavity 103 in end cap member 20, elbow member 105, tube member 113, and elbow member 111, into the hydraulic fluid motor 17, the latter is driven in the opposite direction. Fluid under pressure is adapted to be selectively admitted to either of the openings 100 or 101, in the plate member 17, in a conventional manner.

From the foregoing description it will be realized that when fluid under pressure is admitted to either of the openings 100 or 101 the output shaft 67 of the hydraulic fluid motor 17 will rotate, which will effect rotary movement of the pinion 71, which, in turn, will effect rotary movement of the gear portion 72, gear portion 76, gear portion 77, gear portion 80, gear portion 81, and ring gear 35, causing rotation of the rotatable wheel housing 33. Since the casing 18 of the hydraulic fluid motor 17 is suitably secured to the spaced apart vertically downwardly extending plate members 15 and 16, through the end cap members 20 and 43, the casing 18 is held against rotation which provides a suitable reaction point for driving the cylindrical housing 33.

While we have shown and described what we believe to be a preferred embodiment of our present invention, it will be understood that various rearrangements and modifications may be made therein without departing from the spirit and scope of our present invention.

We claim:

1. A motor-in-wheel construction comprising, a pair of vertically extending spaced apart plate members, a hydraulic fluid motor including a casing disposed intermediate said plate members, a pair of end cap members one secured to each end of said casing, one of said end cap members at the outer end thereof being adapted to seat within an opening in the adjacent plate member, means for mounting the other of said end cap members to the adjacent plate member, a rotatable wheel housing disposed about said fluid motor intermediate said plate members, the ends of said rotatable wheel housing being journaled on said end cap members, said one end cap member having a pair of cavities formed therethrough, said cavities adjacent their outer

ends being adapted to be placed selectively in communication with a source of fluid under pressure, a pair of elbow members secured to said hydraulic fluid motor casing and having communication with said fluid motor, fluid communicating means between said cavities and said elbow members, an output shaft extending from said fluid motor, and drive means between said output shaft and said rotatable wheel housing for effecting driving connection therebetween.

2. A motor-in-wheel construction comprising, a pair of vertically extending spaced apart plate members, a hydraulic fluid motor including a casing disposed intermediate said plate members, a pair of end cap members one secured to each end of said casing, one of said end cap members at the outer end thereof adapted to seat within an opening in the adjacent plate member, means for mounting the other of said end cap members to the adjacent plate member, a rotatable wheel housing disposed about said fluid motor intermediate said plate members, the ends of said rotatable wheel housing being journaled on said end cap members, said one end cap member having a pair of cavities formed therethrough, said cavities adjacent their outer ends being adapted to be placed selectively in communication with a source of fluid under pressure, a pair of elbow members mounted to said one end cap member within said rotatable wheel housing, said elbow members having communication with said cavities in said one end cap member, fluid communicating means between said elbow members and said fluid motor, an output shaft extending from said fluid motor, and drive means between said output shaft and said rotatable wheel housing for effecting driving connection therebetween.

3. A motor-in-wheel construction comprising, a pair of vertically extending spaced apart plate members, a hydraulic fluid motor including a casing disposed intermediate said plate members, a pair of end cap members one secured to each end of said casing, one of said end cap members at the outer end thereof being adapted to seat within an opening in the adjacent plate member, means for mounting the other of said end cap members to the adjacent plate member, a rotatable wheel housing disposed about said hydraulic fluid motor intermediate said plate members, the ends of said rotatable wheel housing being journaled on said end cap members, said one end cap member having a pair of cavities formed therethrough, said cavities adjacent their outer ends being adapted to be placed selectively in communication with a source of fluid under pressure, a first pair of elbow members mounted to said one end cap member within said rotatable wheel housing, said first elbow members having communication with said cavities in said one end

cap member, a second pair of elbow members secured to said hydraulic fluid motor casing and having communication with said fluid motor, fluid communicating means between said first and second pairs of elbow members, an output shaft extending from said fluid motor, and drive means between said output shaft and said rotatable wheel housing for effecting driving connection therebetween.

4. A motor-in-wheel construction comprising, a pair of vertically extending spaced apart plate members, a hydraulic fluid motor including a casing disposed intermediate said plate members, a pair of end cap members one secured to each end of said casing, one of said end cap members at the outer end thereof being adapted to seat within an opening in the adjacent plate member, means for mounting the other of said end cap members to the adjacent plate member, a rotatable wheel housing disposed about said fluid motor intermediate said plate members, the ends of said rotatable wheel housing being journaled on said end cap members, said one end cap member having a pair of cavities formed therethrough, said cavities adjacent their outer ends being adapted to be placed selectively in communication with a source of fluid under pressure, a first pair of elbow members mounted to said one end cap member within said rotatable wheel housing, said first elbow members having communication with said cavities in said one end cap member, a second pair of elbow members secured to said hydraulic fluid motor casing and having communication with said fluid motor, a pair of tube members interconnecting said first elbow members with said second elbow members, an output shaft extending from said fluid motor, and drive means between said output shaft and said rotatable wheel housing for effecting driving connection therebetween.

5. The combination of claim 4 wherein said first elbow members are mounted 180 degrees apart and said second elbow members are mounted 180 degrees apart at opposite ends of said hydraulic fluid motor.

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