

April 17, 1956

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2,742,216

HYDRAULIC SYSTEM FOR FIRE APPARATUS

Filed Oct. 15, 1952

4 Sheets-Sheet 1

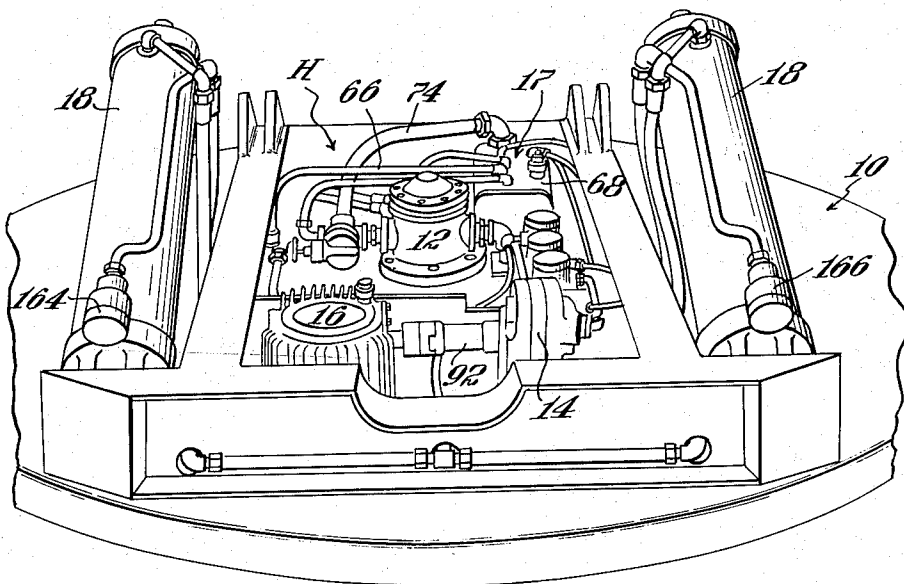
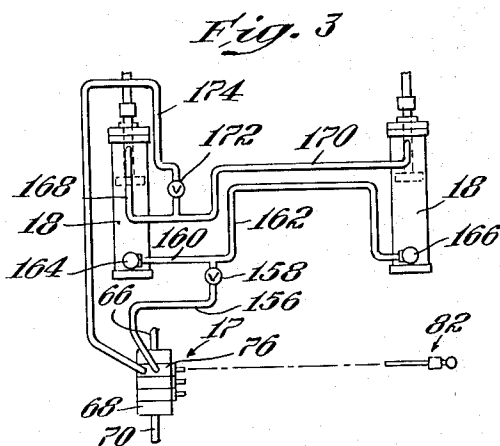
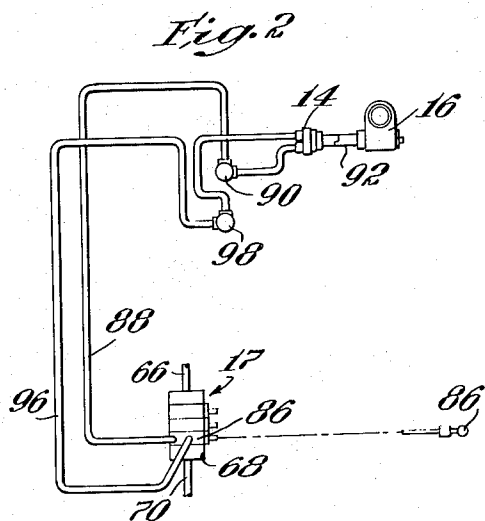


Fig. 1



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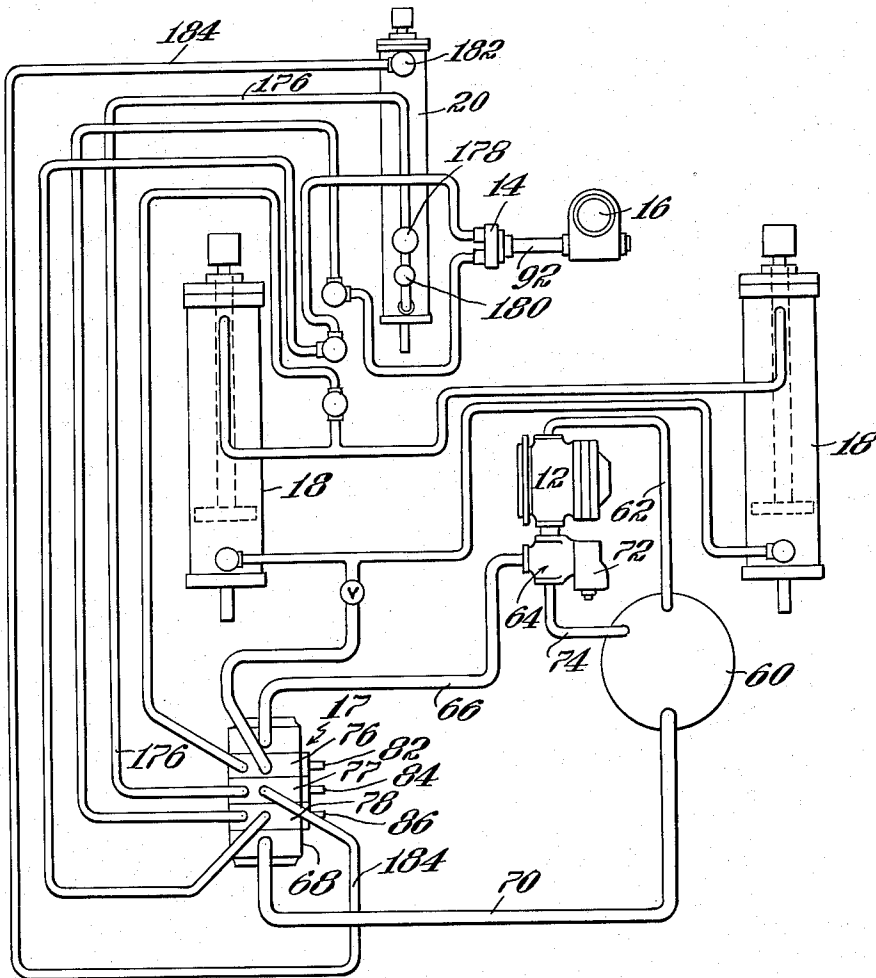


Fig. 4

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4 Sheets-Sheet 3

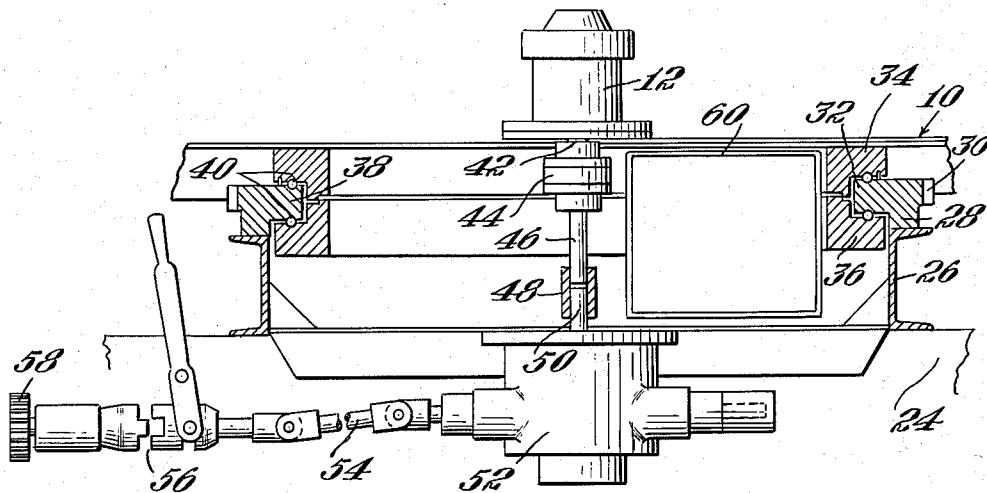


Fig. 5

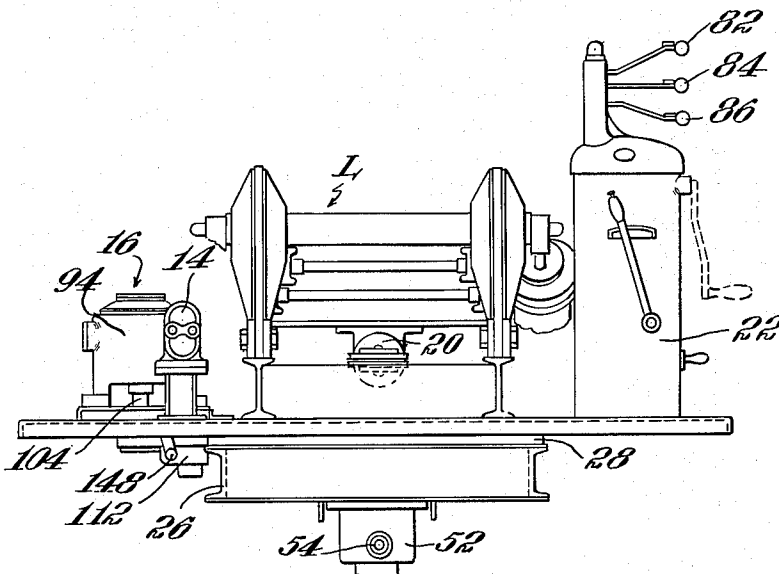


Fig. 6

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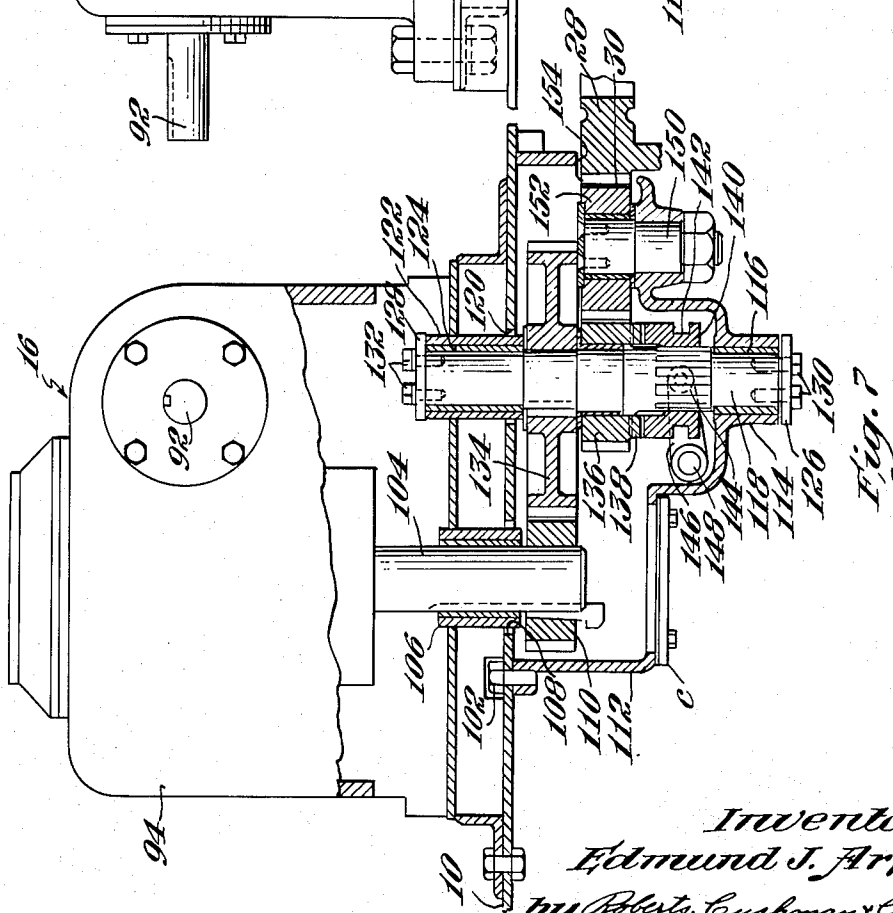
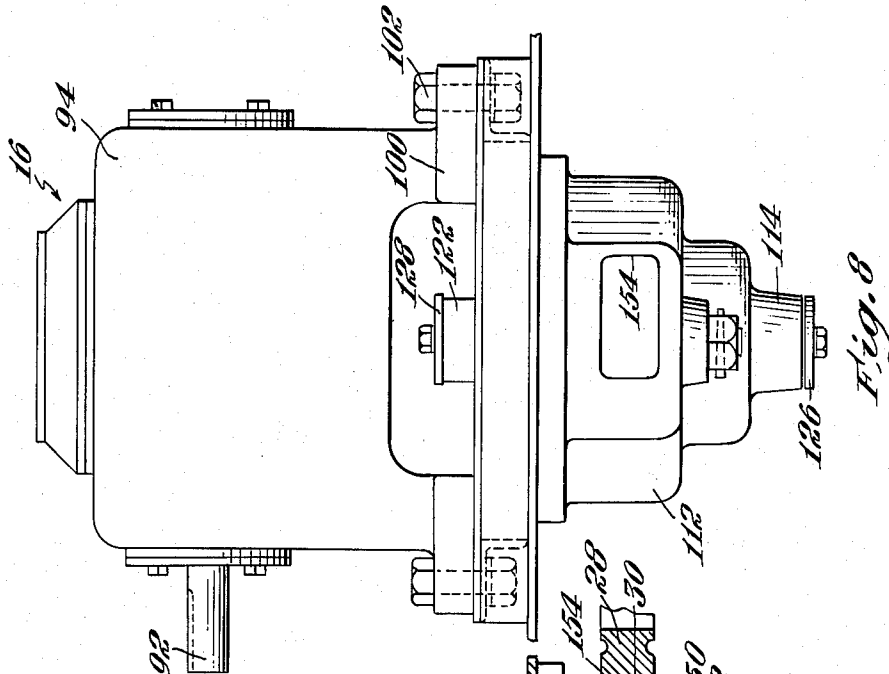
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4 Sheets-Sheet 4



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HYDRAULIC SYSTEM FOR FIRE APPARATUS

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Application October 15, 1952, Serial No. 314,865

10 Claims. (Cl. 228—14)

This invention relates to fire apparatus and constitutes a division of my pending application Serial No. 700,039, filed September 28, 1946, now Patent No. 2,614,743.

It is customary to provide a take-off from the engine of a fire truck controlled by a suitable clutch to drive the turntable, elevate and depress the ladder and extend and retract the same. Sometimes, a purely mechanical drive is employed to transmit the power from the take-off to the table and ladder while in other instances a combination of mechanical and hydraulic means have been employed. Mechanical means involves the use of large gears and differential units which are bulky, hence taking up a great deal of space where economy of space is highly desirable, are costly to manufacture and involve a major dismantling operation if repair is required. Hydraulic means, however, has many advantages over mechanical means in that it can be designed to take up a minimum space and is easy to repair. The chief disadvantage to employing hydraulic means is that it is difficult to make and maintain a leakproof junction between that part of the hydraulic system located on the chassis and that part carried by the turntable.

The principal objects of this invention are to provide a hydraulic drive for the table and ladder which will not require the use of flexible conduits, packed couplings, etc., which will be self contained and compact, which will involve the minimum amount of mechanical connections between it and the power take-off from the engine and which itself will have certain novel aspects such as limit control valves designed to make the operation safe in spite of improper or careless handling by an incompetent or inexperienced operator.

As herein illustrated a turntable is rotatably mounted on the chassis of the apparatus and supports an extension ladder which normally occupies a horizontal position when not in use, the sections of which are normally retracted. The rotation of the table on the chassis, elevation and depression of the ladder and extension and contraction thereof are all effected hydraulically by a hydraulic pump driven by a take-off from the engine and the hydraulic system including the pump, conduits, valves and motor, are all located in a compact self-contained unit on the table so as to turn therewith and so as to avoid the need for packed fluid couplings for any part of the hydraulic system. As herein illustrated a hydraulic pump is mounted on the table at the center of rotation thereof and is driven by a vertically arranged shaft projecting upwardly through the center of the table, the lower end of the shaft being connected by appropriate gearing to the engine. The pump is in turn connected by suitable conduits by way of a multiple control valve to a motor for effecting rotation of the table, a pair of hydraulic cylinders for elevating and depressing the ladder and a hydraulic cylinder for extending and retracting the sections of the ladder. In the hydraulic lines to the hydraulic cylinders there are metering valves for controlling the flow of fluid in one direction and

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hence to prevent too rapid retraction of the ladder sections or too rapid descent of the ladder from its elevated position.

The invention will now be described in greater detail with reference to the accompanying drawings wherein:

Fig. 1 is an isometric view of the turntable showing the hydraulic mechanism;

Fig. 2 is a diagrammatic layout of the hydraulic system showing the course of the hydraulic fluid for effecting rotation of the table;

Fig. 3 is a corresponding view showing the course of the hydraulic fluid for elevating and depressing the ladders;

Fig. 4 is a diagrammatic layout of the entire hydraulic system showing in addition to Figs. 2 and 3 the course of the fluid for extending and retracting the ladder sections;

Fig. 5 is a vertical diametrical section of the table longitudinally of the vehicle, showing the details of the table mounting;

Fig. 6 is an elevation of the table taken transversely of the vehicle showing the hydraulic motor, the ladder mountings and the control tower;

Fig. 7 is an elevation of the hydraulic motor for effecting rotation of the table including the reduction gearing connecting the motor shaft to the table for effecting rotation thereof, the ladder being shown in section; and

Fig. 8 is an elevation of the hydraulic motor shown in Fig. 7 as viewed from the right hand side thereof.

Referring to the drawings, the turntable 10 is shown as of circular shape (Fig. 1) and as having a flat upper surface upon which is mounted for rotation with the table the ladders L (Fig. 6) and hydraulic means H including hydraulic elevating and extension cylinders 18 and 20 for effecting elevation and extension thereof, a hydraulic pump 12 and a hydraulic motor 14 driven by the pump and connected to a gear reduction unit for effecting rotation of the table. The hydraulic fluid delivered by the pump 12 to the motor 14 and the elevating and extension cylinders 18 and 20 are controlled by a multiple selector valve assembly 17 (Figs. 1 and 4) mounted on the table, the individual valves of which are connected for selective operation to a control tower 22 (Fig. 6) also mounted on the table and movable therewith. The extending and retracting cylinder 20 as shown in Fig. 6 is made fast to the ladder and is movable in elevation and depression therewith. The table is supported for rotation on the chassis of the motor vehicle which is of customary construction having spaced parallel beams 24 (Fig. 5) running lengthwise of the vehicle, the beams being joined at their ends to form a rigid substantial rectangular frame. A frame 26 consisting of channel beams is made fast to the chassis beams 24 and forms a support for a ring 28 which is made fast thereto. The ring 28 has a series of teeth 30 (Figs. 5 and 7) formed in its peripheral surface for a purpose which will appear hereinafter and an inwardly projecting shoulder 32. A ring 34 is made fast to the underside of the table and has cut in its lower side right angle grooves. A corresponding ring 36 having a similar groove is bolted to the ring 34 and in combination with the ring provides an annular channel for receiving the lip 32. Ball bearings 40 are interposed between the shoulder 32 and the upper and lower rings 34 and 36 so that the table will turn freely.

The hydraulic pump 12 (Figs. 1, 4 and 5) which supplies fluid under pressure to the various operating elements on the table is located at the geometric center of the table so that its shaft 42 projects downwardly through the table. The shaft 42 is connected by a coupling 44 to a vertical shaft 46 also at the center of rotation of the table and this in turn is coupled by a sleeve 48 to a shaft 50 extending vertically upward from a gear box 52

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bolted to the underside of the frame 26 and which includes meshing gears not shown for changing rotational movement about a horizontal axis to rotational movement about a vertical axis, for example by way of a pinion and ring gear. Power is supplied to the gear box 52 by an articulated shaft 54 and clutch 56 to a gear 58 which in turn meshes with a take off gear on the motor shaft. Thus by a direct drive vertically through the center of rotation of the table the fluid pump 12 may be driven regardless of the rotation of the table and without the necessity of having fluid conduits extending up through the table which require packing. This construction simplifies manufacture because it eliminates the large differentials customarily employed which take up a great deal of space and are costly. Moreover, it eliminates the danger of failure of hydraulic pressure since there are no connections running between a stationary part of the apparatus and the hydraulic system located on the turntable. No leakage of high pressure fluid will therefore go unnoticed by the operator, the entire hydraulic system and connections being located on the top of the table where they can be readily seen.

The fluid supplied under pressure by the pump 12 to the various operating parts is drawn from a reservoir 60 (Figs. 4 and 5) located at the underside of the table within the rings 34 and 36 and may be doughnut-shaped so as to surround the shaft 46. The reservoir is made fast to the table so that it turns with it, thus eliminating any fluid connection between the chassis and table. Referring to Fig. 4, the reservoir 60 is shown as connected by a conduit 62 to the pump 12 so that the latter draws fluid from it and supplies it by way of a three-way coupling 64 and conduit 66 to the multiple selector valve 17. The valve 17 is of the spool type and has a core through which is a central passage through which oil furnished by the pump flows and is returned by way of a conduit 70 to the reservoir. In the event that all the valves are in neutral position fluid supplied by the pump 12 flows through the central passage of the selector valve directly to the reservoir. Sometimes during operations when one of the valve elements is open so as to divert fluid to one or the other of the operating elements excessive pressure may build up due to some interference of movement of parts and to avoid damage the relief valve 72 is provided which connects the three-way coupling 64 directly to the return by-pass conduit 74. Thus, when the pressure exceeds the setting of the relief valve 72 the fluid delivered by the pump 12 is allowed to by-pass the selector valve and to return to the reservoir directly through the conduit 74. The multiple selector valve 17 consists of a spool type core and valve elements 76, 77 and 78 contained in the housing 68, the valve elements being independently operable by levers 82, 84 and 86 respectively, the latter being operable from a control tower 22 shown in Fig. 6 which has on it hand levers correspondingly numbered. Rotation of the table is effected by throwing the control lever 86 forwardly or rearwardly to produce rotation in one direction or the other. Forward rotation of the lever 86 (Fig. 2) diverts fluid from the valve core 68 through the valve element 86 to a conduit 88 which is connected to one side of the hydraulic motor 14. A check valve 90 is interposed in this line. The hydraulic motor in turn is connected by a shaft 92 to the gear reduction unit 16. Movement of the control lever 86 in the opposite direction diverts fluid from the core 68 through the valve element 86 to a conduit 96 and this in turn admits the fluid to the opposite side of the motor 14 by way of a check valve 98; thus it is evident that the motor 14 may be driven in either direction depending upon the position of the control lever 86 or may be held inoperative by placing the lever 86 in a neutral position. The return fluid in either case is conducted back from the reservoir by way of the conduit 70.

Rotation of the table by way of the motor 14 and

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gear reduction unit 16 is effected as follows. The gear reduction unit 16 comprises a housing 94 (Figs. 7 and 8) containing reduction gearing not shown which connects the horizontally arranged shaft 92 entering the housing to a vertically arranged shaft 104 projecting from the bottom thereof through the table. The gear reduction unit is made fast to the table top by bolts 102 extending through a flange formed integral with the base of the unit. The shaft 104 is journaled in a sleeve 106 at the bottom of the unit which contains a suitable anti-friction bushing. The shaft 104 drives the table as follows. On the lower end of the shaft extended downwardly through a hole in the table there is made fast by means of a key a gear 110. A rigid gear housing 112 is bolted to the underside of the table to house this gear and others as will be described. Access may be had to the housing through a cover C bolted over an opening in its bottom. A bearing sleeve 114 is formed integral with the housing. The axis of the sleeve is vertical so as to be parallel to the shaft 104 and is lined with the bushing 116. The lower end of the shaft 118 is journaled in the sleeve and its upper end is journaled in a bearing sleeve 122 lined with a bushing 124 which in turn is made fast to the bottom of the gear reduction unit. The shaft is held in the journal for rotation by caps 126 and 128 fastened to its opposite end by bolts 130 and 132, the caps overlying the ends of the bearing sleeves. The shaft 118 is keyed to the gear 134 which meshes with the gear 110 and is rotated thereby so as to effect rotation of the shaft 118. Also on the shaft 118 there is mounted a gear 136 which alternately may be made fast to the shaft so as to turn with it or allowed to turn freely on the shaft. The gear 136 is located directly below the gear 134. The underside of the gear 136 has a pair of diametrically arranged teeth 138 which may be interengaged with diametrically arranged slots formed in the upper surface of a collar 140 splined on the shaft 118 so as to rotate therewith but free to move longitudinally thereof. The collar has an annular groove 142 therein in which projects a pin 144 carried by a lever arm 146, the latter being fast to a horizontally arranged shaft 148 projecting through the wall of the housing which may be rotated by suitable means to raise or lower the collar 140 on the shaft and hence to engage or disengage the teeth 138 with the grooves in the collar and as a result to lock the gear 136 to the shaft for rotation therewith or to permit it to rotate freely on the shaft. A stub shaft 150 is also made fast in a vertical position to the housing 112 and to this stub shaft there is fastened a gear 152 which meshes with the gear 136 and will be driven thereby when the gear 136 is locked to the shaft 118. An opening 154 is formed in one side of the housing 112 through which an arcuate portion of the gear 152 projects and meshes with the teeth 30 on the member 28 which as heretofore described and as shown in Fig. 5 is fast to the chassis. Rotation of the gear 152 will therefore cause it to travel about the periphery of the member 28 and hence turn the table about its vertical axis.

Thus it is evident that by throwing the control lever 86 in one direction or the other the table may be rotated in one direction or the other and by placing it in neutral the table may be locked in any given position.

Elevation and depression of the ladders which as shown in Figs. 1 and 6 are pivotally mounted at their lower ends on the table and as heretofore pointed out is effected by a pair of hydraulic cylinders 18. As previously described fluid under pressure is delivered by the pump 12 to the selector valve spool 68 and if it is desirable to raise the ladders to an elevated position the control lever 82 (Fig. 3) is thrown forward to divert fluid from the spool to the valve element 76 and hence to admit fluid under pressure to a conduit 156. The conduit 156 is connected by a shut-off valve 158 to branch conduits 160 and 162, these latter extending to the lower ends of the cylinders 18 by way of check valves 164 and 166. As the fluid

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under pressure is admitted to the lower end of these cylinders the pistons therein are raised and fluid at the opposite ends of the cylinders is forced out through conduits 168 and 170 which are connected by way of a check valve 172 to a return conduit 174 which returns the fluid to the spool 68 and thence through the return duct 70 to the reservoir 60. By shifting the lever 82 in the opposite direction the fluid takes an opposite course, that is it passes through the conduit 174, valve 172, branch passages 168 and 170 to the top end of the piston forcing them downwardly while the fluid beneath the piston is forced out through the check valves 164 and 166, branch passages 160 and 162, valve 158 and passage 156 to the valve housing and from thence through the return duct 70 to the reservoir. It is to be noted that the check valves 164 and 166 installed at the lower end of the cylinders automatically prevent the fluid from being pushed out of the cylinders at an excessive rate so that it is impossible for the ladder as it is being depressed to fall rapidly enough to damage it. Moreover, if any of the hydraulic conduits should be broken or otherwise rendered non-conductive of the fluid the ladder will not fall but will descend at a safe rate. The check valves are, as a matter of fact, adjustable so as to meter the fluid in a predetermined rate and this is usually set so as to give a good factor of safety. As thus provided the ladder may be returned to its horizontal position by gravity the rate of descent being controlled solely by the check valves without the use of power. When it is desirable to keep the ladder elevated for any length of time the shut-off valve 158 may be closed so as to hold the fluid pressure in the cylinder. The same result may be had by putting the lever 82 in neutral position, but this has the disadvantage of depending upon the fluid pressure in the system.

Extension and retraction in the ladder sections of which there are three is effected by a cylinder 20 (Figs. 4 and 6) and control of the delivery of the hydraulic fluid to the cylinder is effected by the lever 84. Referring to the diagram Fig. 4, movement of the lever 84 in one direction will divert fluid from the spool through the valve element 77 and conduit 176 to the lower end of the cylinder 20 so as to raise the piston therein. The fluid at the upper side of the piston is simultaneously exhausted through the conduit 184 and returns through the valve spool 168 and thence by way of return conduit 70 to the reservoir. Check valves 178 and 182 are interposed in the lines 176 and 184 so as to prevent too rapid extension or retraction of the sections. A shut-off valve 180 is also interposed in the line 176 so that the ladder sections may be locked in their extended positions rather than to depend upon the fluid pressure in the system when the lever is in neutral position. By throwing the lever 84 in the opposite direction fluid is delivered to the conduit 184 to the top side of the piston to force it downwardly and the fluid beneath it is exhausted through the conduit 176, returns to the selector valve and thence through the return conduit 70 to the reservoir.

As thus constructed it is evident that the entire hydraulic system including the pump, motor, valves, conduits and operating cylinders are all mounted as a compact unit on the top of the table and rotatable therewith so that there is no need for rotatable connections in any of the hydraulic lines which are a source of leakage, wear and frequent replacement because of the high pressures employed. The entire system is driven directly from the apparatus motor by a simple take off as described above in the form of a vertical shaft extending through the center of rotation of the table. Moreover, the system is controlled and interlocked by shut-off and check valves so that the parts cannot be damaged by admission of hydraulic fluid too fast through inexperience or careless operators. In fact, the control valves are so set that even if the levers are thrown to their full

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extent the hydraulic fluid is metered to the operating parts at a rate which is consistent with proper operation. Moreover, should the table become blocked to rotation of the ladder to elevation or extension so that an excessive pressure builds up the relief valves 72 will permit fluid to by-pass the selector valve and return to the reservoir without damage to the operating parts.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. In a fire apparatus a chassis, a power plant mounted thereon, a turntable, means supporting the turntable on the chassis for rotation thereon, said means having supporting contact with the table intermediate its center and its perimeter and said table having a central hole therein affording a clear unobstructed passage from its underside to its top side, hydraulically operated means for effecting rotation of the table in either direction, said hydraulically operated means including means operable upon a part of the table spaced radially of the center hole therein, a source of fluid pressure fast to the underside of the table, a pump for supplying fluid under pressure from said source to said hydraulically operated means, said pump being fastened to the table at its center of rotation over the hole of the table with its shaft extending down through the hole, a selector valve interposed between the pump and said hydraulically operated means for controlling the passage of the hydraulic fluid to said hydraulically operated means, said valve being operable to admit fluid to one side or the other of said hydraulically operated means, said foregoing instrumentalities being located solely on the top of the table and movable therewith in rotation so that there are no fluid connections between the chassis and table and a mechanical coupling connecting the lower end of the pump shaft to the power plant beneath the table.

2. A fire apparatus according to claim 1 wherein the table is supported by an annular bearing concentric with the center of rotation of the table, a ring gear is fast to the chassis concentric with the axis of rotation of the table, the hydraulically operated means includes a motor, motor shaft and gear train driven thereby, one gear in the train meshing with the ring gear and a clutch is interposed in the gear train for alternately making one of the gears fast or loose on its shaft in said train.

3. A fire apparatus according to claim 1 wherein a ring gear is fast to the chassis, a pinion is mounted on the table and meshes with the ring gear, and the hydraulic motor effects rotation of the pinion so as to travel around the ring gear.

4. A fire apparatus according to claim 1 wherein a ring gear is fast to the chassis, a pinion gear is mounted on the table so as to mesh with the ring gear and to travel thereabout upon rotation of the table and a gear reduction unit including a train of gears transmits power from the motor to the pinion.

5. A fire apparatus according to claim 1 wherein a ring gear is fast to the chassis, a pinion gear is mounted on the table so as to mesh with the ring gear and to travel thereabout upon rotation of the table, a gear train is interposed between the motor and pinion, the first gear in the train deriving rotation from the motor and the last gear in the train meshing with the pinion and means is interposed in the gear train for interrupting transmission of rotation through the gear train to the pinion.

6. A fire apparatus according to claim 1 wherein the pump shaft extends downwardly directly through the hole at the center of the table, a horizontal shaft is journaled on the chassis beneath the table and has a forward end of it connected to a take-off from the power plant by way of a clutch and a converter is mounted on the chassis beneath the table connecting the rear end of the horizontal shaft to the lower end of the vertical

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shaft for converting the horizontal rotation of the former to vertical rotation of the latter.

7. A fire apparatus according to claim 1 wherein a ring is fastened in a horizontal position to the chassis, said ring having a shoulder at its inner side and teeth at its outer side, a ring is fastened to the table having a groove at its outer side within which is seated the shoulder on the first named ring, antifriction means is interposed between the shoulder and the groove within which it is seated, a gear is mounted on the table and movable within the table about its center of rotation, said last named gear being in mesh with the teeth on said first ring and means connects said last named gear to the hydraulic means on the table for effecting rotation thereof.

8. A fire apparatus according to claim 1 wherein the hydraulically operated means is a hydraulic motor, conduits connect opposite sides of the motor to the selector valve whereupon shifting the valve in one direction admits fluid to one side of the motor and shifting the valve in the opposite direction admits fluid to the opposite side of the motor.

9. A fire apparatus according to claim 1 wherein there is an extension ladder pivotally mounted on the turntable for elevation and depression, a pair of hydraulic cylinders connected to the ladder, a system of fluid conduits connecting the pump to the cylinders including a selector valve, means for shifting the selector valve in opposite directions to admit fluid to one or the other and simultaneously to exhaust fluid from the other or one of the ends of the cylinders to elevate or depress the ladder, metering valves located in the lower ends of said pair

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of cylinders, limiting the discharge of fluid from their lower ends to a predetermined rate, and a shut-off valve in the discharge conduit operable to cut off return flow of the fluid and hence to lock the ladder in elevated position.

10. A fire apparatus according to claim 1 wherein there is an extension ladder pivotally mounted on the turntable for elevation and depression, a hydraulic cylinder for extending and retracting the ladder sections, a system of fluid conduits connecting the pump to the hydraulic cylinder including a valve, means for alternately shifting the valve in opposite directions to admit fluid to one or the other and simultaneously exhausting fluid from the other or one end of the ends of the cylinder to extend or retract the ladder sections, and a metering valve interposed in the lower end of said hydraulic cylinder to limit discharge of the fluid therefrom at a predetermined rate.

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