July 2, 1968 W. J. LADO ETAL 3,390,785

CRANE WITH TWIN MOTOR WINCH

Filed April 18, 1966 2 Sheets-Sheet 1

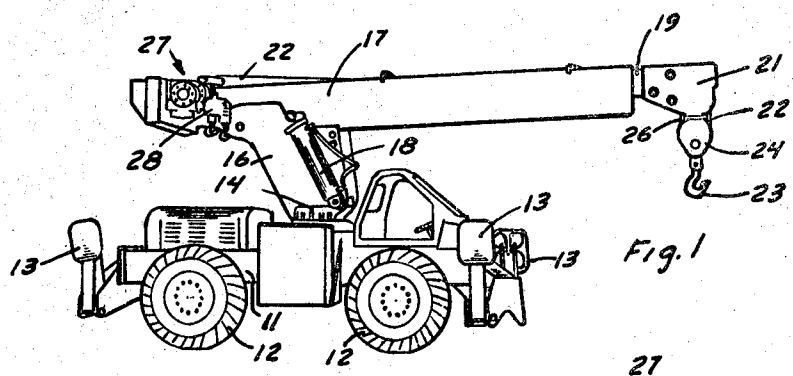


Fig. 1

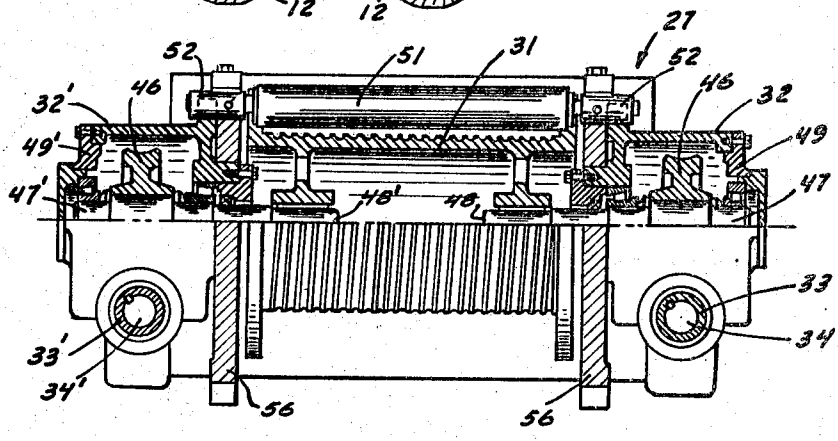


Fig. 2

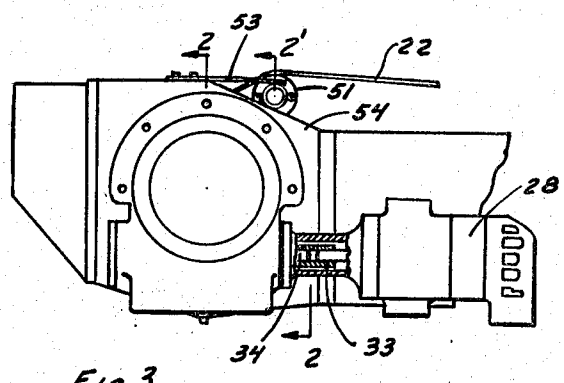


Fig. 3

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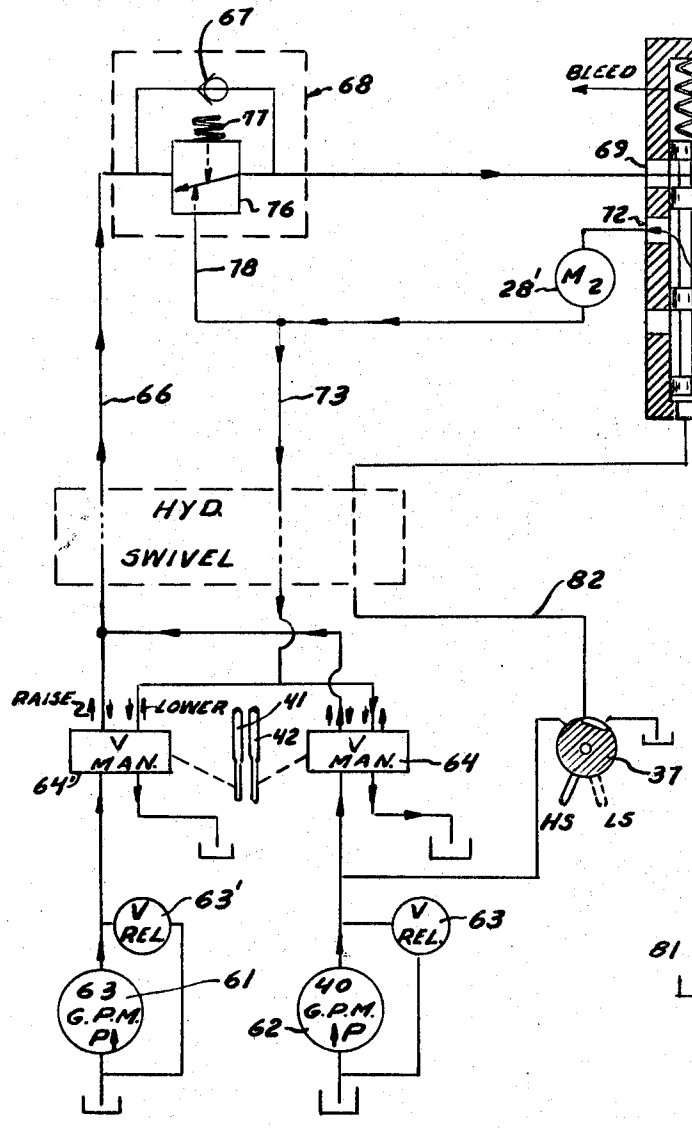


Fig. 4

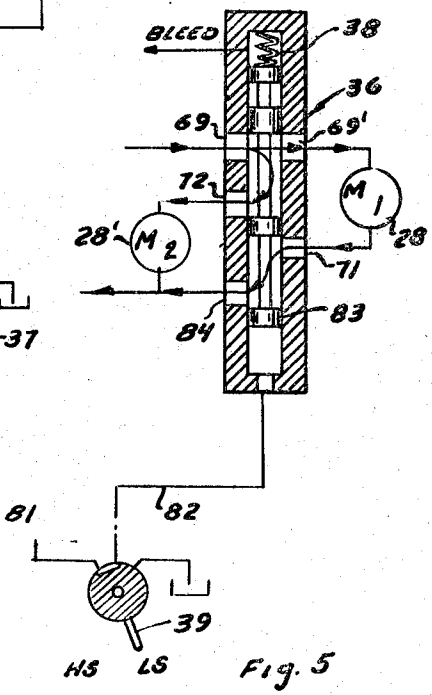


Fig. 5

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CRANE WITH TWIN MOTOR WINCH

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ABSTRACT OF THE DISCLOSURE

A crane winch is driven through two identical hydraulic motors, one at each end of the winch shaft. Each drives the shaft through a worm gear. The motors can be connected hydraulically in series or in parallel to provide two winch speeds and two winch torques. If the hydraulic source includes two pumps of different capacities and separate control valves, the number of speeds with constant pump speed is increased to six.

This application, the disclosure of which is offered for public dissemination in the event that adequate patent protection can be granted, relates to hydraulic cranes, and particularly to twin hydraulic winches on such cranes.

Although some cranes may have uniform loads time after time, mobile cranes tend to be used for a very wide variety of loads. A mobile crane rated at 15 tons of lifting capacity may only rarely have to lift anything that heavy. The rest of the time, its load may vary all of the way down to 100 pounds, or even ten. However, the motor means for driving its winch must be capable of exerting on the line the force necessary for raising the rated load. In the past, the practical ways of achieving the needed force or winch-torque with hydraulic winches have meant that the line speed must be rather low.

Of course, it has been possible to accomplish some adapting of the equipment by using "multipart hooks" which included block and tackle arrangements so that the load might weigh for example six times the line tension. However, a six part line reduces the load speed to one sixth of the line speed, and conversion to provide full line speed is not easy enough to justify the change every time the load weight changes.

One crane manufacturer has provided three line speeds by using two pumps of different capacity each controlled by a separate valve, with the maximum winch speed being attained by opening both valves. However, utilization of the slowest of the three speeds was not accompanied by any increase of line tension, because with all three speeds a maximum line tension was determined by the same maximum hydraulic pressure. Likewise, reducing the speeds still further by merely cracking open the valve does not add any line tension. There has long been a recognized need for the ability to increase the line tension beyond that at which it would be operating the great majority of the time. A speed reduction with the increased line tension is tolerable and often desirable.

To increase the line tension by providing even larger hydraulic motors or by further gear reduction between the motors and the winches, and correspondingly increased pump sizes to maintain speed for light loads was a recognized possibility but not a satisfactory solution of the problem because of the great cost of such equipment, the space it would require, and the power loss represented by pumping for lighter loads the same oil which would have been required for maximum loads.

According to the present invention one step in the solution of the problem is in providing two hydraulic winch motors, each of which may be identical to the single

motors used heretofore (and which are therefore readily available without having to pay premium or custom made prices). The full solution includes, also, providing for the two hydraulic motors (which are mounted at opposite ends of the winch shaft) a hydraulic system that permits connecting the two motors hydraulically in series or hydraulically in parallel. With series connection, the winch will function in the same manner as heretofore with one hydraulic motor of the same size as one of the twin motors now provided. But for the exceptionally heavy loads, a shift of the valve to produce parallel connection will not only reduce all of the speeds to half their previous speeds, but will double the winch-torque, or the available line tension.

Nearly all of the parts would be identical to parts already made and stocked (both for manufacture and for repair) for cranes with the present single winch motors.

Additional objects and advantages will be apparent from the following description and from the drawings.

Designation of figures

FIGURE 1 is a perspective view of a hydraulic crane for which the present invention is highly suitable;

FIGURE 2 is a transverse view partly broken back to an axial section of the winch. It is basically on the line 2—2 of FIGURE 3, but a portion thereof is on the line 2'—2' of FIGURE 3;

FIGURE 3 is a side view of the structure shown in FIGURES 1 and 2;

FIGURE 4 is a hydraulic diagram of the preferred embodiment, and

FIGURE 5 is a fragmentary view similar to part of FIG. 4, but showing the two motors connected in parallel, as distinguished from the series connection of FIG. 4.

General description

Although the following disclosure offered for public dissemination is detailed to ensure adequacy and aid understanding, this is not intended to prejudice that purpose of a patent which is to cover each new inventive concept therein no matter how others may later disguise it by variations in form or additions or further improvements. The claims at the end hereof are intended as the chief aid toward this purpose; as it is these that meet the requirement of pointing out the parts, improvements, or combinations in which the inventive concepts are found.

Although the present invention is largely independent of the form of crane on which it is used, it perhaps finds its greatest utility in connection with heavy duty mobile cranes, such as shown in FIGURE 1. Such a crane may be provided with a chasis **11** running on tires **12**. Preferably there are outrigger feet **13** which can be hydraulically lowered to provide firm and widespread support for heavy duty crane operations. A turntable carries a pedestal **16** to which a main boom or "shipper" **17** is pivoted, to be raised and lowered by hydraulic control of a pair of cylinders **18** of which one is shown. One or more boom extensions **19** may be provided and they can preferably be hydraulically extended to provide a desired boom height when the boom is elevated. A boom head **21** is provided with a sheave, not shown, from which a cable **22** extends downwardly to a hook **23**. In the illustrated form, the hook **23** is carried by a block **24** and hence there would be a multipart line, an additional part being the upwardly extending run **26**. The cable **22** extends rearwardly from its sheave to a winch assembly **27** which is driven through worm gear assembly **32**, by a hydraulic motor **28** to pay out or draw in the cable.

According to the present invention, the drum **31** of the winch is provided with two hydraulic motors **28** and **28'**

(FIG. 4). FIGURE 2 shows the two worm gear assemblies 32 and 32' which would be driven by the two motors, and each of which is coupled to one end of the winch drum. In a sense, each motor is represented in FIG. 2 by the coupler 33 or 33' which couples the hydraulic motor to the respective worn shaft 34 or 34'.

As seen in FIGURE 4 and FIGURE 5, the two motors 28 and 28' are connected in series, with the FIGURE 4 position of a series-parallel valve 36; and in parallel, with the FIGURE 5 position of the same valve 36. Although this valve may be controlled by direct manual operation, there are many situations in which it should be remotely controlled. In such instances, it may be controlled hydraulically by a manual valve 37. In one position, the valve 37 can connect pressure oil to one end of the valve 36 to shift its spool 83 as seen in FIGURE 5, while in the other position it can connect the same end of the valve to drain (back to the reservoir) so that the spool will be pressed to the FIGURE 4 position by a spring 38. The valve 37 may have a handle 39. Regardless of the position in which the valve 37 has been placed, the raising and lowering operations will be controlled by valve levers 41 and 42. These are preferably accessible from the driver's seat of the vehicle, and when either or both are pulled rearwardly, the winch will be driven in a direction to raise the load. When either or both of the handles or valve levers 41, 42 is pushed forwardly from a neutral position, the winch will be driven in a direction to lower the load. With the handles in neutral position, the winch motors will be hydraulically locked and the load will be safely held.

Winch construction

In many respects the winch is identical with hydraulic winches which have been used heretofore. In fact, the hydraulic motor 28 and the worm gear assembly 32, as well as their connecting portions, are preferably identical with those which have been used heretofore when the drum 31 was driven by a single hydraulic motor. Thus the worm on worm shaft 34 has heretofore driven a worm wheel 46 which drove a shaft 47 by which at least one end of the drum 31 was carried, and the drum driven. All of the drive structure is now substantially duplicated at the opposite end of the drum 31. So far as possible, the parts are identical, to provide a minimum number of manufacturing and replacement parts.

Instead of having one shaft extend through the drum 31, the shafts 47 and 47' have their respective ends 48 and 48' projecting into the drum from opposite ends thereof, each being splined or keyed to the drum. With the gear housing covers 49 and 49' removed, and with the worm shafts removed, the assembly at each end can be removed. Thus, the shaft 47, together with its bearings, and worn wheel 46 may all be slipped out axially. When the same thing is done at the other end, the drum may be inserted or removed.

There is preferably provided a guide roller 51 for the cable as heretofore. It runs in bearing housings 52, which are preferably carried by leaf springs 53, and rest on surfaces 54 of the side plates 56 of the winch drum housing. This mounting permits the roller to yield upwardly if the winding of the cable on the drum should so require.

Hydraulic circuit

The preferred form of circuit is shown in FIGURE 4. Two pumps 61 and 62, having different pumping capacities, but pumping at the same pressure, are both driven by the engine of the crane vehicle. Each is provided with a relief valve 63, the settings of which will be the same. Each is provided with a manual valve 64 or 64', the valve 64 being controlled by the handle 41 and the valve 64' being controlled by the handle 42. If either or both valves are operated in the lift direction, pressure oil drawn by pump 61 or pump 62, or both, from the reservoir will be supplied through line 66 to the winch motors 28 and 28'.

From the line 66 it will reach these winch motors by flowing freely through a check valve portion 67 of an anti-cavitation valve assembly 68, and thence to valve 36. With valve 36 in the FIGURE 4 or series position, the oil will flow through ports 69 and 69' to motor 28, and after driving the motor 28 will flow through ports 71 and 72 to motor 28' from which it will return by line 73 to valves 64, 64' and from each of these that has been actuated to the reservoir. For lowering, one or both of the handles 41, 42 will be drawn rearwardly shifting the cores of valves 64, 64' in the opposite direction from their mid-position, and oil will be supplied through line 73 following exactly the reverse course of that just described, except in the anticaviation valve 68. Here the check valve 67 prevents flow through it of the oil in the load-lowering direction. Pilot valve section 76, when at rest, is biased by spring 77 to a position at which it prevents any flow of oil through this section of the valve. However, when pressure oil is supplied to line 73, a connection 78 carries this oil to the pilot aperature of pilot valve 76 where it overcomes the strength of spring 77 and shifts this valve to open it to the flow of oil through this section of the valve, whereupon the oil can flow from the hydraulic motors 28 and 28' through pilot valve 76 and line 66 and valves 64, 64' to the reservoir.

With the valves 64, 64' in their mid or neutral or locked position, the motors 28, 28' can not turn. The weight of the load is unable to cause the motors to turn or even to keep on turning if they had been turning in a load-lowering direction because as soon as pressure oil ceases to be supplied to connection 78, spring 77 shifts the pilot-actuated valve 76 to its closed position.

If an exceptionally heavy load is to be raised so that double the force is desired, or if for some other reason, only half of the lowest speed is desired, the hydraulic actuation is the same except for the changes indicated in FIGURE 5. In this figure, valve handle 39 has been turned to the low-speed position connecting oil pressure line 81 with line 82 to the end or pilot port of series-parallel valve 36 forcing its spool 83 to the position shown in FIGURE 5, thereby compressing spring 38. With the spool 83 in this position, oil entering port 69 can flow both to port 69' (through motor 28) and to port 72 (through motor 28'). The oil returning to valve 36 from motor 28 still enters valve 36 at port 71, but now flows out through port 84 directly to return line 73.

When the extra line tension or extra slow speed is no longer desired, handle 39 is shifted to the high-speed position and valve 37, as seen in FIGURE 4, connects line 82 to the reservoir to permit oil to flow out from the pilot aperture of valve 36 under the influence of spring 38, which shifts the spool 83 to the position shown in FIGURE 4.

Six speeds available

With this arrangement, six line speeds are available with fully open valves. Half of these speeds have double torque. The speeds available are related to each other as follows, the speeds underlined being at double torque: 2; 3; 4; 5; 6 and 10.

It may be a little surprising that with both hydraulic motors working on the drum all of the time, there is any more torque available with parallel connection than with series connection. The reason is that the oil cannot exert the force represented by its maximum pressure on both of the motors when they are connected in series, but it can when they are connected in parallel. When they are connected in series, if the full hydraulic force is utilized on turning the first motor, to which the oil is supplied, there will be none left for turning the second motor. As a matter of fact, the two motors will inherently accomplish automatic distribution of their use of oil pressure so that there will necessarily be at least enough pressure supplied to the second motor to keep it turning. If the first motor does substantially all of the work during

the series connected condition, the action and the wear will be substantially the same as if only one motor were provided. There may, however, be some tendency for the two motors to share the load, in which case the parts will work at about half the frictional contact pressure as would be present if only one motor were provided, and hence the wear may be greatly reduced.

Although six speeds can be made available as noted, economy may dictate using a single main manual control valve. The two speeds then provided by the present invention (and the ability to increase winch tongue for exceptionally heavy loads) will be a tremendous improvement over the single speed by which most hydraulic cranes have been characterized.

We claim:

1. A mobile crane including a powered mobile chassis, and hydraulic crane mechanism thereon having a boom swingable about a vertical axis and liftable about a horizontal axis, and hydraulic winch means associated with the boom, and including a drum, a line wound on said drum and extending down from the boom for raising a load when drawn in by said winch;

said winch including a pair of separate substantially identical hydraulic winch motors connected by substantially identical worm drive assemblies in driving relationship to said drum, said hydraulic motors being substantially identical to one another;

and a hydraulic circuit for driving said hydraulic winch motors including a reservoir, relief-valved pump means drawing fluid from the reservoir, a return line discharging to the reservoir and winch powering lines leading to ports on the winch motors, and manually controlled valve means for connecting the pump means and return line to said powering lines in either direction and for closing them against flow, a series-parallel valve for at will connecting said two hydraulic motors in series or in parallel in their connection to said powering lines when increased torque or reduced open-valve speed is desired.

2. A hydraulic crane having a boom liftable about a horizontal axis, and hydraulic winch means associated with the boom, and including a drum, a line wound on said drum and extending down from the boom for raising a load when drawn in by said winch;

said winch including a pair of separate substantially identical hydraulic winch motors connected by substantially identical worm drive assemblies in driving relationship to said drum, said hydraulic motors being substantially identical to one another;

and a hydraulic circuit for driving said hydraulic winch motors including a reservoir, relief-valved pump means drawing fluid from the reservoir, a return line discharging to the reservoir and winch powering lines leading to ports on the winch motors, and manually controlled valve means for connecting the pump means and return line to said powering lines in either direction and for closing them against flow, a series-parallel valve for at will connecting said two hydraulic motors in series or in parallel in their connection to said powering lines when increased torque or reduced open-valve speed is desired.

3. A hydraulic crane according to claim 2, in which the pump means is a pair of different capacity pumps, and the manually controlled valve means includes a pair of valves each connected to one of the pumps, these valves being operable at will singly or jointly to provide three hydraulic flow rates, in turn providing six winch speeds at two different winch torques upon selective operation of the series-parallel valve.

4. A mobile crane including a powered mobile chassis, and hydraulic crane mechanism thereon having a boom swingable about a vertical axis and liftable about a horizontal axis, and hydraulic winch means associated with the boom, and including a drum, a line wound on said drum and extending down from the boom for raising a load when drawn in by said winch;

said winch including a pair of separate substantially identical hydraulic winch motors connected by substantially identical worm drive assemblies in driving relationship to said drum, said hydraulic motors being substantially identical to one another;

and a hydraulic circuit for driving said hydraulic winch motors including a reservoir, pump means drawing fluid from the reservoir, a return line discharging to the reservoir and winch powering lines leading to ports on the winch motors, and manually controlled valve means for connecting the pump means and return line to said powering lines in either direction and for closing them against flow, a series-parallel valve for at will connecting said two hydraulic motors in series or in parallel in their connection to said powering lines when increased torque or reduced open-valve speed is desired; said circuit including an anticavitation valve means for preventing flow from said motors in the load lowering direction except when there is a positive fluid pressure connected to rotate them in that direction; the pump means including a pair of different capacity pumps, and the manually controlled valve means including a pair of valves each connected to one of the pumps, these valves being operable at will singly or jointly to provide three hydraulic flow rates, in turn providing six winch speeds at two different winch torques upon selective operation of the series-parallel valve.

5. A hydraulic crane having a boom liftable about a horizontal axis, and hydraulic winch means associated with the boom, and including a drum, a line wound on said drum and extending down from the boom for raising a load when drawn in by said winch;

said winch including a pair of separate substantially identical hydraulic winch motors connected by substantially identical worm drive assemblies in driving relationship to said drum, said hydraulic motors being substantially identical to one another;

and a hydraulic circuit for driving said hydraulic winch motors including a reservoir, relief-valved pump means drawing fluid from the reservoir, a return line discharging to the reservoir and winch powering lines leading to ports on the winch motors, and manually controlled valve means for connecting the pump means and return line to said powering lines in either direction and for closing them against flow, a series-parallel valve for at will connecting said two hydraulic motors in series or in parallel in their connection to said powering lines when increased torque or reduced open-valve speed is desired; said circuit including an anticavitation valve means for preventing flow from said motors in the load lowering direction except when there is a positive fluid pressure connected to rotate them in that direction; the pump means including a pair of different capacity pumps, and the manually controlled valve means including a pair of valves each connected to one of the pumps, these valves being operable at will singly or jointly to provide three hydraulic flow rates, in turn providing six winch speeds at two different winch torques upon selective operation of the series-parallel valve.

6. A hydraulic crane having a boom liftable about a horizontal axis, and hydraulic winch means associated with the boom, and including a drum, a line wound on said drum and extending down from the boom for raising a load when drawn in by said winch;

said winch including a pair of separate substantially identical hydraulic winch motors connected by substantially identical worm drive assemblies in driving relationship to said drum, said hydraulic motors being substantially identical to one another;

anticavitation valve means for preventing flow from said motors in the load lowering direction except when there is a positive fluid pressure connected to rotate them in that direction;

and a hydraulic circuit for driving said hydraulic winch motors including a reservoir, relief-valved pump means drawing fluid from the reservoir, a return line discharging to the reservoir and winch powering lines leading to ports on the winch motors, and manually controlled valve means for connecting the pump means and return line to said powering lines in either direction and for closing them against flow, a series-parallel valve for at will connecting said two hydraulic motors in series or in parallel in their connection to said powering lines when increased torque or reduced open-valve speed is desired.

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