

July 29, 1969

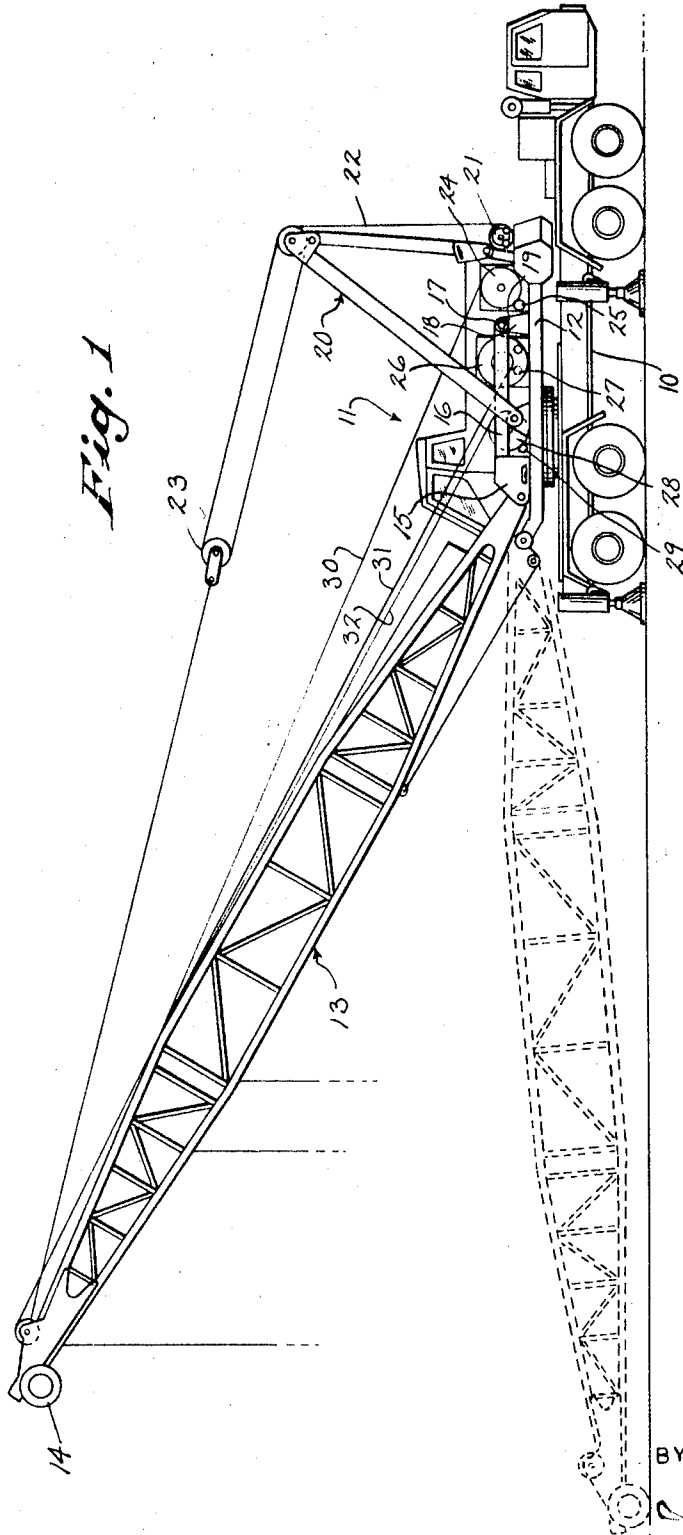
G. REUTER

3,458,053

CABLE CONTROL APPARATUS

Filed Aug. 31, 1967

3 Sheets-Sheet 1



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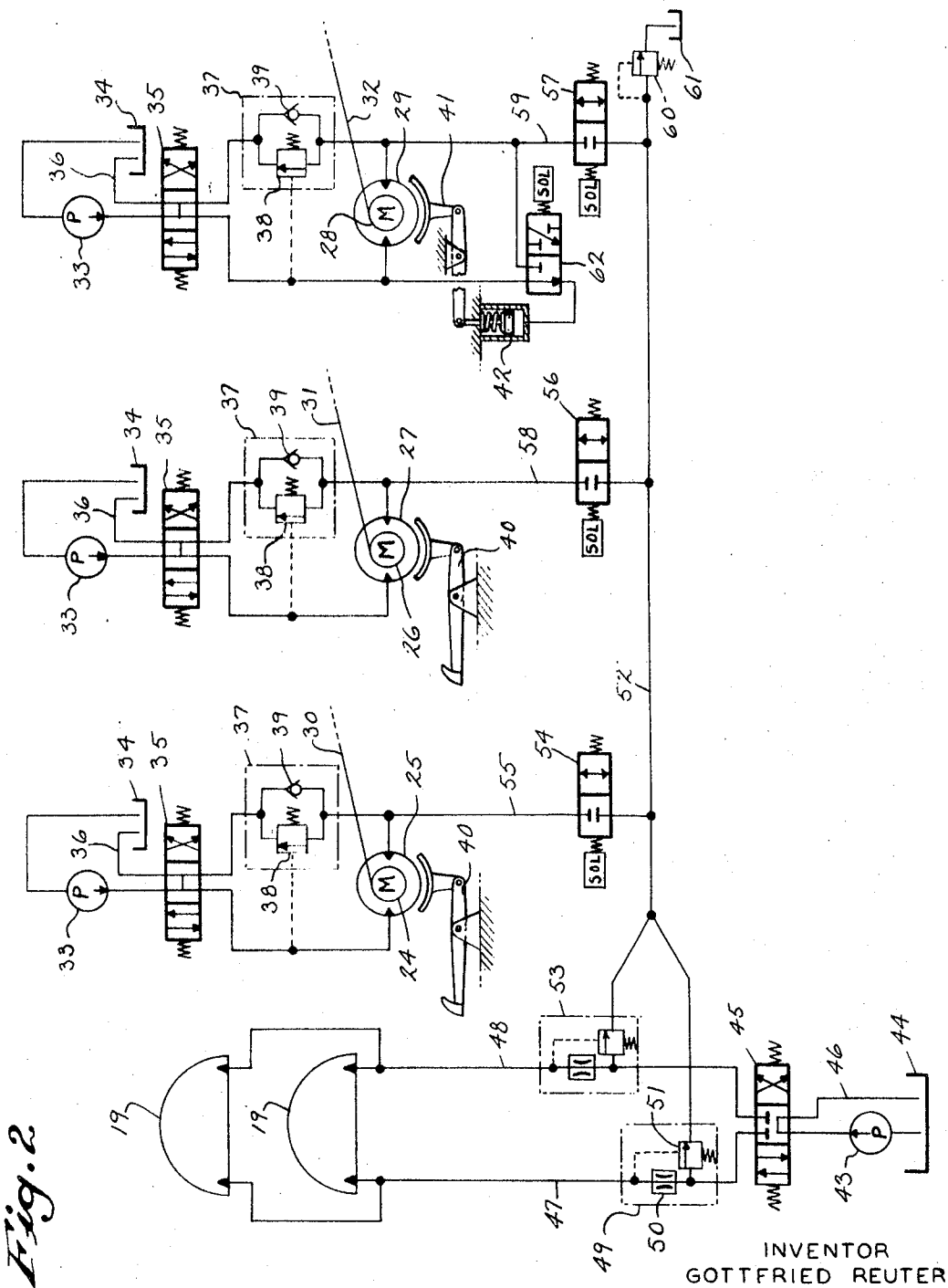
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CABLE CONTROL APPARATUS

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3 Sheets-Sheet 2



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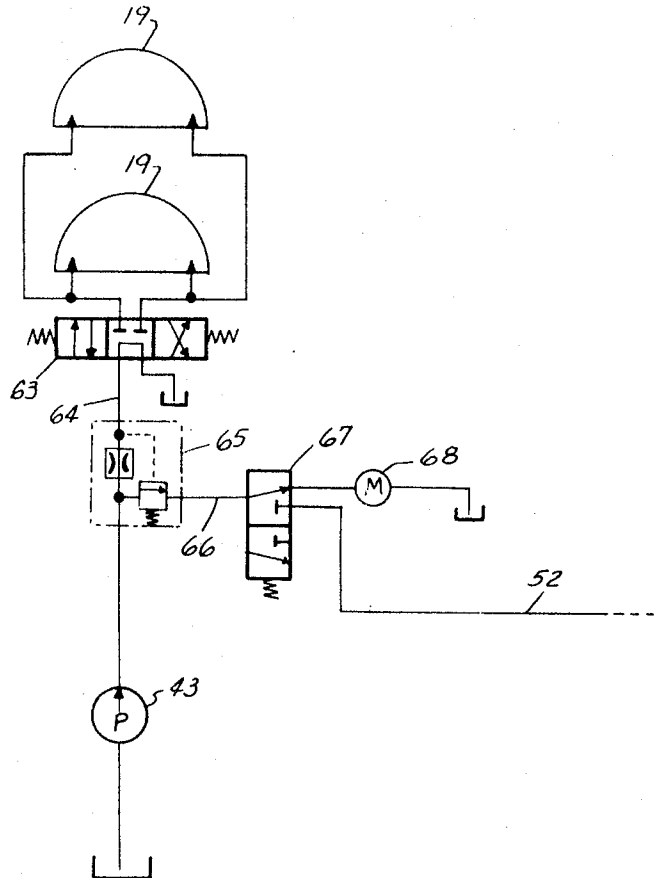
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CABLE CONTROL APPARATUS

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Fig. 3



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3,458,053

CABLE CONTROL APPARATUS

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Int. Cl. B66c 23/62

U.S. Cl. 212-46

7 Claims

ABSTRACT OF THE DISCLOSURE

A crane is shown in which the foot of the boom is shiftable between a working position at the front of the revolving frame to a transport position at the rear of the frame. The boom foot is mounted on the end of conveyor arms and the shift is accomplished by rotating the conveyor arms through an arc. Three hoist cable drums are mounted on the revolving frame and each is driven by reversible hydraulic motors to reel in and pay out hoist cable to hoist and lower loads during normal working of the crane. A control system is shown which operates on the drum motors to keep the hoist cables taut as the boom foot is shifted. The system includes a control line which receives the excess output of a pump for limited rotation motors which rotate the conveyor arms. The control line leads to a pressure relief valve which empties to a reservoir. Working lines are connected between the control line and each drum motor with a normally closed solenoid controlled valve in each working line. The output of the pump is available for boom shifting. The actuation of a control valve which normally blocks the output of the pump makes the fluid output of the pump available for cable drum rotation and automatically energizes the solenoids to open the valves in the working lines. This admits fluid to the drum motors. The motors rotate their respective drums to reel in cable whenever a cable tends to become slack. The pressure relief valve is set sufficiently low that it will merely keep a cable taut and permit cable pay-out at limited cable pull when the distance between the drums and the boom point increases. One of the drums is shown with an automatic brake which is hydraulically disengaged, and a solenoid controlled valve is actuated upon the opening of the boom shift valve to connect the brake to the working line for the motor of such drum.

Background of the invention

This invention relates to a cable control apparatus, and particularly to an apparatus which will maintain a cable taut when their working environment is altered to thereby cause a change in the necessary length of the cable.

It is sometimes necessary to change the effective length of cables used to hoist and lower loads. One example may be found in cranes of the types shown and described in the co-pending application of George W. Mork for "Boom Handling Apparatus," Ser. No. 600,541, filed Dec. 9, 1966, in which the foot of the crane boom is shiftable between a working position at the front of a revolving frame and a transport position at the rear of the revolving frame. Hoist cables are naturally provided for hoisting and lowering loads. Such hoist cables are wound about hoist drums which are secured to the revolving frame. When the boom is to be shifted, these hoist cables are first drawn up tight on the boom. However, as the boom foot is shifted it will be appreciated that the cable path from the respective drum to the boom will change in length. At times during the shifting of the boom foot the cable path will increase in length and at other times it will decrease in length. If the length of the cables remains the same the cables can become hopelessly fouled during

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the shift or provide an undesirable restraining force on the boom.

A need exists for a means to insure that the cables will remain taut as the effective length of the cable changes under the foregoing, and similar, conditions. The apparatus of this invention provides a simple but effective means of accomplishing this function.

Summary of the invention

A cable control apparatus in accordance with this invention comprises a source of hydraulic fluid under pressure, pressure control means, a control line connected between said source and said pressure control means, and a working line leading from said control line, said pressure control means maintaining a back-up pressure in said working line, and said working line being adapted to be connected to the reversible hydraulic motor of a cable drum to direct fluid under pressure to said motor to have said motor rotate said drum to reel in cable when the cable is tending to become slack and to resist the rotation of said drum in an opposite direction to pay out cable until the force on the cable is sufficient to overcome the back-up pressure.

The invention also includes: the provision of a valve normally blocking said working line but opening said working line when a valve is opened to connect said control line to said source; and the provision of means to control a hydraulically actuated brake operable on said drum.

In the specification and accompanying drawings preferred embodiments of the invention are shown and described in such full, clear and concise terms that a person skilled in the art will be taught the manner of making and operating the same. It should be understood, however, that the embodiments shown represent the best modes presently contemplated to practice the invention.

Brief description of the drawings

FIG. 1 is a side view in elevation of a crane on which the invention may be used; FIG. 2 is a diagrammatic view of a hydraulic system for the crane of FIG. 1 which incorporates the invention; and FIG. 3 is a diagrammatic view of a portion of the hydraulic system for the crane and illustrating an alternate embodiment.

Description of the preferred embodiments

The invention is shown applied to controlling the hoist cables on a crane in which the boom foot is moved between a stabilized working position and an over-the-road traveling position. Such a crane is fully disclosed and described in said copending application of George W. Mork, Ser. No. 600,541 to which reference should be had for the details of its construction and operation. Let it suffice for the purposes of this application to generally describe such a crane.

In FIG. 1, there is shown a conventional truck chassis 10 on the rear end of which is mounted a crane 11. A revolving frame 12 is rotatably mounted on the rear end of the truck chassis 10 to support the operating mechanism and super structure of the crane 11. A boom 13 has wheels 14 on its point to support the boom point when the boom is lowered to the ground. The lower end of the boom terminates in a bifurcated boom foot and each bifurcated section of the boom foot is pinned to articulated couplings 15. The other ends of the articulated couplings 15 are fastened on the ends of conveyor arms 16. The opposite ends of the conveyor arms 16 are secured to the ends of a torque tube 17 which is journaled in standards 18 mounted on the revolving frame 12. Hydraulic rotary actuators, or limited rotation motors 19 are connected to rotate the torque tube 17 through about 180°. When the conveyor

arms 16 are in the position illustrated in FIG. 1 with the boom foot in its working position, means are provided to secure the articulated couplings 15 to the revolving frame to stabilize the boom foot.

A lowerable A-frame indicated generally by the reference numeral 20 is mounted toward the back end of the revolving frame 12. A boom hoist drum 21 operated by a hydraulic motor is mounted toward the back of the revolving frame 12 and a boom hoist cable 22 extends from the boom hoist drum up to a multipart suspension bridle 23 which in turn is connected to the boom point. Mounted in line in front of the boom hoist drum 21 are an auxiliary hoist drum 24 driven by hydraulic motors 25, a main hoist drum 26 driven by hydraulic motors 27, and a third hoist drum 28 driven by hydraulic motors 29. Hoist cables 30, 31 and 32 are wound upon the auxiliary hoist drum 24, the main hoist drum 26, and the third hoist drum 28, respectively, and the cables extend to and over sheaves on the boom 13 to support working tools and to hoist and lower loads.

In FIG. 1 the boom 13 is shown in solid lines in its normal working position. To move the boom from its working position to a transport position, the boom hoist drum 21 is first actuated to lower the boom into the position shown in dotted lines in FIG. 1. The hoist cables are then drawn up tight to the boom 13. The articulated couplings 15 are released from their engagement with the revolving frame 12 and the limited rotation motors 19 are energized to begin turning the torque tube 17 in a clockwise direction as viewed in FIG. 1. As the torque tube 17 rotates it rotates the conveyor arms 16 and the boom foot is thus moved through an arc until it reaches the position to the rear of the revolving frame 12. The boom foot is returned to its working position by energizing the limited rotation motors 19 to rotate the torque tube 17 in the opposite direction.

It is obvious that the path of each of the hoist cables 30, 31 and 32 from its respective drum to the boom will change as the boom foot is moved between its working position and its transport position. Accordingly, during part of the shift of the boom foot the cable path will decrease and a cable would become slack. If this is permitted to occur the hoist cables may become hopelessly fouled. During other portions of the shift of the boom foot, the cable path is lengthened and the hoist cables must be paid out from their drums. The means for keeping the hoist cables taut during the shifting of the boom foot is illustrated in FIG. 2.

Referring to FIG. 2, there is shown therein in diagrammatic form the hydraulic circuits for operating the limited rotation motors 19 and the hydraulic motors 25, 27 and 29 for each of the hoist drums. Each of the hydraulic motors 25, 27 and 29 are reversible and each is normally driven for hoisting and lowering of load by a pump with control residing in a control valve. The pump and valve arrangements for each is identical and the description of one will suffice for all three. Specifically, a hoist pump 33 draws hydraulic fluid from a reservoir 34 and carries it to one side of a motor control valve 35. A return line 36 extends from the control valve 35 back to the reservoir 34. The control valve 35 is an internally open, three position valve.

When the control valve 35 is shifted to the right as viewed in FIG. 2 to lower a load on the cable 30, the pump 33 will direct hydraulic fluid under pressure to certain ports of the hydraulic motor 25 to cause the same to rotate in a clockwise direction as seen in FIG. 2. Fluid is exhausted from the other ports of the motor 25 to the reservoir 34 after passing through a counter-balancing valve indicated generally by the numeral 37. The counter-balancing valve 37 includes a pilot controlled pressure relief valve 38 and a check valve 39 in parallel therewith. The relief valve 38 prevents the load on the cable 30 from running away with the drum 24 as the load is lowered.

That is, the pressure relief valve 38 will maintain a back pressure on the motor 25. When the motor control valve 35 is shifted to the left for hoisting, fluid under pressure is delivered by the pump 33 through the check valve 39 to the other ports of the motor 25 to thereby cause the motor to rotate in the reverse direction (counterclockwise in FIG. 2).

The auxiliary hoist drum 24 and main hoist drum 26 are controlled by a normal brake 40 of known construction. In the case of the third hoist drum 28, a hydraulic automatic brake system is shown. In a known manner, the brake 41 is connected to the drum 28 through a one-way clutch and is biased toward engagement by a spring biased hydraulic cylinder 42. The spring biased hydraulic cylinder 42 is actuated hydraulically to release the brake 41.

The system for actuating the hydraulic drum motors to hoist and lower loads which has heretofore been described is a standard system.

The limited rotation motors 19 receive hydraulic fluid under pressure from a pump 43 which draws hydraulic fluid from a reservoir 44 and delivers it to one side of a boom shift control valve 45. A return line 46 likewise leads from such side of the valve 45 back to the reservoir 44. The boom shift control valve 45 is of the three position internally blocked type. When the valve 45 is moved to the right as viewed in FIG. 2, hydraulic fluid under pressure will be directed from the pump 44 through a supply line 47 to one side of each of the limited rotation motors 19 to cause the same to rotate through their permitted degree of rotation to move the torque tube 17 and thereby shift the boom foot. Hydraulic fluid is exhausted from the other side of each of the limited rotation motors 19 through a second supply line 48 which connects to the return line 46. Obviously, shifting the valve 45 to the left as viewed in FIG. 2 will cause the limited rotation motors 19 to be operated in the opposite direction.

To effect the control of the hoist cable drums during movement of the boom foot, a portion of the output of the pump 43 is employed to control the hydraulic motors connected to each of the three drums. That is, a flow divider designated generally by the numeral 49 is disposed on the line 47. The divider 49 limits the rate of flow of hydraulic fluid to the limited rotation motors 19 and directs the remainder of the flow from the pump 43 to a control line 52. The divider 49 includes a pressure compensated restriction valve 50 and a piloted valve 51. A similar divider 53 is disposed in the supply line 48 and will also function to connect the flow of fluid from the pump 43 to the control line 52. Thus, when the valve 45 is shifted in either direction from its neutral position, hydraulic fluid under pressure beyond the demands for operating the limited rotation motors 19 will be delivered to the control line 52.

A solenoid controlled internally blocked, two position valve 54 is connected in a working line 55 which leads from the control line 52 to the hoisting ports of the hydraulic motor 25. Similar solenoid controlled valves 56 and 57 are disposed in working lines 58 and 59, respectively, connected between the control line 52 and the hoist ports of the hydraulic motors 27 and 29, respectively. The control line 52 connects to a pressure relief valve 60 which leads to a reservoir 61.

In the case of the third drum 28, a further solenoid controlled two position valve 62 normally connects the lowering ports of the hydraulic motor 28 to the blind end of the brake cylinder 42. However, when its solenoid is energized the valve 62 will connect the blind side of the brake cylinder 42 to the working line 59. The means for energizing the solenoids of the valves to shift the same may comprise a simple normally open electric circuit with contacts being closed whenever the boom shift control valve 45 is moved by a lever from its neutral position. Then, the circuit is closed and the solenoids are energized.

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The pump 43 can deliver a flow of hydraulic fluid under pressure considerably in excess of that required to power the limited rotation motors 19 to shift the boom foot. Thus, a considerable quantity of fluid from the pump 43 is by-passed by the dividers 49 and 53. With the control valve 45 shifted from its neutral position, the pressure compensated restriction valve 50 of the appropriate one of the dividers 49 or 53 will limit the flow of hydraulic fluid under pressure to the limited rotation motors 19. The increase in pressure in the appropriate one of the supply lines 47 and 48 caused by the resistance of the boom foot to movement will pilot the valve 51 of the appropriate divider. Thus, for example, if the output of the pump 43 is fifty-two gallons per minute, only two gallons per minute would be required for the two limited rotation motors 19 and the remainder will flow through the control line 52. The relief valve 60 will maintain a back-up pressure in the control line and will open when the pressure is reached. As soon as the control valve 45 is shifted from its neutral position the valves 54, 56 and 57 will also open so that the hoist ports of the hydraulic motors 25, 27 and 29, respectively, are connected to the control line 52.

If a cable becomes slack or tends to become slack, the path of least resistance for the fluid flow in the control line will be through a respective working line to the hydraulic motor. Thus, the hydraulic motor will be driven to rotate the drum in a counterclockwise direction to reel in the cable. The cable is reeled in until it is taut at which time the path of least resistance to fluid flow is through the pressure relief valve 60. If, on the other hand, the cable path is lengthened, the force on the cable will tend to rotate the drum in a clockwise direction against the pressure at the hoisting ports of the motor. The paying out of cable is initially resisted until the back-up pressure created by the relief valve 60 is overcome. Then, the motor will act as a pump and direct fluid to and through the control line 52. The drum is permitted to rotate and the cable will be payed out. But, the drum cannot run free.

The hoist cables 30, 31 and 32 will be subjected to both conditions during shifting of the boom foot. And, depending upon the location of the drums relative to the boom foot, one cable may require to be payed out while another cable is required to be reeled in. Regardless of the specific conditions the apparatus will maintain the cables 30, 31 and 32 taut during shifting of the boom foot.

Upon shifting of the boom foot the hydraulic brake cylinder 42 will be subjected to the fluid pressure in the working line 59 so that when the drum 28 is rotated either to pay out or reel in cable the pressure in the working line will be sufficient to release the brake 41.

An alternate arrangement for connecting both the limited rotation hydraulic motors 19 and the control line 52 to the pump 43 is illustrated in FIG. 3. Only a portion of the full hydraulic system of FIG. 2 is shown in FIG. 3. In the alternate embodiment the lines to the limited rotation motors 19 lead from one side of a boom shift valve 63. The other side of the boom shift valve 63 is connected to a supply line 64 and a reservoir. The supply line 64 leads from the pump 43 and includes a flow divider indicated generally by the numeral 65. The flow divider 65 directs excess fluid flow to a line 66 which leads to one side of a selector valve 67. The selector valve 67 will connect the line 66 either to a line leading to a crane swing apparatus, such as a hydraulic motor 68 for the crane swing apparatus, or to the control line 52.

Ideally, the selector valve 67 is normally shiftable from its normal position connecting the flow divider 65 to the motor 68. Shifting of the selector valve 67 will close a circuit to energize the solenoids of the valves 54, 56 and 57 to open the working lines 55, 58 and 59 to the control line 52. Thus, the excess output of the pump 43 will be directed to the control line 52 and the hoist cables 30, 31 and 32 will be drawn taut on the boom 13.

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Then, the boom shift valve 63 can be shifted normally to direct fluid flow to one or the other sides of limited rotation motors 19 for shifting the boom foot. The apparatus will maintain the hoist cables taut during shifting as previously described. When the selector valve 67 is in its normal position, the excess fluid flow from the pump 43 can be used to power the auxiliary functions such as the motor 68.

It would also be possible to provide a separate source of fluid under pressure for the control line 52.

While the invention has been described in relation to controlling the hoist cables of a crane having a shiftable boom foot, it will be appreciated that the invention has application in other situations in which the path of the cable is changed and it is required that the cable be held taut during such change.

I claim:

1. A cable control apparatus for a hoist drum mounting a cable that works on a boom having a shiftable boom foot, said drum being driven by a reversible hydraulic motor with hydraulic fluid under pressure being directed to a lowering port of said motor to rotate said drum to pay out cable and hydraulic fluid under pressure being directed to a hoisting port of said motor to rotate said drum in an opposite direction to reel in cable, said boom being provided with a boom foot shifting mechanism and motive means for operating said shifting mechanism to move the foot of said boom, said control apparatus comprising:

- a source of hydraulic fluid under pressure;
- a control line;
- actuatable valve means adapted when actuated to connect said control line to said source;
- pressure control means in said control line for maintaining a back-up pressure in said control line;
- a working line leading from said control line on the pressure side of said pressure control means to the hoisting port of said motor, and a solenoid controlled valve in said working line, said solenoid controlled valve normally blocking said working line and being energized by the actuation of said valve means to open said working line, said valve means being actuated when said boom foot is to be shifted so that fluid under pressure will be directed to the motor to urge the motor to rotate the drum to reel in cable when the cable tends to become slack and rotation of the drum in the opposite direction to pay out cable is permitted when the force on said cable is sufficient to overcome the back-up pressure in said control line;
- whereby the cable will be held taut during shifting of said boom foot.

2. In combination with hoisting apparatus including a deck, boom, a boom foot shifting mechanism on the deck, a plurality of hoist drums on the deck that mount hoist cables that work on the boom, the hoist drums each being driven by a reversible hydraulic motor, a fluid pressure system for each hydraulic motor operable to direct hydraulic fluid under pressure to alternate ports of the motor for working the drum for paying out and reeling in cable, hydraulic motive means for operating said shifting mechanism to move the foot of said boom, a cable control system for maintaining the hoist cables taut as the boom foot is shifted, comprising:

- pressure control means;
- a control line connected at one end to said pressure control means;
- a pump for supplying a flow of hydraulic fluid under pressure to said hydraulic motive means and to said control line;
- an actuatable control valve adapted when actuated to connect the output of said pump to the other end of said control line;
- and a working line leading from said control line to each of said motors so that upon opening of said

control valve when said boom foot is shifted fluid flow is directed from said control line to each of said motors to have the motor rotate its drum to reel in cable when the cable tends to become slack and fluid flow is directed from each of said motors through the respective working line to said control line when its drum is rotated in an opposite direction by a force on the cable;

said pressure control means supplying a back-up pressure on said control line and working lines which resists paying out of cable until overcome by said force on the cable.

3. A cable control system in accordance with claim 2 wherein a supply line including a flow divider leads to said hydraulic motive means, said other end of said control line connects to said flow divider, and said control valve when actuated connects the outputs of said pump to said supply line whereby said control line receives the output of said pump that is in excess of the demand of said hydraulic motive means.

4. A cable control system in accordance with claim 2 wherein a supply line including a flow divider leads from said pump and is connectable to said hydraulic motive means, and said control valve is disposed between said other end of said control line and said flow divider whereby said control line receives the output of said pump that is in excess of the demand of said hydraulic motive means when said control valve is actuated.

5. A cable control system in accordance with claim 2 wherein said pressure control means comprises a pressure

relief valve responsive to the pressure in said control system.

6. A cable control system in accordance with claim 2 together with a solenoid controlled valve in each of said working lines, said solenoid controlled valves normally blocking said working lines and being energized by the actuation of said control valve to open said working lines to fluid flow to and from said control line.

7. The combination of claim 2 wherein there is a brake operable on one of said drums, said brake being normally engaged and being disengaged upon the application of fluid pressure, and wherein said cable control system includes an actuatable brake valve that is actuated by the actuation of said control valve to connect the working line for the motor of said drum to said brake.

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U.S. Cl. X.R.

60—53; 212—144; 254—172

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,458,053

Dated July 29, 1969

Inventor(s) GOTTFRIED REUTER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3,	Line 46,	for "uables" read --cables--
Column 3,	Line 54,	for "load" read --loads--
Column 6,	Line 37,	for "presure" read --pressure--
Column 6,	Line 54,	for "a deck, boom" read --a deck, a boom--
Column 6,	Line 61,	for "hydrualic" read --hydraulic--
Column 7,	Line 17,	for "outputs" read --output--

SIGNED AND
SEALED

MAR 31 1970

(SEAL)

Attest:

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Attesting Officer

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