United States Patent [19]

Witwer

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[54] **WINCH AND CONTROL MEANS THEREFOR**

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[73] Assignee: **Harnischfeger Corporation,** Milwaukee, Wis.

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[52] **U.S. Cl.** ..... **254/150 FH,** 254/150 R

[51] **Int. Cl.** **B66d 1/30**

[58] **Field of Search** ..... 212/55, 58, 59; 192/3 R; 254/186, 150, 150 R, 150 FH, 180; 137/625.69, 636, 636.1; 188/71.2

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Assistant Examiner—Joseph E. Valenza
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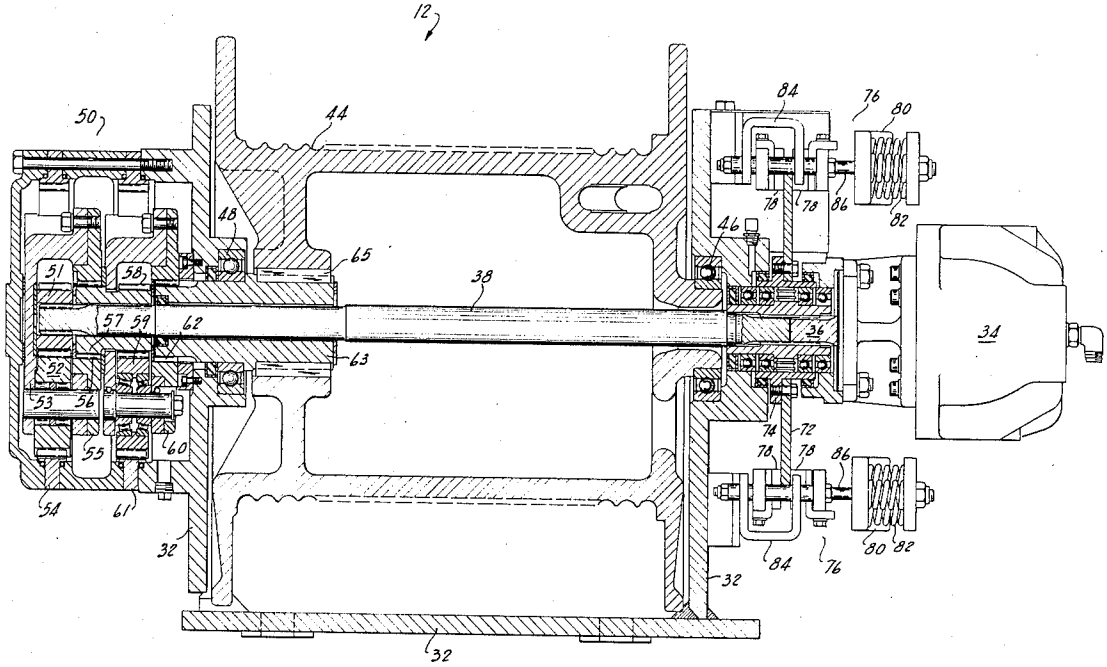
[57] **ABSTRACT**

A winch for use on a mobile crane to hoist or lower a load comprises a hydraulic winch motor, a shaft driven thereby, a winch drum, and planetary gearing through which the shaft drives the drum. A three-position hydraulic control valve controls motor speed and direction of rotation. The winch further comprises a brake disc connected by a uni-directional clutch to the shaft and spring-applied, hydraulic brake cylinder-released brake pads for frictional engagement with the brake disc. A two-position hydraulic brake valve controls operation of the brake cylinder. Both the control valve and brake valve are part of a control means which further includes a control lever and linkage. The control lever acts through the linkage and is movable from a neutral position (wherein both valves are closed) toward a winch-lower position (wherein the brake valve opens before the control valve) and toward a winch hoist position (wherein the brake valve remains closed but the control valve opens). During lowering, the winch drum starts rotating smoothly as the brake is released and the load begins to descend under the force of gravity before lowering power is applied to the winch motor. During a winch-hoist operation, the uni-directional clutch allows winch drum rotation even though the brake is still applied.

8 Claims, 7 Drawing Figures



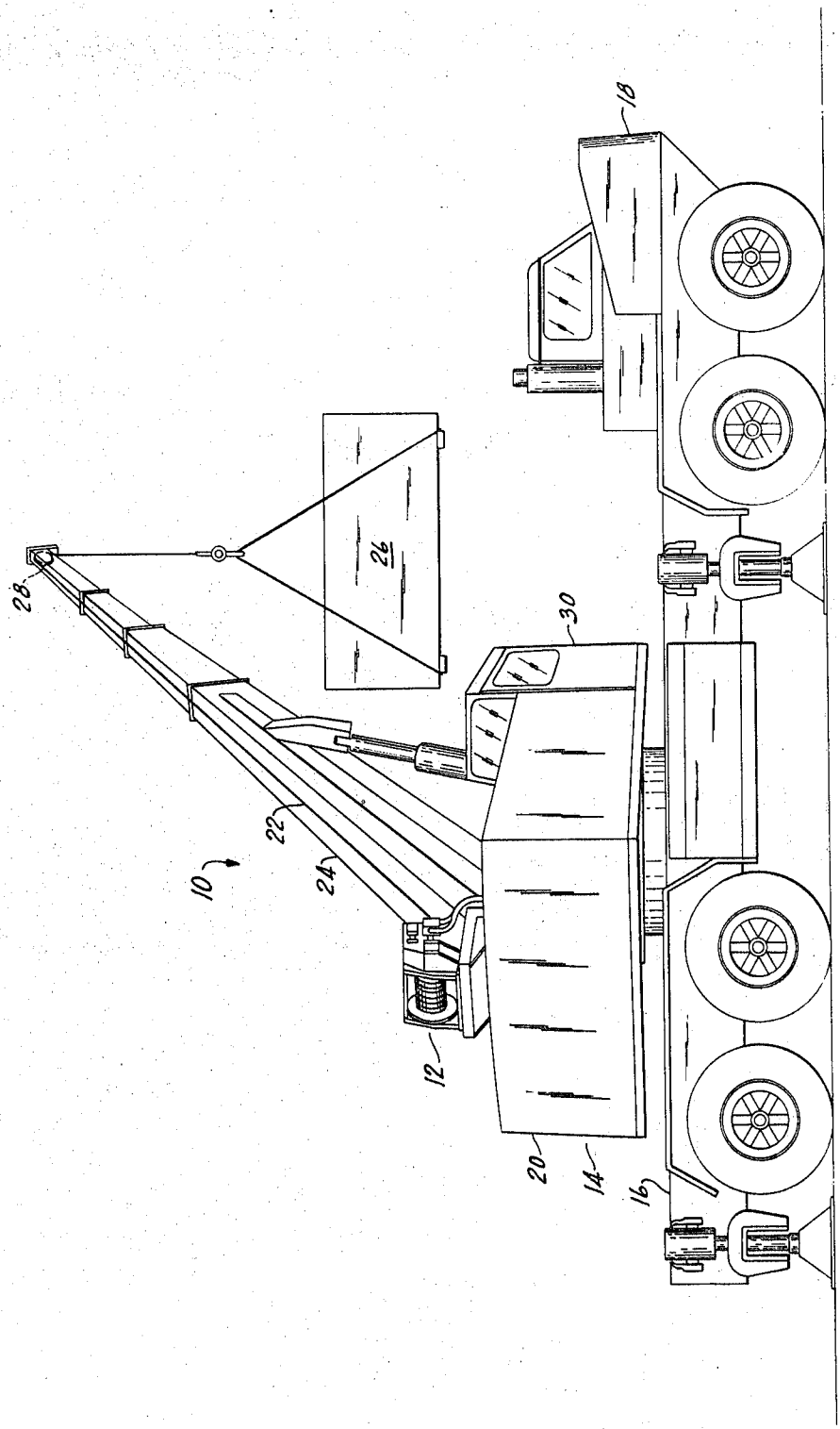


Fig. 1

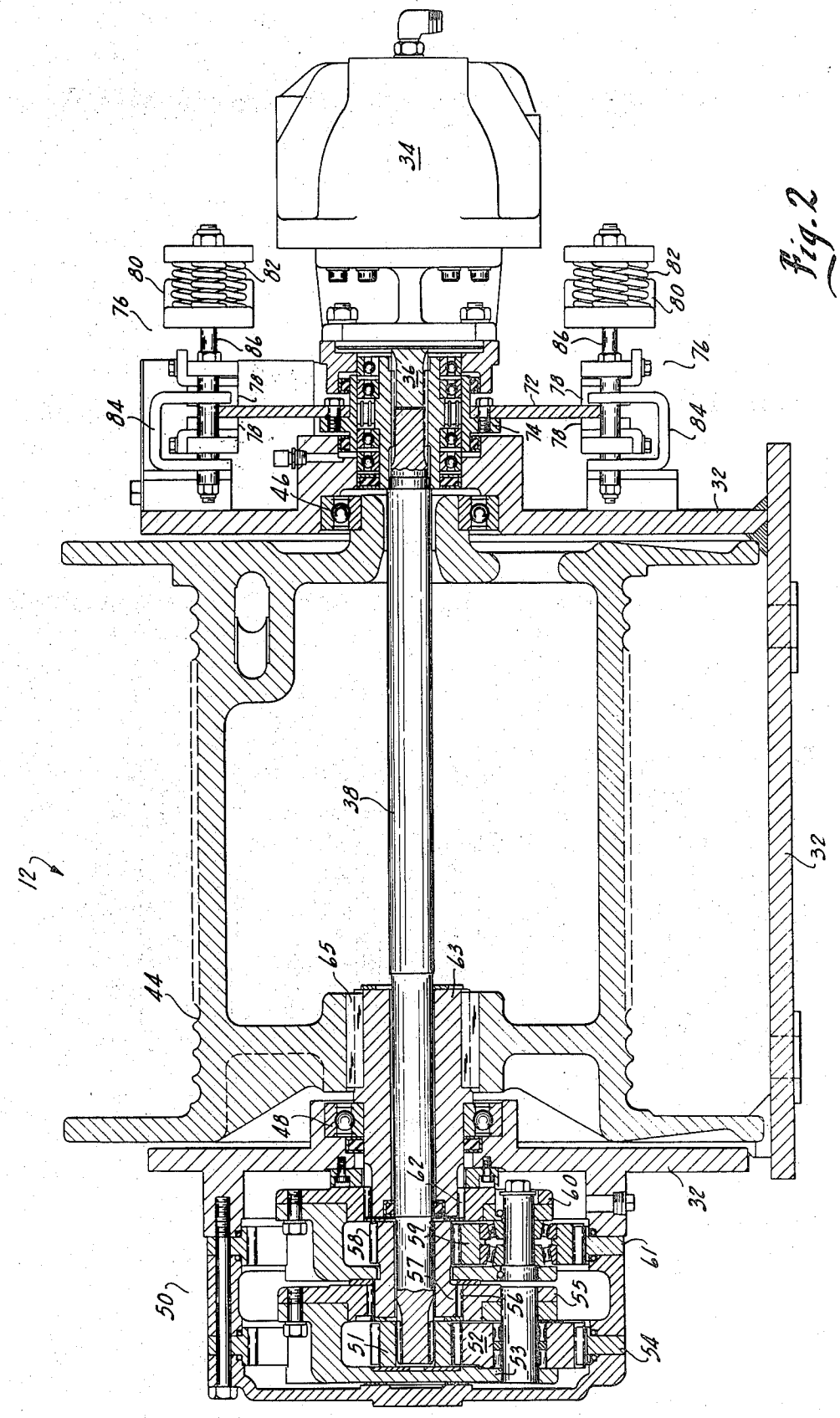

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Fig. 2

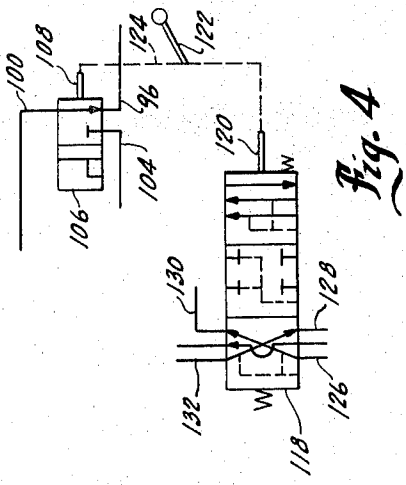

Fig. 4

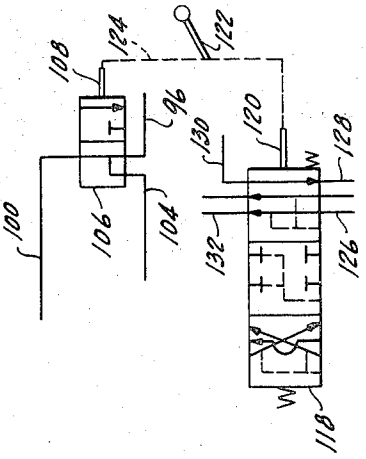

Fig. 5

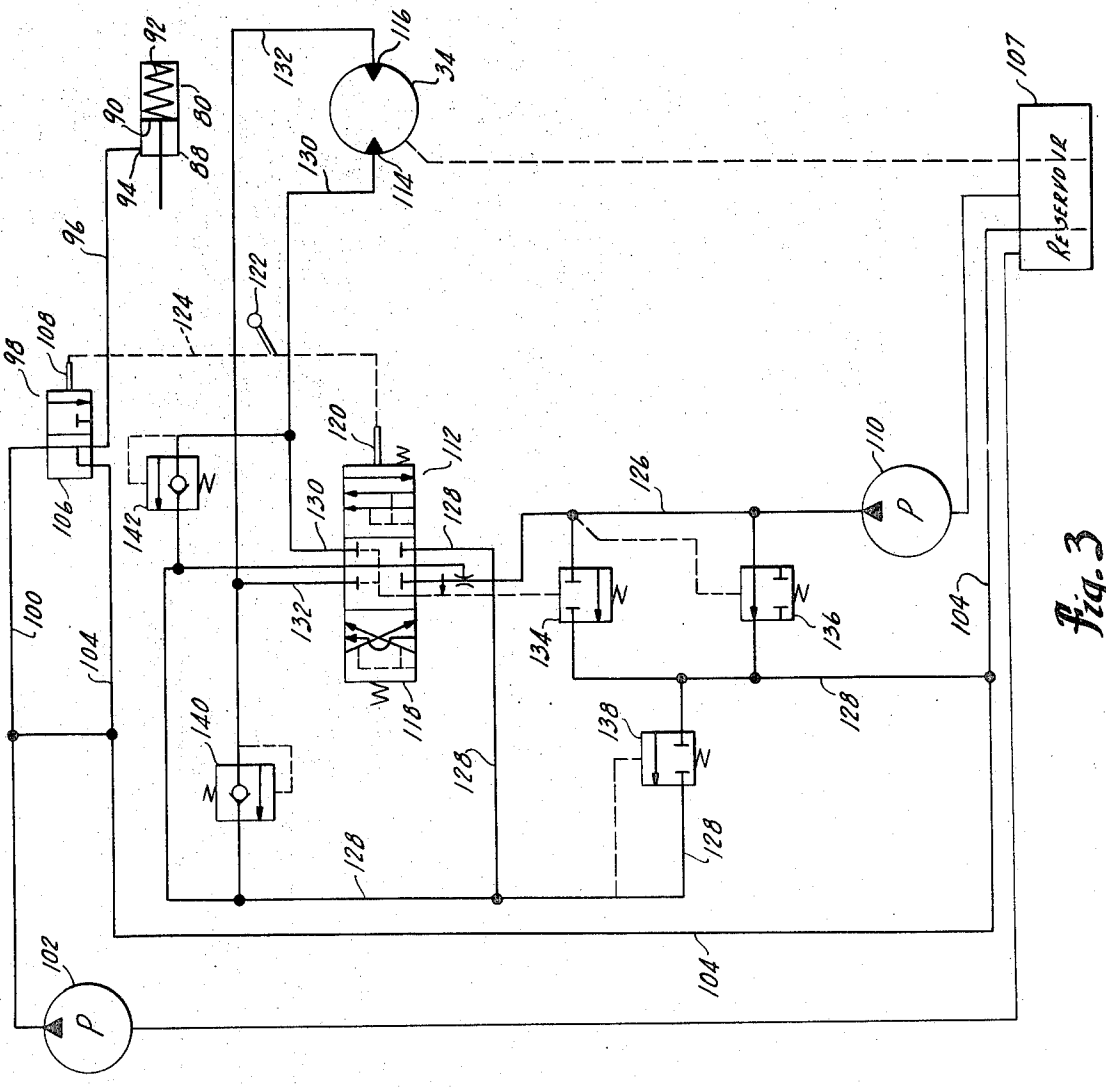

Fig. 3

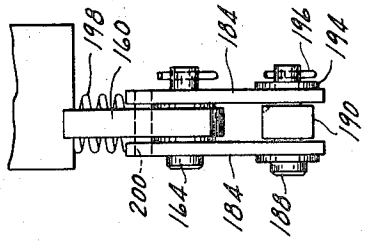
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Fig. 7

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Fig. 6

WINCH AND CONTROL MEANS THEREFOR

BACKGROUND OF THE INVENTION

Field of Use

This invention relates generally to hydraulic winches, hoists or the like and, particularly, to control means therefor whereby operation of the winch drive motor and winch brake are coordinated.

Description of the Prior Art

Mobile cranes and similar equipment employ a winch rotatable in opposite directions to hoist or lower a load. Some winches are driven by a hydraulic motor and employ a spring-set, hydraulically released brake. Both the motor and the brake are operated by suitable control means. In practice, it is normally necessary to release the brake prior to rotation of the winch motor and, in some equipment, control means are provided to effect automatic operation of the winch motor in a desired direction immediately upon release of the brake so as to prevent a load from falling uncontrolled. In some prior art winches and control means therefor, the hydraulic brake cylinder was directly connected to the hydraulic circuit for the winch motor and a counterbalance valve was provided which caused the winch motor to operate in the lowering direction as soon as the brake was released. This arrangement has two drawbacks. First, it is possible for a falling load to overtake and use up the available oil supply to the motor and, consequently, to interfere with proper operation of the brake. Second, the aforesaid arrangement does not permit of smooth operation in load handling because power lowering takes place immediately upon release of the brake. It is desirable, therefore, to provide improved winches and control means therefor which overcome these drawbacks and have other advantages.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a winch for a mobile crane or the like which is rotatable in either hoist or lower direction by a hydraulic motor and employes hydraulically releasable brake means. The winch comprises a hydraulic winch motor, a shaft driven thereby, a winch drum, and planetary gears connected between the shaft and the winch drum to drive the latter. The brake means comprise a brake disc connected through a uni-directional clutch to the aforesaid shaft, brake pads for frictional engagement with the brake disc, spring means normally acting to bias the pads against the disc, and a hydraulic brake cylinder pressurizable to release the brake pads. Pressurization of the brake cylinder is controlled by means of a two-way or two-position brake valve. The motor is controlled by means of a three-way control valve. The control valve and brake valve are both operated by means comprising a three-position control lever and a linkage between the control lever and the valves.

With the control lever in neutral, the brake valve is closed and the control valve is in neutral. This results in the brake being set and the motor being stationary. When the control lever is moved from neutral toward lower position, the brake valve opens first to release the brake, the winch begins to rotate under the force of the load, and subsequently the control valve opens to effect lowering operation of the motor and power lowering of the load. This sequence allows for smooth winch operation. When the control lever is moved from neutral toward hoist position, the brake valve remains closed

and the brake remains set but the control valve opens to effect hoisting operation of the motor and hoisting of the load. This sequence is possible because the uni-directional clutch between the brake disc and motor shaft allows for relative rotation therebetween in the hoist direction with the brake set.

The aforedescribed operations are effected by the control lever acting through a linkage constructed in accordance with the invention and connected to the brake valve and the control valve. The valves are arranged in side-by-side relationship and each valve comprises a linearly movable valve spool, the stem of which extends therefrom. The control stem or spool has a neutral position and is movable outwardly to winch lower position and inwardly to winch hoist position. The brake valve stem or spool has a neutral, closed or brake-applied position and is movable inwardly to brake-release position. The control lever is rigidly connected to a hub or member which is rotatably about a fixed point. The hub or member comprises outwardly extending arms. Lost-motion connection means are connected between the arms and the valve spools. For example, one arm carries a pin which is slideably engageable in a slot in a first link which is pivotably connected to the spool of the control valve. The other arm carries a pin which is pivotably connected to a plate and the plate has a slot which is slideably engageable with a pin on the spool of the brake valve. The plate is provided with a stop pin or projection which is biased into engagement with the said other arm by means of a tension spring connected between the plate and the member. Pivoting of the control lever from neutral toward winch-lower position results in force being transmitted to move the brake valve spool inwardly from closed position to fully open position (to effect release of the brake) prior to force being transmitted to move the control valve spool outwardly from neutral toward winch-lower position. When the brake valve spool bottoms out in fully open position, further movement of the control lever and further outward movement of the control valve spool is possible to increase lowering speed of the winch because the plate pivots on its arm. Pivoting of the control lever from winch-lower position back to neutral results in return of the control valve spool to neutral and subsequent reclosure of the brake valve. Pivoting of the control lever from neutral toward hoist position results in force being transmitted to move the control valve spool inwardly from neutral position toward hoist position but does not result in any movement of the brake valve spool. Pivoting of the control lever from hoist position back to neutral results in return of the control valve spool to neutral but does not result in any movement of the brake valve spool.

DRAWINGS

FIG. 1 is a perspective view of a mobile crane incorporating a winch in accordance with the invention;

FIG. 2 is an enlarged cross-section view of the winch shown in FIG. 1;

FIG. 3 is a schematic view of a hydraulic control circuit for a winch in accordance with the invention;

FIG. 4 is a view showing the brake valve and control valve of FIG. 3 in lowering position;

FIG. 5 is a view showing the brake valve and control valve of FIG. 3 in hoist position;

FIG. 6 is an enlarged side elevational view of the control valve and brake valve shown in FIG. 3; and

FIG. 7 is a detail of the linkage taken on line 7—7 of FIG. 6.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 shows a mobile crane **10** having a winch **12** in accordance with the present invention. Mobile crane **10** comprises an upper crane portion **14** which is mounted for rotation about a vertical axis on the platform **16** of a mobile carrier **18.** Upper crane portion **14** comprises a housing **20** to which the lower end of a movable boom **22** is attached for pivotal movement vertically. Winch **12** is mounted on the top rear of housing **20** and is provided with a line **24** for handling a load **26.** Line **24** is reeved over a pulley **28** at the end of boom **22.** Winch **12** is operable in either the hoist or lower direction and is braked by means of suitable controls (not shown in FIG. **1**) which are understood to be located in an operator's cab **30** in housing **20** of crane **10.**

Referring to FIG. **2,** winch **12** is shown in cross section and comprises a supporting framework **32,** on which a conventional hydraulic winch motor **34** is rigidly mounted. Winch motor **34** comprises an output shaft **36,** rotatable in either direction, which is connected to a drive shaft **38** which is supported for rotation on supporting frame-work **32.** Winch **12** further comprises a winch drum **44** which is mounted for rotation on supporting framework **32** by means of bearings **46** and **48.** Drive shaft **38** is connected through a planetary gear means or mechanism **50** to drum **44** to effect rotation thereof as hereinafter explained. It is to be understood that when hydraulic motor **34** is energized for rotation in either direction it effects corresponding rotation of drive shaft **38** and, through the planetary gear mechanism **50,** effects corresponding rotation of winch drum **44.**

The planetary gear mechanism **50** connecting the drive or input shaft **38** with the output member or drum **44** comprises the following. A sun gear **51** is fixed on shaft **38** for rotation therewith and is also in constant mesh with a plurality of planetary gears **52** which are circumferentially spaced around a revolvable carrier **53.** The planetary gears **52** are also in constant mesh with an internal ring gear **54** which is fixed in the housing of support **32.** The carrier **53** also includes an inner member **55** which has internal gears **56** that mesh with a compound gear **57** which rotates freely with respect to shaft **38.** The compound gear **57** also includes a gear portion **58** which is in constant mesh with another set of planetary gears. **59** that are circumferentially spaced around and rotatably mounted in another carrier **60.** The planetary gears **59** are also in constant mesh with a large internal ring gear **61** also rigidly fixed in the housing of support **32.** The revolvable carrier **60** has internal splines **62** by means of which it is rotationally fixed to a sleeve **63.** The sleeve **63** is mounted on suitable anti-friction bearings **48** and has a key or spline connection **65** with the interior of the drum **44.**

Winch **12** further comprises braking means for preventing drum rotation under certain conditions. As FIG. **2** shows, the braking means comprise a brake disc **72** which is mounted on a conventional uni-directional clutch **74** which, in turn, is mounted on drive shaft **38.** It is to be understood that when shaft **38** rotates in the hoist direction, there is relative movement between brake disc **72** and drive shaft **38** because of the action of uni-directional clutch **74.** However, when drive shaft **38** rotates in the lowering direction, brake disc **72** is rotatable therewith. The brake means further comprise two caliper brake assemblies, each of which comprises two brake pads **78,** a hydraulic brake cylinder **80,** and brake spring means **82.** The brake pads **78** are movably mounted on a bracket **84** which is supported on supporting framework **32** of winch **12.** The brake pads **78** are movable by means of a rod **86** from an open or brake-release position wherein they are disengaged from brake disc **72** to a closed or brake-applied position wherein they engage brake disc **72.** The brake pads **78** are normally biased to brake-applied position against brake disc **72** by the brake spring means **82** acting through rod **86.** However, upon pressurization of brake cylinder **80** from a suitable source of hydraulic fluid, the brake pads **78** are moved against the bias of the brake springs **82** by rod **86** to disengaged position clear of brake disc **72.** When the brake pads **78** engage brake disc **72** they prevent rotation of brake disc **72,** drive shaft **38** and drum **44** in the winch-lower direction. However, when the brake pads **78** engage brake disc **72** while hydraulic motor **34** and shaft **38** are energized for rotation in the winch-hoist direction, they do not prevent rotation of the motor, drive shaft or drum in the hoist direction because of the operation of uni-directional clutch **74.**

FIG. **3** is a schematic diagram of the hydraulic control system for winch motor **34** and brake cylinders **80** of the brake means. It is to be noted that motor **34** and brake cylinder **80** are supplied with hydraulic fluid from separate pumps **110** and **102,** respectively, so that fluid loss in one does not affect the other. Only one brake cylinder **80** is shown in FIG. **3.**

As FIG. **3** shows, brake cylinder **80** comprises a housing **88** having a piston **90** therein which is spring loaded by a return spring **92.** Housing **88** is provided with a fluid port **94** which is connected by a hydraulic fluid line **96** to a winch brake valve **98.** Valve **98** is also connected by a fluid line **100** to a conventional hydraulic brake valve pump **102** and by another fluid line **104** to a hydraulic fluid reservoir **107.**

Brake valve **98,** shown schematically in FIG. **3,** is a conventional two-position type hydraulic valve having a movable valve spool **106** which is shown in brake-applied position in FIG. **3** and is movable leftward (with respect to FIG. **3**) by means of a valve stem **108** to brake-released position. With brake valve **98** in brake-applied position, fluid line **100** is connected to fluid line **104** and fluid flow from pump **102** is diverted to reservoir **107.** Furthermore, in brake-applied position, fluid line **96** is connected to fluid line **104** and any fluid in housing **88** of brake cylinder **80** is exhausted to reservoir **107** as biasing spring **92** biases piston **90** leftward (with respect to FIG. **3**) to brake-applied position. This allows the brake pads **78** shown in FIG. **2** to engage brake disc **72.** With brake valve **98** in brake-released position, fluid line **100** is connected to fluid line **96** and fluid flow from pump **102** pressurizes brake cylinder **80** to move piston **90** rightward (with respect to FIG. **3**) against the bias of spring **92** to brake-release position and causes the brake pads **78** shown in FIG. **2** to disengage from brake disc **72.**

Hydraulic motor **34** of winch **12** is supplied with hydraulic operating fluid for rotation in either direction at a desired speed from a conventional hydraulic winch motor pump **110** and fluid flow between pump **110** and motor **34** is controlled by a conventional three-way or

three-position winch control valve **112.** Hydraulic winch motor **34** is a conventional hydraulic motor having two fluid ports **114** and **116** and direction of rotation of motor **34** is determined by which of the two ports is pressurized. Speed of rotation of motor **34** is determined by the amount of pressurization. It may be assumed for purposes of discussion that when port **114** of motor **34** is energized, winch **12** rotates in the winch-lower direction and when port **116** is energized, the winch rotates in the winch-hoist direction.

Control valve **112,** shown schematically in FIG. **3,** is a conventional three-position type hydraulic valve (similar to that shown in U.S. Pat. No. 3,295,551) having a movable valve spool **118** which is shown in neutral position in FIG. **3** and is movable rightward (with respect to FIG. **3**) from neutral to winch-lower position and leftward from neutral to winch-hoist position. Movement of valve spool **118** is effected by a valve stem **120.** As hereinafter explained, valve stem **108** of brake valve **98** and valve stem **120** of control valve **112** are both operated in coordination by a valve control means comprising a single control lever **122** and a linkage **124.** The extent of movement in either direction from neutral of spool **118** of control valve **112** regulates the amount of pressurization of hydraulic motor **34** and thereby controls motor speed.

Control valve **112** is connected by a fluid supply line **126** to pump **110** and by a fluid return line **128** to reservoir **107** through fluid line **104.** Control valve **112** is also connected by fluid lines **130** and **132** to the ports **114** and **116,** respectively, of winch motor **34.** A conventional low pressure relief valve **138** is connected in fluid line **128.** A conventional anti-void poppet valve **134** and a main relief unloader valve **136** are connected between fluid supply line **126** and fluid return line **128.** A conventional spring-loaded check valve **140** is connected between fluid line **132** and fluid return line **128.** A similar check valve **142** is connected between fluid line **130** and fluid return line **128.** When spool **118** of control valve **112** is in neutral position, as shown in FIG. **3,** fluid flow from pump **110** to motor **34** is blocked and is diverted through control valve **112,** to reservoir **107.**

When control valve spool **118** is moved to winch-lower position (i.e., rightward with respect to FIGS. **3** and **4**), fluid supply line **126** from pump **110** is connected through control valve **112** to fluid line **130** to effect pressurization of port **114** of winch motor **34.** Port **116** of motor **34** is then connected through fluid line **132,** valve **112,** fluid line **128** and low pressure relief valve **138** to reservoir **107.** In this condition, control valve effects rotation of winch motor in the winch-lower direction As hereinbefore noted, the extent of such rightward movement of valve spool **118** determines the speed of rotation of winch motor **34** and winch drum **44.**

When control valve spool **118** is moved leftward with respect to FIGS. **3** and **5** from neutral position, the fluid lines **126** and **128** are connected to the fluid lines **132** and **130** by control valve **112,** respectively, thereby effecting pressurization of port **116** of winch motor **34.** This causes rotation of winch motor **34** and winch drum **44** in the winch-hoist direction and the extent of leftward movement of valve spool **118** controls the speed of rotation.

FIG. **6** is an enlarged side elevational view of control valve **112** and brake valve **98** shown in FIG. **3** and shows their physical configuration and mechanical interconnection. As FIG. **6** shows, brake valve **98** and control valve **112** are rigidly mounted on a suitable supporting structure **146** which is understood to be located in the operator's cab **30** of crane **10.** Control valve **112** is physically located above brake valve **98** and both valves are disposed so that their spools **118** and **106,** respectively, which extend from the ends of the valve housings are in parallel relationship. The spools **118** and **106** operate or are moved linearly in response to the movement of control lever **122** which acts through linkage **124.** Linkage **124** comprises a pivotally movable member **148,** in the form of a hub **150,** which is mounted for limited rotation on bearing means **152** on a fixed shaft **154** about a point. Shaft **154** is rigidly supported on a housing **156** on supporting structure **146.** Control lever **122** is rigidly attached to hub **150** of member **148** and effects rotational movement thereof. In FIG. **6** control lever **122** is shown in neutral position and is understood to be movable counterclockwise or downwardly (with respect to FIG. **6**) to winch-lower position and also movable clockwise or upwardly to winch-hoist position. Movable member **148** is provided with upper and lower arms **158** and **160,** respectively, which are rigidly secured to hub **150** and extend therefrom. Upper and lower arms **158** and **160** are provided with rigidly attached pins **162** and **164,** respectively, at their extreme ends. An upper or first link **166** is connected between pin **162** on upper arm **158** and a pin **170** on valve stem **120** of control valve **112.** Link **166** is held in place on the pins **162** and **170** by means of a washer **172** and cotter pins **176** and **178,** respectively. Link **166** is provided with a slot **180** which slidably engages pin **162** on arm **158** and serves as a lost-motion connection which allows for limited play or travel between pin **162** and link **166** as control lever **122** is moved from neutral toward winch-lower position.

The pin **164** on lower arm **160** pivotally engages a hole **182** in a second link or toggle plate **184** which is connected to valve stem **108** of brake valve **98.** Plate **184** is provided with a slot **186** which slidably engages a pin **188** on the end of shaft **190** which is pivotably connected to valve stem **108** by a pin **192.** Pin **188** is secured in slot **186** by means of a washer **194** and cotter pin **196.** Plate **184** is connected by biasing means in the form of a tension spring **198** to a projection **200** on hub **150.** Spring **198** engages a hole **202** in projection **200** and a pin **204** on plate **184.** Plate **184** is provided with stop means such as a stop projection or stop pin **206** which abuts or engages a side of lower arm **160.**

FIG. **6** shows control lever **122** in neutral position, control valve **112** in neutral position, and brake valve **98** in brake-applied position. Rotation of control lever **122** downwardly from neutral toward winch-lower position results in force being transmitted by arm **160** to plate **184** to move brake valve stem **108** inwardly (rightward in FIG. **6**) from brake-applied position to brake-release position to effect release of the brake. This movement occurs prior to force being transmitted by arm **158** to link **166** to move control valve stem **120** outwardly from neutral toward hoist-lower position. When the brake valve spool **106** bottoms out in full rightward position, further movement of control lever **122** and further outward movement (leftward in FIG. **6**) of the control valve spool **118** is possible to increase lowering speed of motor **34** because the plate **184** is able to pivot with respect to arm **160** and shaft **190.** Ro-

tation of control lever **122** from hoist-lower position back to neutral results in return of control valve spool **118** to neutral prior to return of brake valve spool **106** to brake-applied position. Rotation of control lever **122** from neutral toward winch-hoist position results in force being transmitted by arm **158** to link **166** to move control valve spool **118** inwardly from neutral position toward winch-hoist position but such movement does not result in any movement of brake valve spool **106** because plate **184** is able to move with respect to pin **188.** Rotation of control lever **122** from winch-hoist position back to neutral resutls in return of control valve spool **118** to neutral but, again, does not result in any movement of brake valve spool **106.**

OPERATION

Winch **12** of crane **10** operates as follows. Assume that both pumps **102** and **110** are in operation, that control lever **122** is in neutral, that brake valve **98** is in brake-applied position, and that control valve **112** is in neutral position. With these assumptions, winch motor **34,** winch shaft **36** and winch drum **44** are stationary, winch brake cylinder **80** is depressurized and the brake pads **78** engage brake disc **72.**

To operate winch **12** in the winch-lower direction, control lever **122** is moved counterclockwise (with respect to FIG. **6**) from neutral toward winch-lower position. As this occurs, valve spool **106** of brake valve **98** is moved inwardly from brake-applied to brake-release position, brake cylinder **80** becomes pressurized, and the brake pads **78** disengage from brake disc **72.** Winch drum **44** is now free to rotate in the winch-lower direction and begins to do so as load **26** on line **24** of crane **10** begins to descend under the force of gravity. At this point, a smooth transition has occurred as load begins to descend under the force of gravity. As control lever **122** is moved further toward winch-lower position, valve spool **118** of brake valve **98** bottoms out in fully open position, and linkage **124** causes valve spool **118** of control valve to commence movement outwardly with respect to FIG. **6**) from neutral toward winch-lower position. Such movement causes port **114** of winch motor **34** to become pressurized and the motor begins rotation in the winch-lower direction. Motor **34** drives shaft **38,** and the latter, acting through the planetary gears **50,** causes winch drum **44** to be driven in the winch-lower direction. Winch drum **44** is already rotating but now driven for rotation at a faster speed. At this point another smooth transition in drum rotation has occurred. Further, movement of control lever **122** in the winch-lower direction causes an increase in the speed of winch motor **44.** Reverse movement of control lever **122** (short of a full return to neutral) results in a decrease in the speed of drum rotation.

When control lever **122** is returned to neutral, linkage **124** causes valve spool **118** of control valve **112** to return to neutral and effect depressurization of port **114** of motor **34.** Subsequent to this, linkage **124** effects return movement of valve spool **106** of brake valve **98** to brake-applied position, depressurization of brake cylinder **80,** and re-engagement of the brake pads **78** with brake disc **72** to brake winch **12.**

To operate winch **12** in the winch-hoist direction, control lever **122** is moved clockwise (with respect to FIG. **6**) from neutral toward winch-hoist position. As this occurs, valve spool **118** of control valve **112** is moved inwardly by linkage **124** from neutral to winch-hoist position. Such movement causes port **116** of winch motor **34** to become pressurized and the motor begins rotation in the winch-hoist direction. It is to be noted that such movement of control lever **122** does not result in any movement of brake valve spool **106** because the spool is not movable outwardly beyond its brake-applied position. However, slot **186** in plate **184** of linkage **124** permits plate **184** to move clockwise sufficiently with respect to pin **186** to allow for inward movement of valve spool **118** of control valve **112.** Since, brake valve **98** is still in brake-applied condition, brake cylinder **80** remains depressurized and the brake pads **78** still engage brake disc **72.** However, uni-directional clutch **74** between brake disc **72** and motor shaft **36** and drive shaft **38,** allows both these shafts to rotate in the winch-hoist direction despite the fact that the brake is still applied. Further movement of control lever **122** in the winch-hoist direction causes an increase in the speed of winch motor **44.** Reverse movement of control lever **122** (short of a full return to neutral) results in a decrease in the speed of drum rotation.

When control lever **122** is returned to neutral, linkage **124** causes valve spool **118** of control valve **112** to return to neutral and effect depressurization of port **116** of motor **34.** However, valve spool **106** of brake valve **98** does not move from brake-applied position. Since the brake is still applied, rotation of winch drum **44** in the winch-lower direction is prevented.

RESUME

A winch **12** for use on a mobile crane **10** to hoist or lower a load **26** comprises a hydraulic winch motor **34,** a shaft **38** driven thereby, a winch drum **44,** and planetary gearing **50** through which the shaft **38** drives drum **44.** A three-position hydraulic control valve **112** controls motor speed and direction of rotation. The winch **12** further comprises a brake disc **72** connected by a uni-directional clutch **74** to the shaft **38** and springs-applied brake pads **78** for frictional engagement with the brake disc **72.** The brake pads **78** are released from engagement with disc **72** by pressurization of a hydraulic brake cylinder **80.** A two-position hydraulic brake valve **98** controls operation of the brake cylinder **80.** Both the control valve **112** and brake valve **98** are operated by the same control lever **122** through a linkage **124** which is movable from a neutral position (wherein both valves **112** and **98** are closed) toward a winch-lower position (wherein the brake valve **98** opens before the control valve **112**) and toward a winch hoist position (wherein the brake valve **98** remains closed by the control valve **112** opens). During lowering, the winch drum **44** starts rotating smoothly as the brake is released and the load **26** causes the winch to start rotating by gravity before lowering power is applied to the winch motor **34.** During a winch-hoist operation, the uni-directional clutch **74** allows winch drum **44** rotation even though the brake pads **78** still engage the brake disc **72.**

The invention allows for a smooth transition in winch drum speed during a lowering operation. The linkage provides compact, simplified, positive control for the two valves being operated. The fluid supply for the brake valve and brake cylinder are separate from the fluid supply for the control valve and winch motor so that loss of pressure in one does not affect operation of the other.

I claim:

1. A crane having a main frame, a boom pivotally mounted on said frame for vertical swinging relative thereto, said boom comprising a plurality of telescoping boom sections for changing the length of the boom, a winch on said frame, a load line connected to said winch and trained over a free end of said boom for engaging a load, said winch comprising, a shaft, a hydraulic motor for driving said winch through said shaft in winch hoist and winch lower directions, a unidirectional clutch on said shaft, and hydraulic brake means for said winch connected to said unidirectional clutch means, said hydraulic brake means having brake-applied and brake-release positions, said unidirectional clutch means enabling said winch to be operated in the hoist direction when said hydraulic brake means are in brake applied position and enabling braking of said winch when the latter is operated in the lower direction and said hydraulic brake means are in brake applied position, control valve means for said motor, brake valve means for said brake means, and control means for operating said control valve means and said brake valve means, said control means including a movable control lever connected to and for operating both said valve means, said control lever being operable in the winch-lower direction to effect operation of said brake valve means and release of said brake means and to effect subsequent operation of said control valve means and operation of said motor in the winch-lower direction.

2. A combination according to claim 1 wherein said control means for operating said valve means are operable in the winch-hoist direction to effect operation of said control valve means and effect operation of said motor in the winch-hoist direction while permitting said brake valve means and brake means to remain in the brake-applied positions.

3. A combination according to claim 2 wherein said control means for operating said valve means comprises a movable control lever and a linkage connected between said control lever and said control valve means and said brake valve means.

4. A crane having a main frame, a boom pivotally mounted on said frame for vertical swinging relative thereto, said boom comprising a plurality of telescoping boom sections for changing the length of the boom, a winch on said frame, a load line connected to said winch and trained over a free end of said boom for engaging a load, said winch comprising, a shaft, a hydraulic motor for driving said winch through said shaft in winch hoist and winch lower directions, a unidirectional clutch on said shaft, and hydraulic brake means for said winch connected to said unidirectional clutch means, said hydraulic brake means having brake-applied and brake-release positions, said unidirectional clutch means enabling said winch to be operated in the hoist direction when said hydraulic brake means are in brake applied position and enabling braking of said winch when the latter is operated in the lower direction and said hydraulic brake means are in brake applied position, control valve means for operating said motor in the winch-hoist and winch-lower direction, brake valve means for applying and releasing said brake means, and control means for operating both of said valve means, said control means for operating both of said valve means comprising a control lever connected to both of said valve means and movable to winch-hoist and winch-lower directions, said control lever being operable in the winch-lower direction to effect operation of said brake valve means and release of said brake means prior to operation of said control valve means and operation of said motor in the winch-lower direction, said control lever being operable in the winch-hoist direction to effect operation of said control valve means and operation of said motor in the winch-hoist direction while said brake valve means and brake means remain in the brake-applied position.

5. A combination according to claim 4 wherein each of said valve means comprises a movable valve stem for effecting operation thereof and wherein said control means for operating said valves further comprises a linkage connected between said control lever and each valve stem.

6. A crane having a main frame, a boom pivotally mounted on said frame for vertical swinging relative thereto, said boom comprising a plurality of telescoping boom sections for changing the length of the boom, a winch on said frame, a load line connected to said winch and trained over a free end of said boom for engaging a load, said winch comprising, a shaft, a hydraulic motor for driving said winch through said shaft in winch hoist and winch lower directions, a unidirectional clutch on said shaft, and hydraulic brake means for said winch connected to said unidirectional clutch means, said hydraulic brake means having brake-applied and brake-release positions, said unidirectional clutch means enabling said winch to be operated in the hoist direction when said hydraulic brake means are in brake applied position and enabling braking of said winch when the latter is operated in the lower direction and said hydraulic brake means are in brake applied position, a control valve for said hydraulic motor having a neutral position, a winch-hoist position and winch-lower position, a brake valve for said brake cylinder having a brake-applied position and a brake-release position, a control lever for said control valve and for said brake valve, said control lever having a neutral position, a winch-hoist position and a winch-lower position, and a linkage comprising lost-motion connection means connected between said control lever and said control valve and said brake valve, said linkage, when said control lever is moved from neutral to lower position, effecting movement of said brake valve to brake-release position and subsequently effecting movement of said control valve to winch-lower position, and said linkage, when said control lever is moved from neutral to winch-hoist position, effecting movement of said control valve to winch-hoist position but permitting said brake valve to remain in brake-applied position.

7. A crane having a main frame, a boom pivotally mounted on said frame for vertical swinging relative thereto, said boom comprising a plurality of telescoping boom sections for changing the length of the boom, a winch on said frame, a load line connected to said winch and trained over a free end of said boom for engaging a load, said winch comprising, a shaft, a hydraulic motor for driving said winch through said shaft in winch hoist and winch lower directions, a unidirectional clutch on said shaft, and hydraulic brake means for said winch connected to said unidirectional clutch means, said hydraulic brake means having brake-applied and brake-release positions, said unidirectional clutch means enabling said winch to be operated in the hoist direction when said hydraulic brake means are in

brake applied position and enabling braking of said winch when the latter is operated in the lower direction and said hydraulic brake means are in brake applied position, said brake means comprising a brake and hydraulic brake cylinder connected to said brake and operable to effect release of said brake, a control valve for said hydraulic motor and comprising a movable valve stem having a neutral position, a winch-hoist position and a winch-lower position, a brake-valve for said brake cylinder and comprising a movable valve stem having a brake-applied position and a brake-release position, said brake valve stem when in brake-release position effecting operation of said brake cylinder, a control lever connected to said control valve stem and to said brake stem, said control lever having a neutral position, a winch-hoist position and a winch-lower position, and a linkage comprising lost-motion connection means connected between said control lever and said control valve stem and said brake valve stem, said linkage, when said control lever is in neutral position, maintaining said control valve stem in neutral position and said brake valve stem in brake-applied position, said linkage, when said control lever is moved from neutral to lower position, effecting movement of said brake valve stem to brake-release position and subsequently effecting movement of said control valve stem to winch-lower position, and said linkage, when said control lever is moved from neutral to winch-hoist position, effecting movement of said control valve stem to winch-hoist position but permitting said brake valve stem to remain in brake-applied position.

8. A crane having a main frame, a boom pivotally mounted on said frame for vertical swinging relative thereto, said boom comprising a plurality of telescoping boom sections for changing the length of the boom, a winch on said frame, a load line connected to said winch and trained over a free end of said boom for engaging a load, said winch comprising a hydraulic motor, a shaft driven by said motor, a winch drum and gear means connected between said shaft and said drum to effect rotation of said drum; brake means for said winch comprising a brake disc, a unidirectional clutch for connecting said disc to said shaft, a caliper brake assembly comprising brake pads for engagement with said disc, spring means for normally biasing said pads against said disc, and a hydraulic brake cylinder pressurizable to release said pads from said disc, a three-position control valve for said motor and comprising a spool having a neutral position, a hoist position and a lower position, a source of pressurized hydraulic fluid for said control valve, a two-position brake valve for said brake cylinder and comprising a spool having a brake-closed position and a brake release position, a source of pressurized hydraulic fluid for said brake valve, control means for said valves comprising a control lever and a member pivotably movable thereby, said member having first and second arms and being movable about a point in response to movement of said control lever, first and second pins on said first and second arms, respectively, a first link pivotably connected between said first pin and the spool of said control valve, said first link being provided with a slot in which said first pin is engaged, a second link pivotably connected between said second pin and the spool of said brake valve, said second link being provided with a slot in which a pin on said brake valve spool is engaged, a stop projection on said second link engageable with said second arm, and a biasing spring connected between said second link and said hub.

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