United States Patent

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[54] **BOOM ROTATION BRAKE RELEASE MEANS FOR DERRICKS**

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[52] **U.S. Cl.** **173/43,** 173/46, 212/35, 212/66

[51] **Int. Cl.**.....**E21c 5/00**

[58] **Field of Search** 212/66, 69, 35; 173/43, 46

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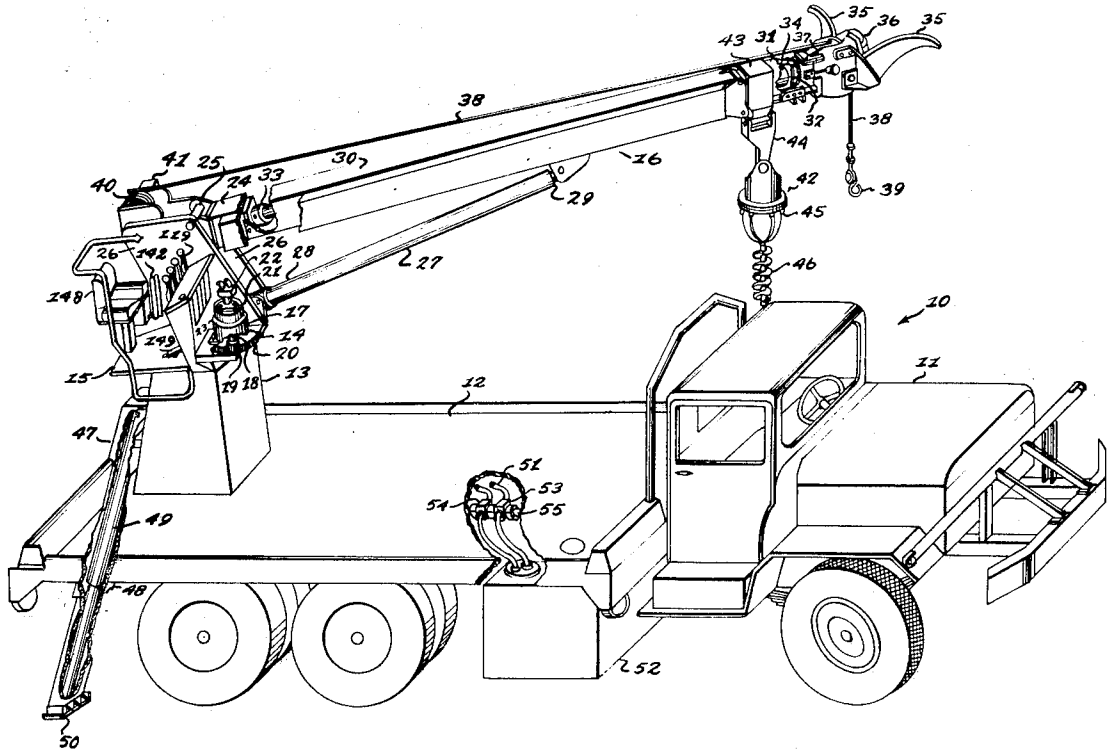
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[57] **ABSTRACT**

A derrick having boom rotation brake release means operable to allow the boom to be rotated by side loading above a predetermined magnitude and thereby relieve the extent of side loading so as to avoid damage to the derrick. The boom is rotated by a hydraulic motor with which is associated a double relief valve that allows reverse operation of the motor as an idler pump while imposing a limited resistance to rotation. The brake release means is hydraulically operated to release a brake mechanism that normally prevents boom rotation, with the brake release means being connected in the hydraulic system of the derrick for operation to release the brake mechanism in response to an increase in the hydraulic pressure in the system occurring during operation of the rotation motor and also during operation of other hydraulically operated derrick functions to allow the boom to rotate during operation of the rotation motor and to be rotated by side loading during operation of the other derrick functions, with the resistance of the rotation motor preventing rotation until a predetermined magnitude of side loading is imposed. Deactuation of the rotation motor and all of the other derrick functions results in a pressure decrease that renders the brake release means inoperable to allow the brake mechanism to prevent further rotation of the boom when the derrick functions have been completed or at any time that it becomes necessary to stop boom rotation, e.g., to avoid damaging contact with an adjacent object.

18 Claims, 3 Drawing Figures



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SHEET 1 OF 3

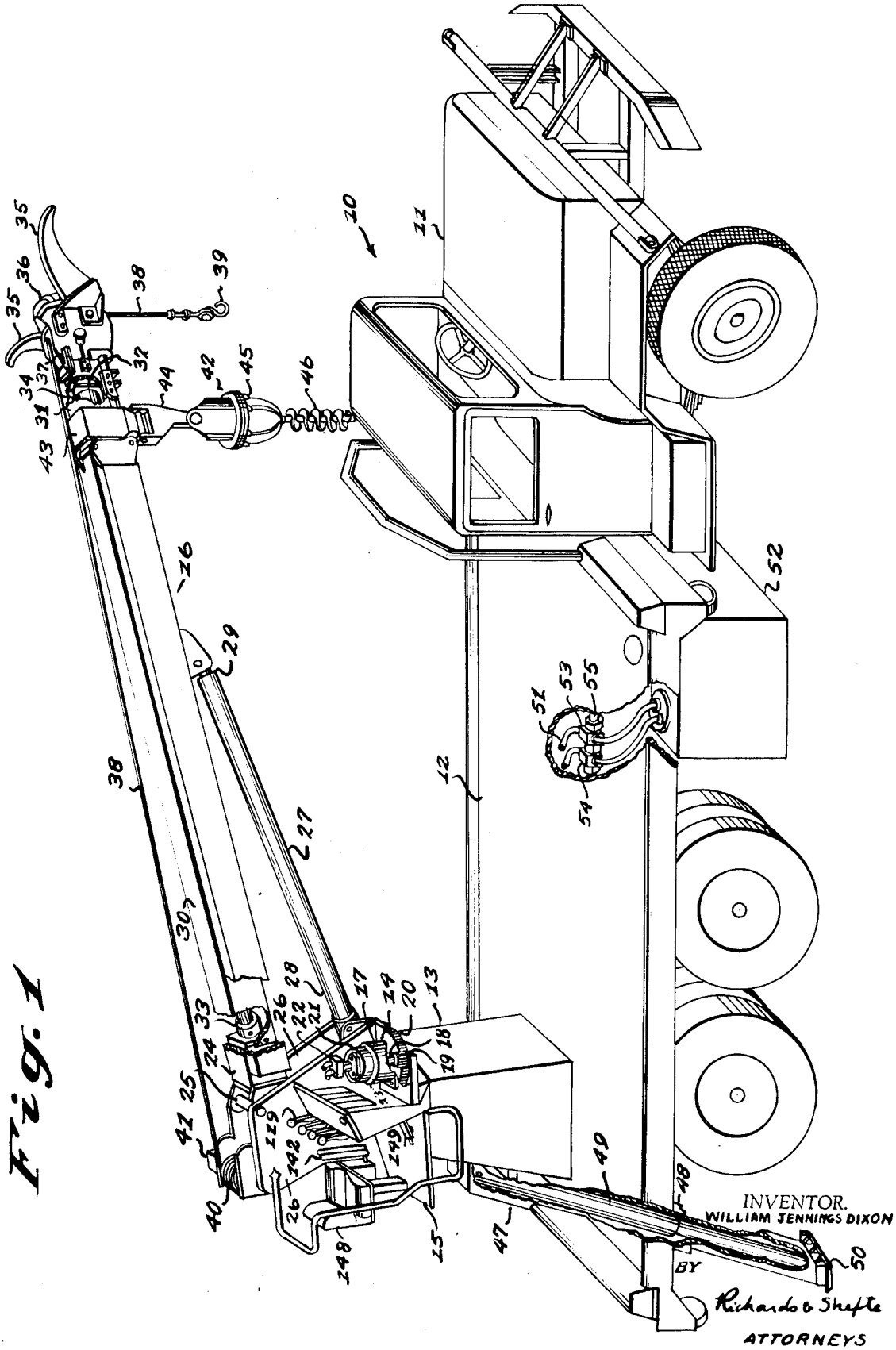


Fig. 1

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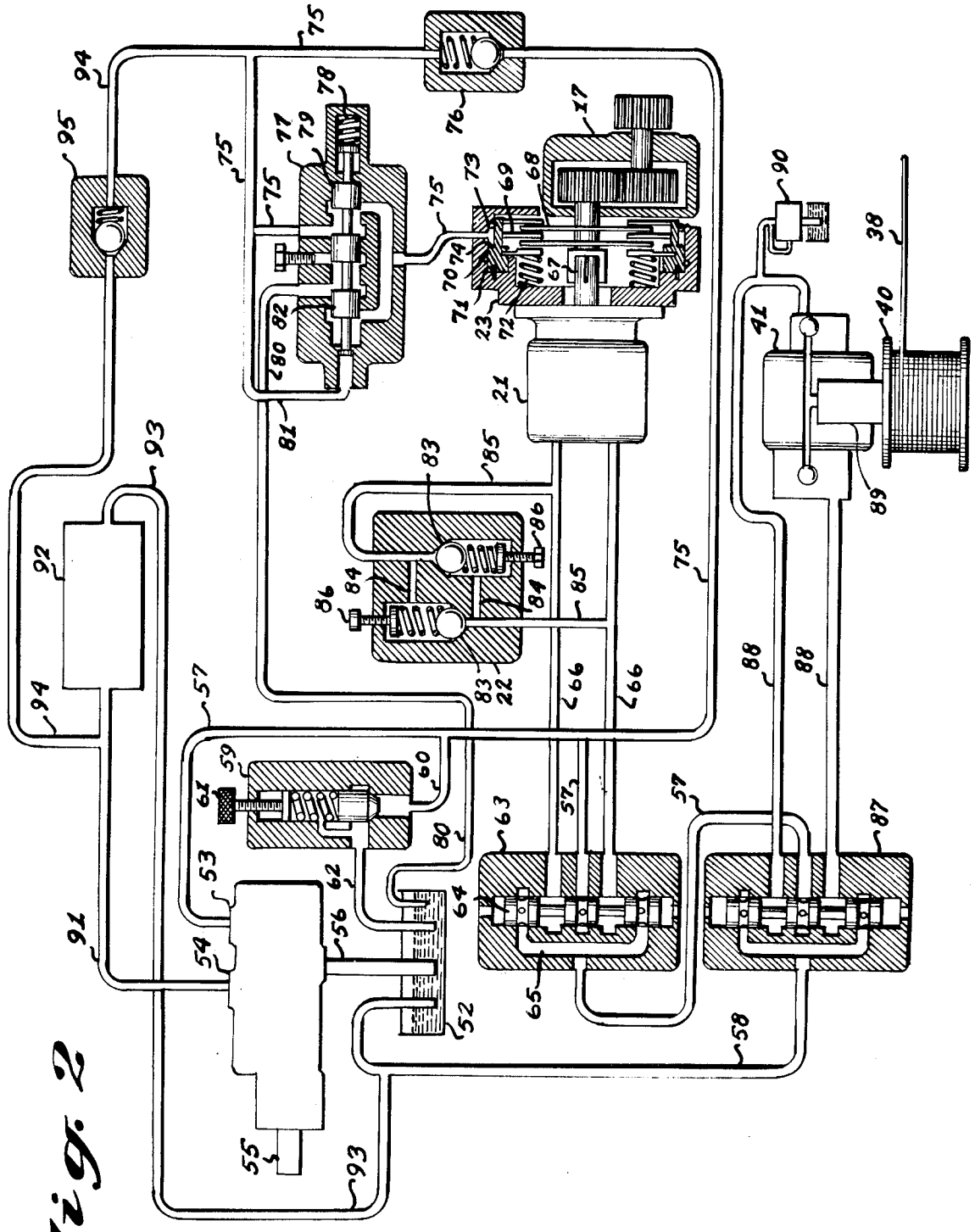


Fig. 2

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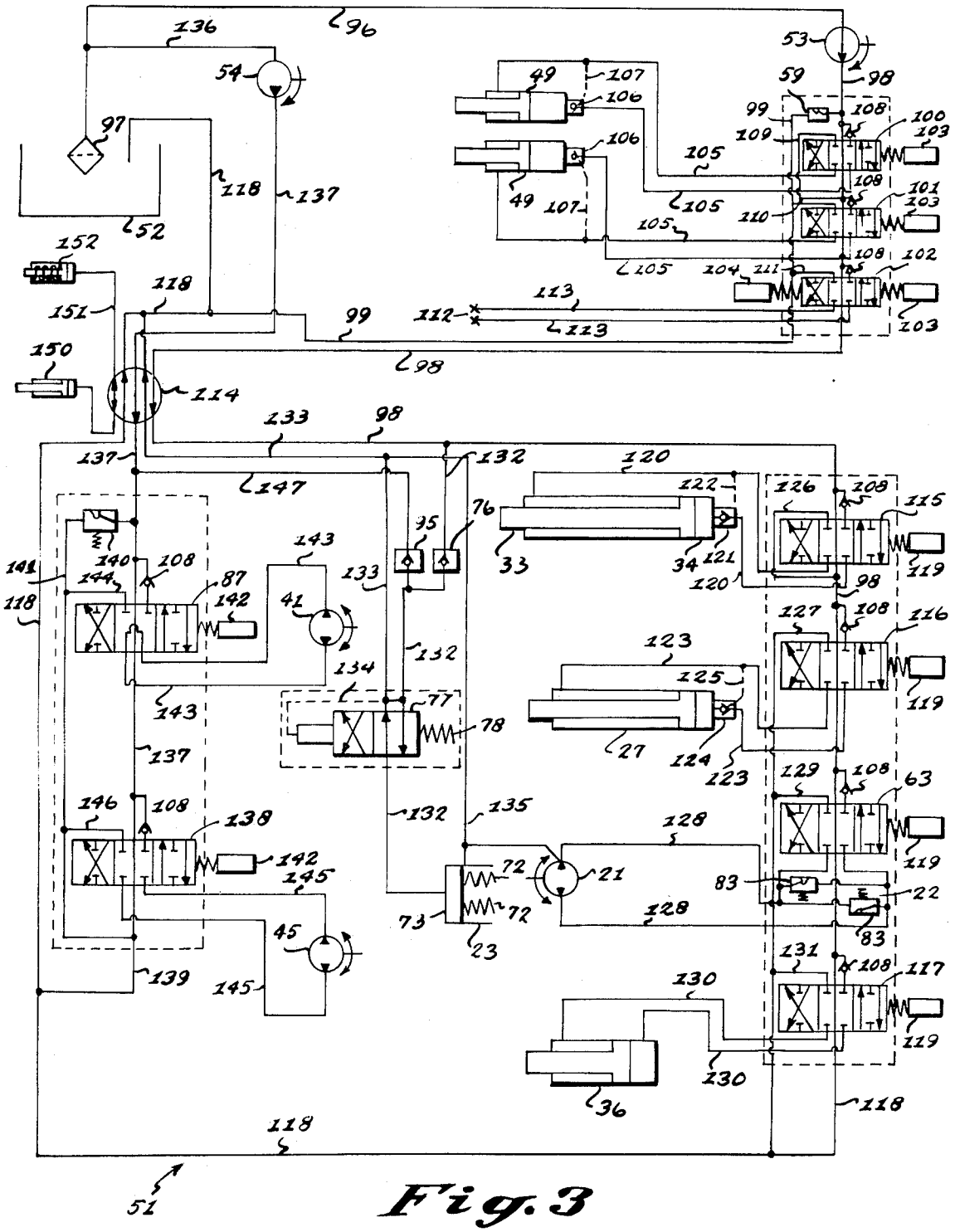


Fig. 3

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BOOM ROTATION BRAKE RELEASE MEANS FOR DERRICKS

BACKGROUND OF THE INVENTION

The present invention relates to derricks and more particularly to a derrick having boom rotation brake release means operable to allow the boom to be rotated by side loading above a predetermined magnitude so that the side loading will be relieved without damage to the derrick that could result from excessive side loading.

In the use of most derricks, the development of side loading conditions are unavoidable in performing many of the usual derrick functions. For example, at any time the winch line of the derrick is connected to a load that is located to one side or the other of the boom and the winch line is pulled in or the boom is extended or retracted or the boom is raised or lowered, a significant side loading condition may result. Also, if the derrick is equipped with a digger mechanism or with pole claws or similar load engaging means, side loading can occur. Because of this, derricks are usually constructed to withstand side loading within practical design limitations. However, it is impractical to design derricks to withstand all possible side loading conditions, and heretofore reliance has been placed on the operator to avoid imposition of side loads sufficiently excessive to cause damage to the derrick, but the magnitude of side loading is not always readily detectible by an operator and to leave control to the judgment of the operator can, and often does, result in breakdowns due to excessive side loading.

The effect of side loading is to apply a force at the end of the boom which, if unopposed, would tend to rotate the boom in the direction of side load application. This force is transmitted through the boom to the rotation gearing that is provided to transmit power from a drive motor into positive rotation of the boom. This gearing, such as a worm and worm gear, is usually irreversibly incapable of allowing rotation of the boom by a side loading force. As a result, excessive side loading will break the teeth of the gearing, or, if the gearing is strong enough to withstand the side loading, damage will occur in the boom or some other component structurally related to the boom. Any damage of this type requires taking the derrick out of operation for repair, with a loss of the productivity of the derrick crew as well as the derrick, which may be especially disadvantageous when the derrick is being used at a location remote from repair parts and repair facilities, as may often be the case.

By the present invention the problem of damage due to excessive side loading of a derrick boom is eliminated entirely by inherent operation of the components independent of the control of the operator. This has not been accomplished heretofore, particularly in the simple, versatile, and reliable manner of the present invention, which has the capability of selective adaptation to allow boom rotation in relief of side loading during operation of any of the various derrick functions that could result in excessive side loading.

The prior art discloses, in Balogh et al. U. S. Pat. No. 3,396,852, a hydraulic relief valve that allows a derrick boom to move downwardly when the vertical load becomes excessive, and, in Stauffer U. S. Pat. No. 3,315,820, a hydraulically operated release of a derrick winch when the winch line block binds against the end of the boom during boom extension, but neither of these prior art patents suggest the provision of the present invention for boom rotation by side loading during operation of various derrick functions to avoid damage to the boom rotating means, such as the gearing, and more particularly these prior art patents do not suggest the manner in which this advantageous feature is obtained by the present invention. Further, each of these patents is specific to operation when a load is applied in only one direction, i.e., when a vertically downward, not upward, load is applied in Balough U. S. Pat. No. 3,396,852, and when an outward, not inward, load is applied in Stauffer U. S. Pat. No. 3,315,820, whereas the present invention is capable of allowing boom rotation in either direction of side loading.

SUMMARY OF THE INVENTION

Briefly described, the derrick of the present invention includes a boom rotatably mounted on a base and rotated by means that is inherently reversible with a limited resistance to rotation for allowance of rotation of the boom upon imposition of a side loading condition above a predetermined magnitude. Means is also included in the derrick for performing a derrick function that may result in side loading of the boom. The boom is normally prevented from rotating by a brake mechanism that is releasable to allow boom rotation by operation of brake release means that is operable in response to operation of the boom rotating means, thereby allowing the boom to be rotated by the boom rotating means. The brake release means is also operable in response to operation of the derrick function performing means for releasing the brake mechanism to allow the boom to be rotated by side loading above the predetermined magnitude during operation of the derrick function performing means. Further, the brake release means is rendered inoperable in response to deactuation of both the boom rotating means and the derrick function performing means to allow the brake mechanism to prevent rotation of the boom upon such deactuation.

Thus, the present invention provides protection against damage due to excessive side loading by allowing the boom to be rotated by side loading of a predetermined magnitude, which rotation relieves the side loading and is inherently allowed without requiring control by an operator. Further, such rotation by side loading is stopped inherently simply by deactuation of both the boom rotating means and the derrick function performing means, which stopping is of particular importance when external objects are in the path of boom rotation and it is preferable to stop the boom rather than strike the object even though damage to the boom or boom rotating means may result from such premature stopping.

Preferably, the boom rotating means and brake release means are capable of allowing boom rotation in either direction so that upon operation of the brake release means the boom may be rotated by side loading in either direction of boom rotation, which provides an advantageous versatility in the present invention.

The aforementioned derrick function performing means may be any means that may directly or indirectly produce side loading of the boom, such as means for

extending and contracting the boom, means for raising and lowering the boom, means for rotating a winch, means for operating a hole digging auger, or various other derrick function performing means. The brake release means is responsive to any one or more of these derrick function performing means and preferably is responsive to all such means that would produce boom side loading within the range of intended use of a particular derrick.

In the preferred embodiment of the present invention both the boom rotating means and the derrick function performing means are hydraulically operated and are connected for selective operation to a hydraulic system that includes means for pumping a liquid through the system with sufficient pressure development capability to operate the boom rotating means and the derrick function performing means. The brake release means is also connected to the hydraulic system for operation in response to operation of any one of the boom rotating means and derrick function performing means and to be rendered inoperable in response to deactuation of hydraulic operation of both the boom rotating means and derrick function performing means. The brake release means is preferably hydraulically operated by the system and is connected to the system upstream of the boom rotating means and derrick function performing means for operation in response to an increase of pressure in the system resulting from operation of either the boom rotating means, or the derrick function performing means.

Where some derrick function performing means, such as stabilizing outriggers, are incorporated in the derrick and have little likelihood of producing excessive side loading, they may be operatively connected to the hydraulic system upstream of the connection of the brake release means so as not to effect unnecessary or undesirable operation of the brake release means.

Thus, the advantages of the present invention can be obtained practically, simply and reliably in the preferred embodiment by incorporating the control and operation of the components in a hydraulic system that can be versatilely designed to provide release of the boom for rotation by variously imposed side loading conditions, while providing for stopping of such boom rotation when necessary or desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a derrick incorporating the preferred embodiment of the present invention and partially broken-away to show various pertinent components;

FIG. 2 is a schematic illustration of the hydraulic system of a simplified from of the present invention; and

FIG. 3 is a schematic illustration of the hydraulic system of the preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the preferred embodiment of the present invention, as illustrated in FIG. 1, the derrick **10** is mounted on a conventional self-propelled truck **11** having a flat bed **12** at the rear of which is mounted an upstanding base **13**. A large circular rotary bearing **14** is attached to the top of the base **13** and rotatably supports a turret **15** on which a boom **16** is pivotally mounted. Thus, the boom **16** is rotatably mounted on the base **13** through the intermediate turret **15** and bearing **14**.

Means for rotating the turret **15** and with it the boom **16** is provided in the form of conventional planetary gearing **17** that is mounted on the turret **15** and has a depending drive pinion **18** with teeth **19** engaging gear teeth **20** formed around the periphery of the rotary bearing **14**. The planetary gearing **14** is driven by a conventional hydraulically operated rotation motor **21** mounted on top of the gearing **17**. Thus, operation of the rotation motor **21** causes rotation of the drive pinion **18**, which, through the gear teeth engagement with the rotary bearing **14**, causes the turret **15** and boom **16** to be rotated with respect to the base **13**.

The planetary gearing **17** is conventionally reversible, i.e., it is capable of transmitting rotation from the motor **21** to the pinion **18** or from the pinion **18** to the motor **21**, and the motor **21** is also reversible to act as an idler pump, for which purpose a double acting relief valve **22** is connected across the hydraulic lines to the motor **21** to permit hydraulic circulation through the motor upon a rotational input imposed by the drive pinion **18** through the gearing **17**. Thus, the reversible motor **21** and gearing **17** will allow the boom **16** to be rotated by an external force, such as a side loading condition, with the inertia of the boom **16** and turret **15**, the frictional resistance inherent in the gearing **17** and the inherent hydraulic resistance of the relief valve **22**, which is adjustable for this purpose as will be described hereinbelow, providing a limited resistance to rotation for allowance of rotation of the boom **16** upon imposition of a side loading condition above a predetermined magnitude.

Rotation of the boom **16** and turret **15** is normally positively prevented by a brake mechanism **23** (FIGS. 2 and 3) located between the motor **21** and gearing **17**, which is hydraulically releasable to allow boom rotation during driving operation of the rotation motor **21** or when it is desired to allow side loading to rotate the boom **16**.

To support the boom **16** on the turret **15** for vertically pivotal movement, the inner end **24** of the boom **16** is fixed to a connecting pin **25** that is journalled in spaced upstanding turret plates **26**, between which the inner boom end **24** is disposed. The boom **16** is further supported on the turret **15** by a piston-cylinder mechanism **27** that has an inner end **28** pivotally secured between the turret plates **26** at a spacing below the boom **16** and an outer end **29** pivotally secured to the underside of the boom **16** intermediate its ends. This piston-cylinder mechanism **27** not only supports the boom **16**, but also is hydraulically operated to extend and retract its piston, and, therefore, serves as means for raising and lowering the boom **16**.

The boom **16** is formed compositely of telescoping sections to permit longitudinal extension and contraction. The telescopingly outer boom section **30** is fixed to the inner boom end **24** and the telescopingly inner section **31** is slidable in the outer section **30** and has an outer end **32** projecting therefrom. A hydraulically operated piston-cylinder mechanism is mounted internally in the boom **16** with its piston end **33** secured to the inner end **24** of the boom **16** and its cylinder end **34**

secured to the outer end 32 of the inner sliding boom section 31. Thus, this piston-cylinder mechanism serves as means for extending and contracting the boom 16.

The projecting outer end 32 of the inner boom section 31 has pivotally mounted thereon a pair of pole claws 35 and a hydraulically operated piston-cylinder mechanism 36 that operates the pole claws 35 for engaging and holding a pole or other object at the boom end 32.

Also mounted on the projecting boom end 32 is an idler sheave 37 over which a load manipulating winch line 38 is supported and guided. This winch line depends from the sheave 37 and has a load supporting hook 39 fixed to its depending end. The winch line 38 extends along the boom 16 to a winch 40 mounted between the aforementioned turret plates 26 adjacent the inner boom end 24. The winch 40 is rotated by a hydraulically operated winch motor 41 that serves as means for rotating the winch 40 to pay out or pull in the winch line 38.

The derrick 10 is further provided with an auxiliary function performing means in the form of a device 42 for digging holes in the ground, such as are required for utility poles and the like. This hole digging device 42 is mounted at the extending end of the outer boom section 30 so that it can be maneuvered by the boom 16 to desired hole locations. It consists of a mounting fixture 43 attached to the outer boom section 30, a depending connecting arm 44 pivotally suspended from the fixture 43, a hydraulically operated auger motor 45 pivotally suspended from the connecting arm 44, and a helical auger 46 extending from and driven by the motor 45. The pivotal connection of the arm 44 to both the fixture 43 and the motor 45 allows the auger 46 to be disposed at any desired inclination with respect to the boom.

The derrick 10 is stabilized during operation by a pair of outriggers 47, one of which is shown in FIG. 1, that are secured to the rear of the base 13 and extend downward therefrom at a lateral inclination. These outriggers 47 have extendible leg sections 48 that are extended and retracted by hydraulically operated piston-cylinder mechanisms 49 mounted within the leg sections 48. The outriggers 47 are normally in a retracted position when the boom 16 is not in an operating condition and are extended preparatory to use of the boom 16 to stabilize the boom 16 by pressing the feet 50 at the lower ends of the leg sections 48 against the ground.

The various hydraulically operated components described hereinabove are connected for selective operation in a hydraulic system 51 that includes a reservoir 52 mounted on the underside of the truck bed 12 and means for pumping a liquid from the reservoir 52 through the hydraulic system 51 with sufficient pressure development capability to operate the various components. Preferably, the pumping means includes a plurality of hydraulic pumps of different capacities for providing suitable power for the different requirements of the various components. In the embodiment illustrated, the pumping means consists of two pumps 53 and 54, one of which, designated 53, is a relatively low volume pump, and the other, designated 54, is a relatively high volume pump. Both pumps 53 and 54 are located under the truck bed 12 and are arranged in tandem for driving by a power take-off shaft 55 that is driven by the truck motor (not shown).

A simplified version of the hydraulic system of the derrick of the present invention is illustrated in FIG. 2, which shows the pumps 53, 54 drawing liquid from the reservoir 52 through supply line 56. The pumps 53, 54 are driven by the shaft 55, with the pump 53 circulating liquid under pressure through the pressure line 57 to the operating components of the system and therefrom through the return line to the reservoir 52.

Downstream from the pump 53 and upstream from the operating components is a main relief valve 59 connected by a branch line 60 to the pressure line 57. This main relief valve 59 is a conventional piston-spring type valve that is normally closed and opens when the line pressure becomes great enough to overcome the spring pressure, which is adjustable by manipulation of the adjustment screw 61, to allow the liquid to flow from the pressure line 57, through the valve 59, and through a valve return line 62 to the reservoir 52. Thus, the main relief valve 59 prevents pressure development in the system beyond a safe maximum.

Located across the pressure line 57 downstream from the main relief valve 59 is a three position rotation control valve 63. This is a conventional shuttle valve having a neutral position, as illustrated, in which liquid is received at the center from the pressure line 57 and flows through a bore in the valve shuttle 64 to the ends of the valve and through a connecting chamber 65 to the return line 57 downstream of the valve 63. Operation of the valve 63 is accomplished by shifting the shuttle 64 in either axial direction, which connects one of two motor connection lines 66 to the upstream portion of the pressure line 57 for liquid flow to the rotation motor 21 connects the other of the motor connection lines 66 to the downstream portion of the pressure line 57 for return of liquid from the rotation motor 21. Shifting of the shuttle 64 from one extreme to the other reverses the hydraulic input to the motor to reverse its direction of operation.

The rotation motor 21 rotates a drive shaft 67 that drives the rotation gearing 17 to rotate the boom 16 as explained hereinabove. Rotation of the drive shaft 67, and, therefore, rotation of the motor 21 and gearing 17, is controlled by the brake mechanism 23, which is located intermediate the motor and the gearing. The brake mechanism includes discs 68 fixed on the shaft 67 and extending radially between discs 69 fixed in an annular piston 70 that is fixed in the brake mechanism 23 by a key 71 against rotation, but is capable of limited axial movement. Springs 72 disposed within the brake mechanism 23 act on the piston discs 69 to force them and the piston 70 axially for compression against the drive shaft discs 68 to lock the shaft 67, gearing 17 and motor 21 against rotation.

Hydraulically operated brake release means is provided to deactuate the brake mechanism 23 and allow the motor 21 to drive the gearing 17 and thereby rotate the boom 16. This brake release means includes an annular chamber 73 in the brake mechanism 23, having one end defined by a shoulder 74 of the piston 70, against which hydraulic pressure in the chamber 73 will act to move the piston 70 axially against the bias of the springs 72 to relieve the braking compression on the discs 68 and 69. Hydraulic pressure in the chamber 73

is obtained from the pressure line 57 upstream of the rotation control valve 63 through a brake release line 75 having a check valve 76 and a brake release control valve 77 located therein. The brake release control valve 77 is a conventional two position, pilot operated shuttle valve having a spring 78 normally biasing the shuttle 79 in a leftward position in relation to FIG. 2, which causes the shuttle to block the passage of liquid through the brake release line 75 to the brake mechanism 23, and opens the brake release chamber 73 to a return line 80 so that the chamber 73 will be unpressurized and the brake mechanism applied to prevent boom rotation. The force of the spring 78 is sufficient to maintain the shuttle 78 in brake operating position when no hydraulic system components are operated to increase the line pressure, which is applied against the shuttle 79 through a pilot line 81 that connects the brake release line 75 to the left (FIG. 2) end of the shuttle 79. When the line pressure increases due to diversion of the hydraulic fluid to the rotation motor 21 or other hydraulically operated component, such as the winch motor described below, and the line pressure exceeds the resistance of the spring 78, the shuttle 79 will be shifted rightward by the hydraulic pressure to the position shown in FIG. 2, in which the brake release line 74 is open through the control valve 77 to the chamber 73, with the hydraulic pressure acting on the piston 70 to release the braking compression of the discs 68 and 69. When the line pressure drops upon termination of operation of whatever component has been operating, the check valve 76, which is a conventional ball and spring check valve, will prevent pressure relief on the pressure line side of the control valve 77, but a land 82 formed on the valve shuttle 79 will allow liquid to flow from the chamber 73 to the return line 80, thereby causing a release of pressure that allows the brake mechanism to return to braking condition at a controlled rate so as to avoid damage to the derrick components that might occur if the brake acted instantaneously. The land 82 results in return flow of liquid even when the brake release is functioning, but the rate of flow is sufficiently slow to allow the line pressure to maintain the brake release means operable when the line pressure is increased due to operation of one of the components of the system.

With this brake release arrangement, the brake mechanism 23 will be released when the rotation control valve 63 is shifted to divert the main pressure line 57 to the rotation motor 21 and the line pressure increases due to the resistance of the motor 21. Thus the motor 21 will be free to rotate the boom. Similarly, the brake mechanism 23 is released at any time the main pressure line 57 is diverted to operate a component other than the rotation motor 21, but in such case the rotation motor connection lines 66 would be blocked by the rotation control valve 63 so that the liquid in the motor and connecting lines could not circulate and the motor could not operate, with the result that the motor would serve as a brake to prevent boom rotation even when the brake mechanism 23 is released. To avoid this brake action of the rotation motor 21, and thereby, allow the motor to act as an idler pump and for allowance of boom rotation, the double acting relief valve 22 is connected across the motor connection lines 66. This double acting relief valve 22 has a pair of parallel, oppositely acting, ball and spring check valves 83 formed wherein with connecting passages 84 arranged so that liquid under pressure in either one of the motor connection lines 66 will flow through a connected branch line 85 into one or the other side of the relief valve 22, through the inline check valve 83, assuming the pressure is sufficient to overcome the bias of the check valve spring, through the downstream one of the two connecting passages 84, and thence through the other of the branch lines 85 to the other motor connection line 66. The hydraulic pressure will also be transmitted through the upstream one of the connecting passages 84 into the other of the check valves 83 but will not flow therethrough due to the blocking arrangement of the valve to flow in this direction. Thus, circulation of pressurized fluid is allowed from one motor connection line 66 to the other whenever the pressure is sufficient to overcome the spring bias in the valve. In this way, when a side load acts on the boom 16 in either direction of boom rotation to create sufficient hydraulic back pressure in the rotation motor to overcome the resistance of the relief valve 22, the relief valve will allow hydraulic flow to permit the motor to act as an idler pump, which permits the boom to be rotated by the side load, provided the brake release means is in operation. The resistance pressure of the relief valve 22 is adjustable by manipulation of the adjusting screws 86 to vary the spring resistance, which is normally set to prevent flow through the relief valve 22 during desired operation of the rotation motor 21, but will allow idler pump action of the motor and will also prevent excessive pressure loading of the motor 21 during operation.

Located in the pressure line 57 downstream of the rotation motor control valve 63 and in series therewith is a winch motor control valve 87, which is identical in construction and operation to the rotation motor control valve 63 and functions identically through connecting lines 88 to operate the aforementioned winch motor 41 for rotation of the winch 40 in either direction to pay out or pull in the winch line 38. A winch brake 89 is included in this system to prevent winch operation when the winch motor is inoperative, and a relief valve 90 is connected to the connecting line 88 that powers the winch motor 41 for line pulling, which prevents excessive pressure development in the winch motor 41.

The downstream side of the winch motor control valve 63 is connected to the aforementioned return line 58 for return of the liquid to the reservoir 52.

When the winch motor control valve 87 is manipulated to operate the winch motor 41, the resistance of the winch motor will cause an increase in the upstream pressure, causing the brake release control valve 77 to function to release the brake mechanism 23 to allow the boom 16 to be rotated upon side loading sufficient to overcome the resistance in the relief valve 22, the frictional resistance of the motor 21 and gearing 17 and the enertia of the boom 16 and turret 15. When the side loading is within design limits as controlled by the adjustment of the relief valve 22, the non-circulating condition of the liquid in the motor 21 will maintain the boom stationary.

Release of the boom for limited resistance rotation is particularly appropriate in relation to winch operation

as the winch line **38** is commonly used to handle loads to one side or the other of the boom **16**, which may result in excessive side loading that dictates protection of boom and other derrick components by allowing boom rotation as is provided by the present invention. However, release of the boom **16** for rotation can additionally alternatively be effected during operation of other derrick function performing means, as is indicated in FIG. **2** by the high volume pump **54**, secondary auxiliary line **91** connecting the high volume pump **54** to one or more derrick function performing means **92**, auxiliary return line **93** from the means **92** to the reservoir **52**, auxiliary brake release line **94** connecting the auxiliary pressure line **91** to the aforementioned brake release line **75**, and a check valve **95** in the auxiliary brake release line **94**. In this arrangement the corresponding check valves **76** and **95** serve the additional function of preventing flow and pressure application form one side of the system to the other upstream of the brake release control valve **77**.

A hydraulic system capable of effecting brake release for side load boom rotation during operation of various derrick function performing means in addition to rotation and winch operation is disclosed in the FIG. **3** illustration of the preferred embodiment of the present invention. As this system is generally similar to the system of FIG. **2**, with many of the components being identical, like reference numerals are shown indicating various ones of the identical components. This FIG. **3** hydraulic system **51** contains the derrick components described hereinabove in relation to the derrick illustrated in FIG. **1**.

In this system **51**, a primary supply line **96** leads from a filtered intake **97** in the reservoir **52** to a primary hydraulically operated pump **53** that pumps liquid through a primary pressure line **98**. A main relief valve **59** is connected to the primary pressure line **98** downstream from the pump **53** and is adjustable to prevent excessive pressure buildup in the system by opening at a predetermined pressure to allow liquid to flow through a relief valve return line **99** to the reservoir **52**.

Downstream from the main relief valve **59** is a bank of three consecutive control valves, **100**, **101**, **102**, each connected to the primary pressure line **98** and each being a three position valve identical in construction and operation to the above-described rotation control valve **63**, with each valve having a spring biased, manually operable control lever **103** that requires maintenance of manual pressure to maintain the valve in an operable position, although the last valve **102** has a detent **104** that may be used to lock the valve in an operable condition.

The first two valves **100** and **101** in this three valve bank control hydraulic operation of the aforesaid outrigger piston-cylinder mechanisms **49** by connecting opposite ends of the mechanisms to the pressure line **98** trough connecting lines **105** for extending or contracting the outriggers as controlled by the positions of the valves **100**, **101**. A pilot releasable check valve **106** is located in the connecting lines **105** at the head end of each mechanism **49** to prevent back flow of the liquid from the head end when the line pressure is reduced, thereby maintaining the outriggers **47** in extended condition following an extension operation. These pilot releasable check valves **106** are opened by pressure in pilot lines **107** from the connecting lines **105** for the rod ends of the mechanisms **49** so that upon an outrigger retraction operation of the system the operating pressure in the pilot lines **107** will release the pilot check valves to allow return of liquid from the head ends of the mechanisms. Safety check valves **108** are provided at the pressure side of each of these valves as well as all of the other control valves in the entire system to prevent back flow and a corresponding pressure drop that could be hazardous.

The return line **109** from the first outrigger control valve **100** is connected to the primary pressure line **98** upstream of the second outrigger control valve **101** so that these valves can be operated in series for simultaneous manipulation of both outriggers **47**, but the return lines **110** and **111** from the second and third valves **101** and **102** of this bank are connected to the aforementioned relief valve return line **99** for return of liquid to the reservoir **52**.

The third control valve **102** in the three valve bank is connected to power take-off outlets **112** by connecting lines **113** for operation of auxiliary equipment.

The primary pressure line **98** continues from the three valve bank through a rotary manifold **114** located in the connection of the base **13** and turret **15** and provided to maintain communication between the portions of the various hydraulic lines below the turret **15**, which are shown above the manifold **114** in FIG. **3**, and the portions that are on the turret **15** and rotate therewith, which are shown below the manifold **114** in FIG. **3**. From the rotary manifold **114** the primary pressure line **98** extends to and through a bank of four consecutive control valves **115**, **116**, **63**, and **117** and then becomes a primary return line **118** extending back through the rotary manifold **114** to the reservoir **52**.

These four valves **115**, **116**, **63**, and **117** are three position valves identical to the valves **100**, **101** and **102** in the abovedescribed three valve bank, with each having a similar spring biased control lever **119**. The first of these four valves is a boom extension and contraction control valve **115** connected to the aforementioned boom extension and contraction piston-cylinder mechanism **33**, **34** by connecting lines **120** with a pilot operated check valve **121** and connecting pilot line **122** the same as described above in the outrigger operating portion of the system. Similarly, the second valve **116** in the four valve bank is a boom raising and lowering control valve connected to the aforementioned boom raising and lowering piston-cylinder mechanism **27** by connecting lines **123** with a pilot operated check valve **124** and connecting pilot line **125** the same as described above in the outrigger operating portion of the system. Thus, these two valves **115** and **116** control extension and contraction and raising and lowering of the boom **16** in the same manner as the outrigger operation is controlled, with the return side of the extension and contraction control valve **115** being connected by return line **126** to the primary pressure line **98** upstream of the raising and lowering control valve **116** to allow simultaneous operation of the controlled functions. The return side of the raising and lowering control valve **116** is connected by a return line **128** to the aforementioned primary return line **118**.

The third of the valves in the four valve bank is a boom rotation control valve **63** identical to that described above in the FIG. **2** embodiment and connected in the same way to an identical rotation motor **21**, with connecting lines **128** for operation of the motor **21** in either direction of rotation, and with a double acting relief valve **22** connected between the connecting lines **128** and containing parallel, oppositely acting check valves **83** for allowing limited resistance idler pump operation of the rotation motor **21** when the boom is subjected to side loading of a predetermined magnitude as well as to provide a limitation on the pressure that can be applied to the motor **21** through the primary pressure line **98**, all as described above in relation to the similar arrangement in the FIG. **2** embodiment. The return side of this rotation motor control valve **63** is connected to a return line **129** to the primary return line **118**.

The fourth of the valves in the four valve bank is a pole claw operating valve **117** similar to the previously described valves and connected to opposite ends of the pole claw operating piston-cylinder mechanism **36** by connecting lines **130** for reversible operation of the mechanism to open and close the pole claws **35**. The return side of this valve **117** is connected by a return line **131** to the primary return line **118**.

Rotation of the boom **16** by the rotation motor **21** or by any external loading is prevented by a brake mechanism **23** acting on the drive shaft **67** of the motor **21** with springs **72** normally biasing the brake mechanism **23** in a braking condition and releasable by hydraulic pressure in a chamber **73** acting to relieve the spring pressure, as described above in regard to the same arrangement in the FIG. **2** embodiment.

Release of the brake mechanism **23** is accomplished by brake release means that includes a brake release line **132** connecting the primary pressure line **98** upstream of the four valve bank to the brake mechanism pressure chamber **73**. A check valve **76** is located in the brake release line **132** to avoid a possible damaging instantaneous brake operation when the pressure drops in the primary pressure line **98** and to prevent back flow from the secondary pressure line described hereinbelow. Also connected in the brake release line **132** downstream of the check valve **76** is a pilot operated brake release control valve **77** that is a two position valve identical to the one described above in regard to the FIG. **2** embodiment and having a spring **78** normally biasing the valve in a position that connects the brake mechanism chamber **73** to a return line **133** that extends through the rotary manifold **114** and is connected to the primary return line **118**, with the result that there is no brake releasing pressure in the brake mechanism chamber **73** and the brake springs **72** will bias the brake mechanism **23** in braking condition. To effect brake release, a pilot line **134** is connected to the brake release line **132** intermediate the check valve **76** and the brake release control valve **77** and to the end of the valve opposite the spring **78** so that an increase in pressure in the primary pressure line **98**, brake release line **132**, and pilot line **134** sufficient to overcome the bias of the spring **78** will cause the brake release control valve **77** to shift to connect the brake mechanism chamber **73** to the primary pressure line **98**, thereby pressurizing the chamber **73** and relieving the spring pressure to release the brake mechanism **23**. The capacity of the spring **78** in the brake release control valve **77** is sufficient to prevent valve operation when the primary pressure line **98** is open to the primary return line **118**, but is sufficiently limited to be overcome by an increase in pressure in the primary pressure line **98** resulting from operation of any one of the mechanisms and motor controlled by the valves **115**, **116**, **63** and **117** in the four valve bank. Thus, when any of these functions are operating, the brake mechanism will be released so that the boom **16** can be rotated by the rotation motor **21**, if it is operating, or can be rotated by side loading when any of the other four valve bank mechanisms are operating and the side loading is sufficient to overcome the resistance of the double acting relief valve **22**, the frictional resistance of the motor **21**, and the inertia of the boom **16** and **15**.

When the pressure in the primary pressure line **98** decreases upon termination of operation of all of the four valve bank mechanisms and motor, the check valve **76** will prevent a corresponding pressure drop in the brake mechanism chamber **73**, but a land on the shuttle of the brake release control valve **77** (which is not shown in FIG. **3**, but is described above in relation to the FIG. **2** embodiment) will allow a limited rate flow of liquid from the brake release line **132** to the return line **133** until the pressure drops below the biasing pressure of the brake release control valve spring **78**, at which point the spring will return the valve to its normal condition to connect the brake mechanism chamber **73** with the return line **133** to relieve the brake releasing pressure and allow the brake mechanism springs **72** to impose the normal braking condition.

A drain line **135** is provided to connect the brake mechanism **23** and rotation motor **21** to the brake release return line **133** to return any liquid escaping from the mechanism and motor to the reservoir **52**.

The hydraulic system **51** of the preferred embodiment of FIG. **3** also includes a secondary section for hydraulically operating and controlling the aforementioned winch motor **41** and auger motor **45**. This secondary section includes the aforesaid high volume pump **54**, which draws liquid from the reservoir **52** through a secondary supply line **136** and pumps the liquid through a secondary pressure line **136** that extends through the rotary manifold **114**, through a bank of two control valves **87** and **138**, and through a secondary return line **139** that connects to the primary return line **118**.

A secondary relief valve **140** identical to the main relief valve **59** is connected to the secondary pressure line **137** upstream from the two valve bank to limit the pressure in the line to a safe maximum above which the secondary relief valve **140** will open to allow pressure relieving flow from the secondary pressure line **137** through a return line **141** to the secondary return line **139**.

The valves **87** and **138** in the two valve bank are three position valves identical to the previously described valves in the three valve bank and in the four valve bank, and having similar manually operable levers **142**. The first of these two valves is a winch motor control valve **87** connected to the winch motor **41** by connecting lines **143** for hydraulic operation

thereof in either direction of rotation to pay out or pull in the winch line **38**. The return side of the winch motor control valve **87** is connected by a return line **144** to the secondary relief valve return line **141**. The second of these two valves is an auger motor control valve **138** connected to the auger motor **45** by connecting lines **145** for hydraulic operation thereof in either direction of rotation to drive the auger **46** in digging and retracting directions of rotation. The return side of the auger motor control valve **138** is connected by a return line **146** to the secondary relief valve return line **141**.

The secondary pressure line **137** is connected to the brake release means in the same manner as is the primary pressure line **98**. This is accomplished by a secondary brake release line **147** connected to the secondary pressure line **137** upstream from the two valve bank and to the abovedescribed brake release line **132** upstream from the brake release control valve **77** and having a check valve **95** therein for functioning identical to the above-described check valve **76**. Thus, an increase in pressure in the secondary pressure line **137** due to operation of either the winch motor **41** or the auger motor **44** will cause the brake release control valve **77** to operate, releasing the brake mechanism and allowing the boom to be rotated by side loading imposed by winch **40** or auger **46** operation above a predetermined magnitude.

In operation of the hydraulic system **51** of the preferred embodiment of FIG. **3**, the brake mechanism **23** is normally in boom braking position to prevent the boom **16** from rotating out of whatever position it may be in. Operation of the pumps **53** and **54** without operation of any of the control valves will not cause the brake mechanism **23** to be released. Also, operation of the outriggers **47** and any equipment from the power take-off outlets **112** will not cause release of the brake mechanism **23** because the control valves for these functions are upstream from the brake release line **132**. However, operation of any one of the boom extension and retraction control valve **115**, boom raising and lowering control valve **116**, rotation motor control valve **63**, pole claw operating control valve **117**, winch motor control valve **87**, or auger motor control valve **138** will result in release of the brake mechanism **23** to allow the boom **16** to be positively rotated by operation of the rotation motor **21** or to be roated by side loading above a predetermined magnitude when any one of these valves is positioned to operate its controlled derrick function performing means. As long as any one of these derrick functions is being performed the brake mechanism **23** will be in released condition and upon termination of performance of all of the functions the brake mechanism **23** will be returned to boom braking condition. Should the boom **16** be rotating under the influence of side loading and in doing so approach an object in its rotation path that could be damaged by boom contact or could damage the boom **16**, the operator can stop boom rotation to prevent such damaging contact simply by removing his hands from all of the control valve levers, which will terminate all functions and thereby allow the brake mechanism **23** to return to boom braking condition.

The various control valve levers are all located on the derrick **10** at locations convenient for the operator. The levers **103** for the valves **100**, **101** and **102** of the three valve bank are located on the back of the base **13** of the derrick **10** where the operator can operate these levers **103** while standing on the ground to manipulate the outriggers **47** or auxiliary equipment. The levers **119** for the valves **115**, **116**, **63**, and **117** of the four valve bank are located on the turret **15** in front of the operator's seat **148** where the operator can operate these levers **119** while seated to extend or retract the boom, raise or lower the boom, rotate the boom, or operate the pole claws **35**. The levers **142** for the valves **87** and **138** of the two valve bank are located alongside the operator's seat **148** where the operator can operate the levers **142** while seated to pay out or pull in the winch line **38** or operate the hole digging auger **46**.

Also conveniently located for ease of manipulation by the operator is a foot pedal **149** in front of the seat **148** and operably connected to a throttle master cylinder **150** (FIG. **3**) that is hydraulically connected by a throttle control line **151** extending through the rotary manifold **114** to a spring biased throttle slave cylinder **152** that controls the derrick motor and thereby controls the output of the two hydraulic pumps **53** and **54** in the hydraulic system **51**.

A notable feature of the present invention is that it is adaptable to many varied applications where it is desired to produce release of the brake mechanism **23** upon performance of any one or more or all selected functions. For example, the FIG. **3** embodiment could be modified to connect the brake release line **132** to the primary pressure line **98** upstream of the three valve bank so that brake release would occur upon operation of the outriggers **47** as well as upon operation of all of the other functions, or the system could be otherwise modified to eliminate selected ones of the functions from brake release operation.

The present invention is capable of various other modifications and adaptations, and is not intended to be limited by the embodiments illustrated and described or otherwise except by the scope of the appended claims.

I claim:

1. A derrick comprising a base, a boom rotatably mounted on said base, means for rotating said boom, said boom rotating means being inherently reversible with a limited resistance to rotation for allowance of rotation of said boom upon imposition of a side loading condition above a predetermined magnitude, means for performing a derrick function that may result in side loading of said boom, a brake mechanism normally acting to prevent rotation of said boom, means operable to release said brake mechanism to allow rotation of said boom, said brake release means being operable in response to operation of said boom rotating means to allow said boom to be rotated by said boom rotating means, said brake release means also being operable in response to operation of said derrick function performing means for releasing said brake mechanism to allow said boom to be rotated by side loading above said predetermined magnitude during operation of said derrick function performing means, and said brake release means being rendered inoperable in response to deactuation of both said boom rotating means and said derrick function performing means to allow said brake mechanism to prevent rotation of said boom.

2. A derrick according to claim 1 and characterized further in that said reversible boom rotating means is capable of allowing rotation of said boom in either direction of rotation, and said brake release means is operable to release said brake mechanism for boom rotation by side loading in either direction of boom rotation during operation of said derrick function performing means.

3. A derrick according to claim 1 and characterized further by a plurality of derrick function performing means, and in that said brake release means is operable in response to operation of any one of said plurality of derrick function performing means and is rendered inoperable in response to deactuation of said boom rotating means and all of said plurality of derrick function performing means.

4. A derrick according to claim 1 and characterized further in that said derrick function performing means is means for manipulating said boom and includes means for extending and contracting said boom and means for raising and lowering said boom, with said brake release means being operable in response to operation of any one of said boom rotating means, boom extending and contracting means, and boom raising and lower means.

5. A derrick according to claim 1 and characterized further by a load manipulating line extending from said boom, a winch mounted on said derrick and on which said line is wound, and in that said derrick function performing means includes means for rotating said winch to pay out and pull in said line, with said brake release means being operable in response to operation of said winch rotating means to release said brake mechanism during either paying out or pulling in of said line.

6. A derrick according to claim 1 and characterized further in that said derrick function performing means includes an auger mounted on said boom for digging holes in the ground, and means for operating said auger, with said brake release means being operable in response to operation of said auger operating means to release said brake mechanism during operation of said auger.

7. A derrick according to claim 1 and characterized further by a load manipulating line extending from said boom, a winch mounted on said derrick and on which said line is wound, and by a plurality of derrick function performing means including means for extending and contracting said boom, means for raising and lowering said boom, and means for rotating said winch to pay out and pull in said line, with said brake release means being operable in response to operation of any of said plurality of derrick function performing means.

8. A derrick comprising a base, a boom rotatably mounted on said base, hydraulically operated means for rotating said boom, said boom rotating means being inherently reversible with a limited resistance to rotation for allowance of rotation of said boom upon imposition of a side loading condition above a predetermined magnitude, hydraulically operated means for performing a derrick function that may result in side loading of said boom, a brake mechanism normally acting to prevent rotation of said boom, means for releasing said brake mechanism to allow rotation of said boom, and a hydraulic system operatively connected to said boom rotating means and derrick function performing means for selective operation thereof and including means for pumping a liquid through said system with sufficient pressure development capability to operate said boom rotating means and said derrick function performing means, said brake release means being connected to said hydraulic system for operation in response to operation of any one of said boom rotating means and derrick function performing means for releasing of said brake mechanism to allow rotation of said boom by operation of said boom rotating means or by side loading above said predetermined magnitude during operation of said derrick function performing means and to be rendered inoperable in response to deactuation of hydraulic operation of both said boom rotating means and said derrick function performing means to allow said brake mechanism to operate to prevent rotation of said boom.

9. A derrick according to claim 8 and characterized further in that said brake release means is connected to said hydraulic system upstream of both said boom rotating means and said derrick function performing means and is operated in response to hydraulic pressure in said system sufficient to operate said boom rotating means or said derrick function performing means.

10. A derrick according to claim 9 and characterized further in that the hydraulic pressure in said system at said brake release means connection increases upon hydraulic operation of said boom rotating means or said derrick function performing means, and said brake release means is operable in response to said increase in pressure.

11. A derrick according to claim 10 and characterized further in that said brake release means is hydraulically operated by said hydraulic system upon said increase in pressure at said brake release means connection.

12. A derrick according to claim 11 and characterized further in that said hydraulic system includes a boom rotation control valve connecting said hydraulic system to said boom rotating means for selective operation of said boom rotating means and a derrick function control valve connecting said hydraulic system to said derrick function performing means for selective operation of said derrick function performing means, with said brake release means being connected to said hydraulic system upstream of said valves.

13. A derrick according to claim 11 and characterized further in that said hydraulically operated brake release means includes a pressure responsive pilot operated valve connected to said hydraulic system and operable in response to said increase in pressure to connect said brake release means to said hydraulic system for operation thereby to release said brake mechanism, said pilot operated valve being responsive to a subsequent reduction of pressure in said hydraulic system to render said brake release means inoperative and thereby allow said brake mechanism to operate to prevent rotation of said boom.

14. A derrick according to claim 9 and characterized further by an additional derrick function performing means hydraulically operated by said hydraulic system and being connected thereto upstream of said brake release means connection for operation without operation of said brake release means.

15. A derrick according to claim 8 and characterized further by a plurality of hydraulically operated derrick function performing means operatively connected to said hydraulic system, and said brake release means being operable in response to operation of any one of said plurality of derrick function performing means.

16. A derrick according to claim 15 and characterized further in that said means for pumping includes a plurality of hydraulic pumps, each of which is connected in said hydraulic system to at least one of said derrick function performing means for hydraulic operation thereof, with said brake release means being connected to said hydraulic system downstream of each pump and upstream of said derrick function performing means for operation of said brake release means in response to operation of any one of said plurality of derrick function performing means.

17. A derrick according to claim 8 and characterized further in that said hydraulically operated means for rotating said boom includes a hydraulic motor connected to said hydraulic system for operation thereby, and relief valve means connected to said motor to allow said motor to operate reversely as an idler pump, said relief valve means being operable at a predetermined hydraulic pressure to allow said boom to be rotated by side loading above said predetermined magnitude.

18. A derrick according to claim 17 and characterized further in that said relief valve means is double acting to allow said motor to operate as an idler pump in either direction of boom rotation to allow said boom to be rotated in either direction by side loading above said predetermined magnitude.

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