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Axelsson et al.

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[54] **PIPELAYER HYDRAULIC DRAWWORKS WITH FREE-FALL**

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[52] **U.S. Cl.** **91/497**

[51] **Int. Cl.** **F01b 13/06**

[58] **Field of Search** 91/472, 491; 417/214; 254/186; 60/52

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[57] **ABSTRACT**

In cable winding gear driven by a hydraulic motor of the kind having radial pistons driving a surrounding cam ring, a control is provided for applying differential pressure to the motor pistons so that they are disengaged from the cam ring which can then rotate freely. This provision enables the cable to be run out freely, so that, for example, in a crane free fall of the load can be allowed while avoiding damage to the motor. Pipe-laying equipment including the free-fall provision is described.

13 Claims, 4 Drawing Figures

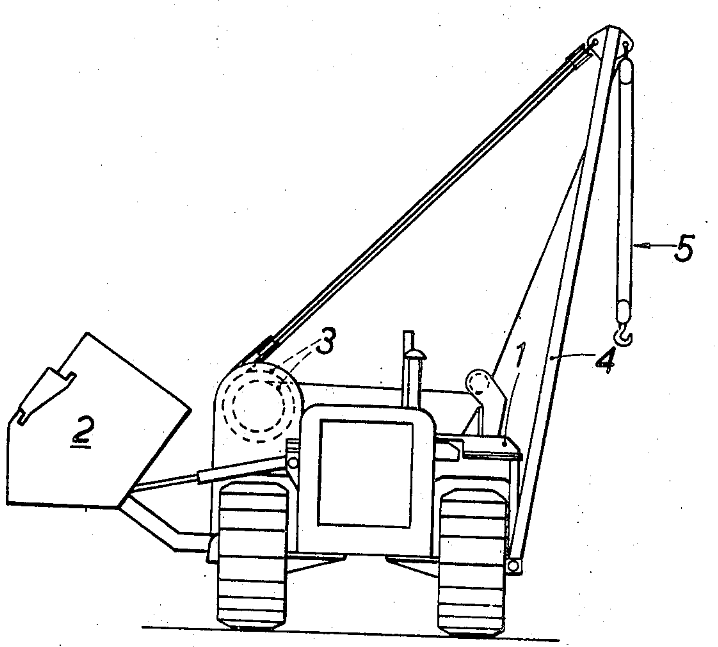
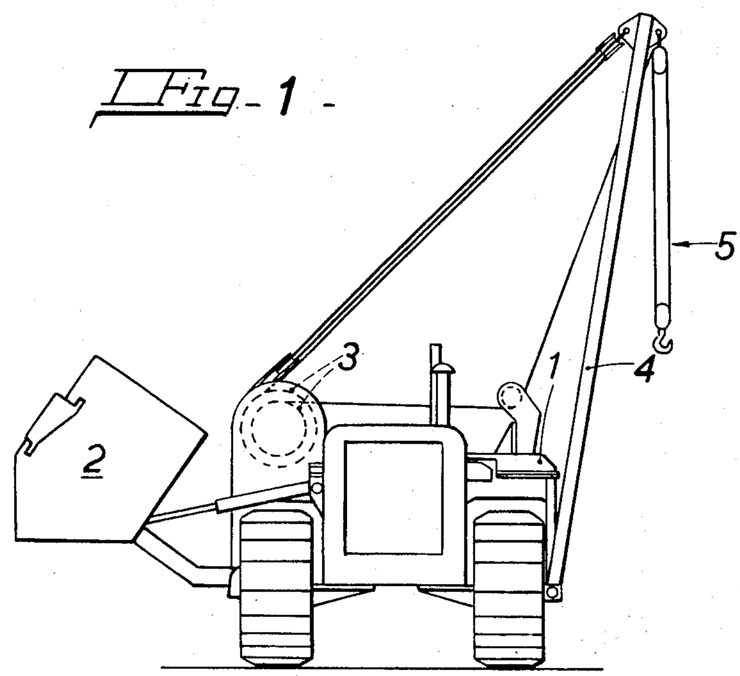


FIG-1-



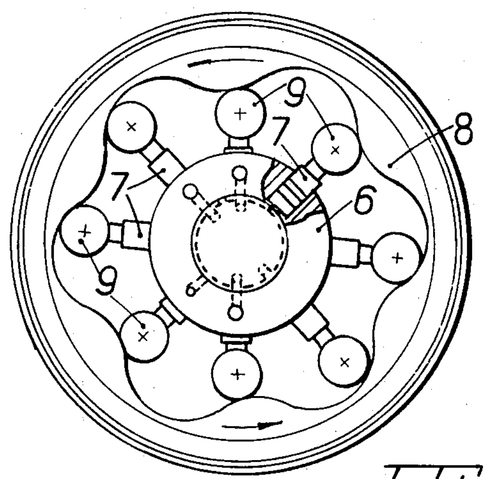


FIG-2-

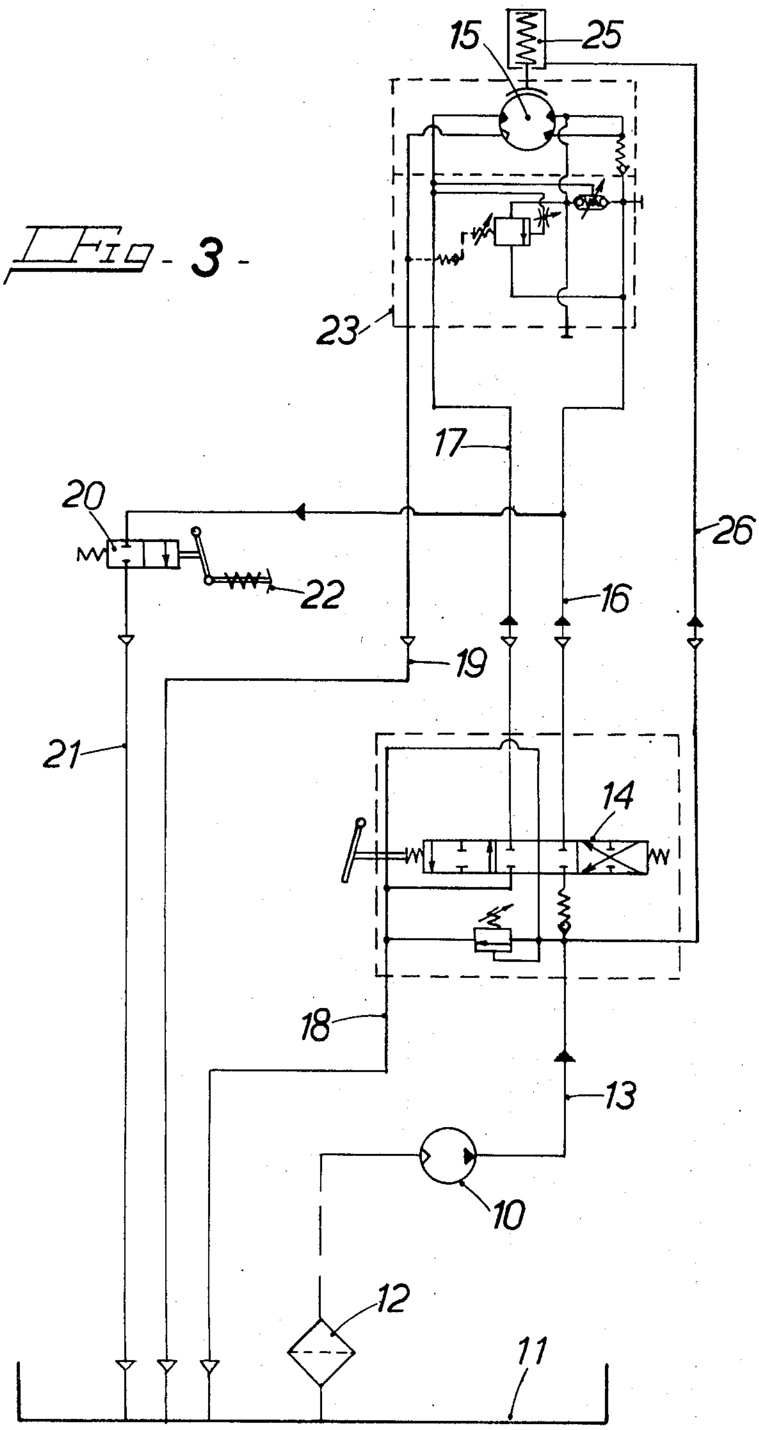


Fig. 3

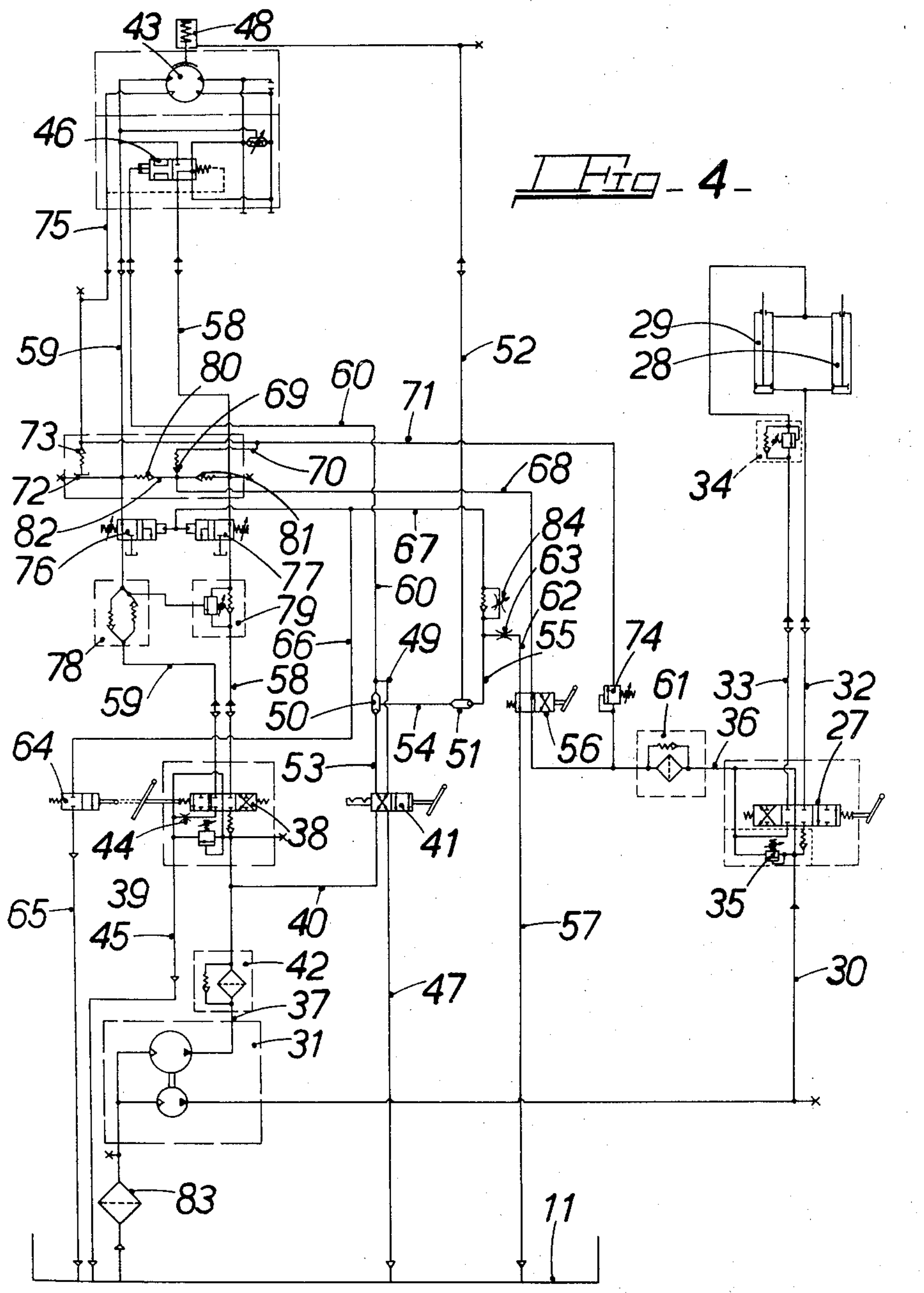

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FIG. 4

PIPELAYER HYDRAULIC DRAWWORKS WITH FREE-FALL

This invention is concerned with improvements in or relating to systems for operating and controlling winches, hoists, windlasses or the like which are driven by hydraulic motors.

In particular, this invention is concerned with systems embodying a hydraulic motor of the kind including a stationary cylinder having a number of radial bores in each of which a piston is displaceable, and a cam ring which is rotatably driven by the pistons. The cam faces of the cam ring are engaged by driving means, such as rollers mounted on the radially outward ends of the pistons, or the outer end faces of the pistons, and hydraulic fluid is selectively supplied to the bores to radially displace the pistons in a predetermined sequence whereby the pressure engagement of the driving means with the cam faces rotates the cam ring from which the drive is obtained in any suitable manner. Such hydraulic motors as above described are herein referred to as of the kind specified.

Hydraulic motors of the kind specified are already well known and they are used for driving winches, hoists, windlasses or the like. Although in such applications hydraulic motors of the kind specified are very satisfactory, it is most desirable to be able to operate the winch or the like in the conventional manner in which the drive can be disengaged so as to allow the winch drum or the like to rotate freely or over-run the drive. For example, it is desirable to provide an operating condition such that the load supported by the winch can fall freely under gravity, or such that the cable or drag line can run out freely.

In systems having a mechanical drive transmission this drive-free condition can easily be achieved by a releasible clutch arrangement. However, with a hydraulic motor of the kind specified direct drive to the winch or the like is utilised. We have found that in a hydraulic system where the source of hydraulic fluid for the motor is derived solely from one or more pumps, and not a pressure accumulator, free-rotation of the cam ring cannot be obtained without risk of damaging the hydraulic motor. The reason for this is that in a hydraulic motor of the kind specified the flow of hydraulic fluid is arranged so that the pistons are urged radially outward whereby the driving means are maintained in engagement with the cam faces. Even if the supply of hydraulic fluid to the bores is interrupted or reduced, then at least some of the pistons will fall radially outwardly of their bores due to gravity so that at least some of the driving means engage with the cam faces. Accordingly, when the cam ring is not being driven by the driving means, but is rotated by the torque applied by the load on the winch cable or the like, the uncontrolled engagement of the driving means with the cam faces of the rotating cam ring causes excessive damage to the motor; in certain instances the cam faces are damaged, or the motor bearing may crack or break up.

It is an object of this invention to provide in a system for operating and controlling a winch hoist or the like driven by a hydraulic motor of the kind specified, an improvement whereby such free fall of the load, or free-running out of the load cable can be achieved without the aforementioned risk of damage to the hydraulic motor.

Further objects of this invention are to provide an improved hydraulic system for operating and controlling a winch, hoist or the like driven by a hydraulic motor of the kind specified, and to provide a winch, hoist or the like operated and controlled by such improved hydraulic system.

Other objectives will be apparent from the description of preferred embodiment of this invention given later herein.

According to the broadest aspect of this invention, we provide in a system for operating and controlling winding gear, such as a winch, hoist, windlass or the like, driven by a hydraulic motor of the kind specified and to which hydraulic fluid is supplied by pump means, the improvement of valve means for controlling the flow of hydraulic fluid and which valve means on actuation is arranged to produce in the hydraulic motor a hydraulic pressure differential acting on the pistons to displace them radially inwards to an extent such that the driving means are maintained out of contact with the cam faces of the cam ring which can then rotate freely.

In theory there are probably many ways in which such hydraulic pressure differential may be developed by controlling the flow of hydraulic fluid through valve means. However, practical considerations are of paramount importance because of problems that may arise such as, the adaptability of the hydraulic motor, the overheating of the hydraulic fluid, the maximum flow capacity of the pump means, and the overall complexity and cost of providing a special valve arrangement. We believe that we have devised a most practical system which avoids the kinds of problems aforementioned.

One of the preferred ways of obtaining the hydraulic pressure differential in the hydraulic motor is to arrange for the valve means to reduce hydraulic pressure in the cylinder bores and to maintain a low hydraulic pressure in the motor casing so as to develop a pressure differential sufficient to displace the pistons radially inwards. In this manner a relativey low hydraulic pressure in the motor casing can be utilised to displace the pistons, and when the drive is to be restored, hydraulic fluid can be supplied to the cylinder to re-engage the driving means with the cam ring, and then hydraulic fluid for driving the motor may be supplied at the required flow rate.

Although it is envisaged within the scope of this invention to arrange for the valve means merely to control the flow of hydraulic fluid into the motor casing so as to develop therein a hydraulic pressure acting on the radially outer parts of the pistons greater than the hydraulic pressure in the cylinder bores as applied to the radially inner parts of the pistons, this has the disadvantage that the motor casing, including the cam ring will have to be designed to withstand very high bursting loads due to the high hydraulic pressures involved. Additionally, the flow capacity of the pump means and overheating of the hydraulic fluid may lead to further problems. Usually a hydraulic motor of the kind specified is designed to operate with no or very low hydraulic pressure in the motor casing, and thus where it is desired merely to apply our invention to existing hydraulic motors of the kind specified the aforementioned preferred way of developing the hydraulic pressure differential can most conveniently be adopted.

Of course the valve means has to be arranged to act, on actuation, in concert with the other essential operational controls of the winch or the like which must be maintained either inoperative or functional, for instance when the load is released the winch brake must be held off. However, these considerata will be fully understood from an embodiment of the invention which is described later herein.

This invention is also deemed to include a winch, hoist, windlass or the like operated and controlled by a hydraulic system, embodying our improvement as well as the hydraulic system per se.

One application of this invention is in a hydraulic system for operating and controlling pipe-laying apparatus adapted for attachment to, or incorporation in a tractor, preferably of the tracked type.

By way of example an embodiment of this application of this invention will now be described with reference to the accompanying drawings in which:

FIG. **1** is a front-elevation of pipe-laying apparatus according to the invention mounted on a tractor;

FIG. **2** is a diagrammatic view of a hydraulic motor of the kind specified;

FIG. **3** is a diagram of the hydraulic operation and control system for the boom of the pipe-laying apparatus of FIG. **1** and;

FIG. **4** is a diagram of the hydraulic operation and control system for counterweights and a hoist of the pipe-laying apparatus.

The principal components of the pipe-laying apparatus which are mounted on the tractor comprise a saddle **1** on one side of which are carried a set of hydraulically controlled counterweights **2** and two winches **3** each adapted to be driven by a hydraulic motor of the kind specified and of which further details will be given later. On the other side of the saddle is mounted the boom **4** which is raised and lowered by one of the winches **3**, and the other end of the boom carries the hoist **5** which is raised and lowered by the other winch **3**. The hoist **5** and boom **4** can be operated independently or simultaneously.

The hydraulic motors driving the winches **3** are each of the kind shown in FIG. **2** and including a stationary cylinder block **6** having a number of radial bores in each of which a piston **7** is displaceable, and a cam ring **8** which is rotatably driven by the pistons. The cam faces of the cam ring **8** are engaged by driving means, such as rollers **9** mounted on the radially outward ends of the pistons, or the outer end faces of the pistons, and hydraulic fluid is selectively supplied to the bores to displace the pistons **7** radially in a predetermined sequence whereby the pressure engagement of the driving means with the cam faces rotates the cam ring from which the drive is obtained in any suitable manner.

The hydraulic system depicted in FIGS. **3** and **4** is for operating and controlling the foregoing apparatus and its ancillary parts. The power is derived from the tractor engine independently of drive transmission, and it is arranged to drive the fixed displacement hydraulic pumps which supply hydraulic fluid to the three parts of the hydraulic system for actuating:

i. the boom **4**;

ii. the counterweights **2**; and

iii. the hoist **5**.

Each of these three parts of the system will now be described with reference to FIGS. **3** and **4** which are in the form of circuit diagrams with all the control valves shown in the neutral position.

i. The Boom System

A fixed displacement hydraulic pump **10** driven from the engine draws hydraulic fluid through a suction filter **12** from an open or low pressure reservoir **11**. Hydraulic fluid supply from the output line **13** of the pump **10** is controlled by a three position open-centre valve **14** which is shown in the neutral position. By means of the valve **14** hydraulic fluid may be supplied to a reversible hydraulic motor **15** of the kind specified which is connected directly to the winch drum, and the hydraulic fluid may be returned to the reservoir **11**.

For raising the boom **4**, the valve **14** is displaced to a second position, which corresponds to moving it to the extreme right in the accompanying drawing. In this second position the motor **15** is rotated in one sense by hydraulic fluid supplied through line **16** to the motor **15** and discharged through the line **17** through the valve **14**, to line **18** returning to the reservoir **11**. Hydraulic fluid is also drained from the motor casing through line **19** back to the reservoir **11**.

Associated with line **16** is a valve **20** which is normally closed, but which on actuation serves to connect the line **16** with line **21** leading to the reservoir **11**. The valve **20** is actuated by the engagement of a spring loaded abutment **22** which is arranged to be engaged by the boom if it is raised to an over-centre position, or other predetermined attitude of elevation in relation to the tractor. As will be appreciated, on such actuation of the valve **20**, the supply of hydraulic fluid through line **16** to the motor **15** is prevented as the line **16** is connected through valve **20** to the reservoir return line **21**, and further elevation of the boom is prevented.

For lowering the boom, the motor **15** is rotated in the opposite sense by changing the direction of flow of the hydraulic fluid supplied to the motor **15**. This is achieved by displacing the valve **14** to a third position, corresponding to the extreme left in the accompanying drawing. In this third position, hydraulic fluid is supplied to the motor **15** from the pump output line **13** through line **17** and discharged through line **16**, through valves **14** to line **18** which is connected to the reservoir **11**.

In order to maintain the boom at a particular attitude, the motor **15** is provided with a counterbalance valve arrangement as depicted in the rectangular outline referenced **23**. This counterbalance valve arrangement is adapted only to open when a predetermined high pressure is exceeded so that the motor can operate with full back pressure.

The boom winch is provided with a conventional spring operated band brake that is arranged to be held in the "off" position by a hydraulic brake cylinder **25** which is connected to the valve **14** by a line **26**. Hydraulic pressure is maintained in the brake cylinder **25** whilst the motor **15** is driven in either sense. When no hydraulic fluid is supplied to the motor **15**, namely when valve **14** is in the neutral position as depicted, the brake line **26** is open to the reservoir return line **18** and the hydraulic cylinder **25** is released so that the brake is applied. Additionally, if there should be a loss of hydraulic fluid with consequent reduction in pressure in any of the supply lines aforementioned the brake is automatically applied.

By way of further explanation of the boom system of FIG. **3**, the control valve **14**, when in the neutral position shown, blocks lines **16** and **17** from lines **13** and **18** and communicates flow from pump **10** to tank **11** via conduits **13** and **18.** In this condition, the brake **25** is in communication with the tank via the conduit **26** which is a branch of conduit **13.** Brake **25,** which is normally applied by spring force, is allowed to be applied to restrict movement of the boom. Release of the brake is accomplished by pressurization of the brake cylinder to overcome the spring bias when desired.

In order to lower the boom, the selector control valve **14** is shifted to position **92** in which it allows pump flow to be communicated to motor **15** via the conduit **17** and to the counter-balance valve **93** via the conduit **94.**

The orifice choke **96** modulates pilot flow to the counter-balance valve **93** and prevents over sensitive operation thereof. When the pilot pressure reaches the range of 300–500 psi, the valve **93** will shift to an open position in which is allowed communication between the motor ports **102** and the tank **11** via conduits the **97,98,99,16** and **18.** The counter-balance valve **93** maintains a minimum back pressure range of 300–500 psi in the motor which pressure assures the release of the brake **25** prior to the lowering of the boom and prevents cavitation in the motor **15.**

The two-way relief valve **100** protects the motor circuitry by directing flow back to the motor inlet via the conduits **101** and **17** at such times that the load is excessive and back pressure in the motor reaches the 3,000 psi level. This provision also reduces cavitation in the motor by supplying make-up fluid to the inlet ports when the load becomes excessive.

Shifting of the selector control valve **14** to position **90** places the circuit in a boom raise mode. In this condition, flow from pump **10** is communicated through conduits **13** and **16** to motor **15.** Conduit **26** also communicates the pressurized pump flow to the brake **25** for the release thereof. The two-way relief valve **100** establishes maximum motor pressure at 3,000 psi and relieves the system by communicating relief flow to the tank **11** via the conduits **101** and **17.** Relief valve **106** protects the pump **10** from excessive pressure by communicating conduit **13** with conduit **18** and with tank **11.**

Check valves **104** and **105** are provided to block flow in the direction indicated and to maintain fluid in the respective associated conduits and also to block flow to the motor **15** until after the brake spring force is overcome by pressurized fluid and the brake is released.

The Counterweight System

The lateral position of the counterweights (not shown) relative to the tractor is hydraulically controlled by a three position valve **27** similar to valve **14.** Two hydraulic cylinders **28, 29** are arranged to move the counterweights transversely of the tractor centreline by means of hydraulic fluid supplied through line **30** from the small section of a double hydraulic pump **31** of the fixed displacement type drawing hydraulic fluid through a suction filter **83** from the reservoir **11.**

When the valve **27** is in the central neutral position as depicted, the supply of hydraulic fluid is straight through is straight through the open-centre of valve **27** into line **36** connected to the hoist system which is described later. If the valve **27** is displaced into either a second or third position, then hydraulic fluid is supplied to one end of the hydraulic cylinders **28, 29** through one of lines **32, 33** and displaced hydraulic fluid flows out of the other end of the hydraulic cylinders **28, 29** through the other one of lines **32, 33.** A counterbalance valve arrangement **34** is provided in line **33.** A pressure relief valve **35** is associated with valve **27** and is connected to line **36.**

The Hoist System

The supply of hydraulic fluid to the hoist system is derived from the large section of the double hydraulic pump **31.** Hydraulic fluid in output line **37** is directed through line **39** to a three-position valve **38,** through line **40** to a two-position valve **41** with the output line **37** including a by-pass filter **42.**

The valve **38** is for controlling a two speed hydraulic motor **43** of the kind specified. Valve **38** is substantially the same as the other three position valves **27** and **14,** except that it includes a restrictor **44** which serves to throttle flow to the reservoir **11** through line **45** when the valve **38** is in its second or third position.

The valve **41** is provided for operating the valve **46** of the hydraulic motor **43** that controls, in known manner, the speed of the motor. The valve **41** is connected to a line **47** leading to the reservoir **11,** and in either operative position provides a through passage for hydraulic fluid to the brake cylinder **48** of the spring-operated band type winch brake (not shown) that is held off by the brake cylinder **48.**

With reference to the operation of the brake cylinder **48,** when the valve **38** is in the neutral position depicted in the drawing there is no hydraulic fluid supplied to the brake cylinder **48** and the brake is in the applied position. The hydraulic fluid in line **39** flows through the open centre of valve **38** to the reservoir **11** via return line **45.** The brake cylinder line **52** is also open to the reservoir **11** through shuttle valve **51,** line **54** through shuttle valve **50,** and the line **49,** valve **41** to line **40** and thence to the reservoir **11** through open-centred valve **38.**

When the valve **38** is in either its second or third positions, that is when the hydraulic motor **43** is being driven, hydraulic fluid is supplied to the brake cylinder **48** to hold the winch brake in the "off" position. When the motor speed control valve **41** is in the position depicted, hydraulic fluid flows through line **40** through port *p* to port *a* of valve **41.** Flow is then through line **49,** through shuttle valve **50** into line **54** to actuate shuttle valve **51** and into the brake line **52.** The actuation of the shuttle valve **51** prevents the return flow of hydraulic fluid to the reservoir **11** through line **57.** When the motor speed control valve **41** is in its other position, the hydraulic fluid flows through line **40,** through port *p* to port *b* of valve **41,** through line **53** to actuate shuttle valve **50** to close line **60.** The flow is then to the brake line **52** through line **54** and shuttle valve **51** which is actuated in the same way as just described.

As will be appreciated, when there is a reduction in hydraulic pressure in the brake line **52,** the winch brake will be applied. Such reduction in hydraulic pressure will occur when valve **38** is moved to the neutral position, or if a supply line fails, or under other circumstances which will be explained later in connection with the system for operating the hoist winch with free fall of the load.

The speed of the hydraulic **43** is controlled in known manner by the actuation of spool valve **46** to which hydraulic fluid is supplied through line **60** when the control valve **41** is in the position depicted and valve **38** is in its second or third position with hydraulic fluid being supplied through line **40.**

The supply of hydraulic fluid for driving the motor **43** is either through line **58,** or through line **59** depending on the position of valve **38.** The return flow of hydraulic fluid from the motor **43** is through either line **59** or **58.** There is also provided an arrangement of valves to maintain a predetermined pressure acting on the motor pistons. This arrangement includes a non-return pressure limiting circuit **78** and a counter-balance valve **79.** From this arrangement of valves the hydraulic fluid returns through the valve **38,** restrictor **44** to the line **45** leading to the reservoir **11.**

The crux of this invention is that the hydraulic motor **43** can be operated so that free fall of the hoist load can be obtained, and controlled without risk of damage to the motor **43.** This operation and control will now be explained having regard to the foregoing description and explanation.

The free-fall hydraulic system associated with control valve **56** is arranged so that it can only be effective when the hoist control valve **38** is in the neutral central position, that is when the hydraulic motor is not being driven, such as when a load is suspended on the hoist in mid-air. This is done by providing a drain valve **64** which is mechanically coupled by a suitable linkage to the operating linkage of valve **38.** When valve **38** is in either its second or third position, the line **66** leading to valve **64** is open to the reservoir **11** through drain line **65** and thus pressure cannot be developed in line **67** which is in the free fall system. Accordingly, free fall of the load can only be obtained when the hoist valve **38** and drain valve **64** are in the operative positions depicted in the accompanying drawing.

The free fall of the hoist load is controlled by the control valve **56** to which hydraulic fluid flows from the control valve **27** of the counterweight system, through line **36** including by-pass filter **61.** The free fall control valve **56** is depicted in the inoperative position whereby the brake line **52** is open to the reservoir **11,** flow being through line **55,** line **62** including restrictor **63,** through port B to port T of the valve **56** to the reservoir return line **57.** The hydraulic fluid flows through port P to port A of valve **56,** through line **68** to a non-return valve **69** in line **70,** to a line **71** and thus to an open reservoir **72** to which flow is controlled by a non-return valve **73** having a predetermined opening pressure. The line **71** also includes a pressure relief valve **74** for relieving the pressure in line **36,** but under normal conditions as now being described, this relief valve **74** merely acts as a non-return valve in line **71.**

The open reservoir **72** which may be integral with reservoir **11,** is also connected to the motor casing by line **75** so that a minimum pressure is maintained in the motor casing by the restricted opening pressure of the non return valve **73.** The pressure is selected in accordance with the necessary hydraulic pressure differential which has to be developed before free rotation of the cam ring of the hydraulic motor **43** is allowed.

When the free fall control valve **56** is actuated hydraulic fluid flows through port P to port B into line **62** and through restrictor **63** into line **55,** through shuttle valve **51** into brake line **52** so as to actuate the brake cylinder **48.** Hydraulic fluid also flows from the line **62** to line **67** connected to a pair of spool valves **76, 77,** which are thus actuated. The lower hydraulic pressure which is present in the idle hydraulic motor **43** and which is determined by the valves **78, 79** is vented to an open reservoir through the valves **76, 77** on their actuation, and thus the pressure maintained in the motor casing by the valve **73** is greater than that in the motor cylinder bores and the pistons are displaced radially inwards by the hydraulic pressure in the motor casing so that the driving means as aforedescribed is moved out of engagement with the cam ring.

Accordingly, as the spool valves **76, 77** are merely operated by a relatively low pilot pressure, and the brake cylinder **48** has a much higher actuation pressure, the brake is released slightly after the motor pistons have been displaced.

In practice, we have found that if the motor cylinder bore pressure can be reduced to a very low figure, then a motor casing pressure of from 22 p.s.i. to 36 p.s.i. is sufficient in a hydraulic motor of the kind specified developing a maximum torque of 545 ft. lbs, per 100 p.s.i.

To stop the free fall of the load, the free fall control valve **56** is returned into the position as depicted in the drawing. However, now there is no hydraulic pressure in the motor supply and discharge lines **59, 58.** A positive pressure, greater than the motor casing pressure has to be developed quickly to render the motor **43** operative again for operating the hoist winch. This development of operative hydraulic pressure in the motor **43** to displace the pistons radially outwards to re-engage the driving means with the cam ring is achieved when the free fall control valve **56** is returned to position depicted in the drawing. When valve **56** is in this position hydraulic fluid from line **36** flowing now through line **68** can overcome the two non-return valves **80, 81** in line **82** connected to motor lines **58, 59.** The operating opening pressures of these valves **80, 81** are set lower than the non-return valve **69,** thus the minimum operating pressure determined by the arrangement of valves **78** and **79** is quickly restored. Hydraulic fluid also flows to the reservoir **11** from the brake line **52,** through shuttle valve **51** through line **55,** through the restrictor **63** in line **62,** and through valve **56** to line **57.** This exhausts the brake cylinder **48** which is released and the brake is applied. The spool valves **76** and **77** are also released again by the pressure drop in line **67,** but a throttle non-return valve **84** in line **67** the restrictor **63** provides a restriction which delays the release of the spool valves **76, 77** for a short time to ensure that the brake is applied slightly before the motor pistons are displaced outwards to re-engage the driving means. The hoist winch is then ready for operation under the control of valve **38.**

It will be appreciated that the opening and limiting pressures are calculated in relation to a specific application with a particular motor and pump capacity, and without detracting from the scope of this invention, a modified form of hydraulic circuit as just described could be employed to achieve the same result. However, in this embodiment of the invention simple operation and control is achieved, and other advantages are obtained.

It should be noted that the three-position valves **14, 27** and **38** are of the open-centre kind so that when any of these valves are maintained in the neutral position, such as when the tractor is idling, the hydraulic fluid is returned directly to the reservoir **111** without passing through the associated hydraulic circuits. This arrangement is most advantageous because excessive heating of the hydraulic fluid is prevented and the provision of additional oil coolers can be avoided.

The actuation of the hoist winch brake is synchronised with the readiness of the hydraulic motor, and this provides a fail-safe feature. Additionally, the coupling of the drain valve **164** to the hoist winch motor control valve **138** provides another fail-safe feature. Each of the manually operable control valves are of the "dead-man" type biased to return to the neutral position.

Additionally, if there should be a failure in the hydraulic fluid supply to the hoist winch motor **143** it is still possible to operate the free fall to release, for instance a suspended load. This is because the hydraulic fluid supply to actuate the free fall sub-system is taken from the counterweight system.

With this invented system a luffing crane can be controlled and operated completely by a hydraulic system embodying hydraulic motors of the kind specified. This reduces the overall complexity and weight of hydraulic/mechanical arrangements.

Although the preferred embodiment of this invention as just described is directed to operating and controlling the winches and counterweights of pipe-laying apparatus adapted for attachment to a tractor, it will be appreciated by those familiar with hydraulic engineering that this invention may be embodied in the original equipment of the tractor or embodied in other apparatus such as simple lifting hoists, jib cranes, and winches for trawling or dredging by appropriately modifying the hydraulic systems.

We claim:

1. In a system for operating and controlling a winding gear driven by a rotary hydraulic motor of the kind including a first member having a plurality of radial bores, a motor element displaceable in each of the bores and each having an associated driving means, a cam ring having cam faces engaged by the driving means and means for selectively supplying hydraulic fluid to the bores to displace the motor elements radially in a predetermined sequence and by pressure engagement of the driving means with the cam faces to produce relative rotation between the cam ring and said first member, the system including pump means for supplying hydraulic fluid to the hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, the improvement comprising; free-run means including fluid communication means for applying to the motor elements of the hydraulic motor a hydraulic pressure differential to displace the motor elements radially inwardly and withdraw the associated driving means from contact with the cam faces of the cam ring whereby the cam ring can rotate freely, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said pressure differential has been developed to condition said motor elements and associated driving means to move radially inwardly away from contact with said cam faces of said cam ring, the hydraulic pressure for the free-run means being derived from a source separate from the pump means supplying the motor.

2. The invention of claim **1** including a casing for said hydraulic motor and means for applying, on actuation of the free-run means, a hydraulic pressure in the interior of said casing of the motor higher than that obtaining in said bores.

3. The invention of claim **1** including means for reducing, on actuation of the free-run means, standing hydraulic pressure in said bores.

4. The invention of claim **2** further including valve means for actuating the free-run means.

5. The invention of claim **4** including a casing for said hydraulic motor and wherein said valve means are adapted, on actuation, to connect a source of hydraulic pressure to the interior of said casing.

6. The invention of claim **5** further including means for maintaining a standing pressure in the bores when the motor is idle and wherein said valve means, on actuation, operate means for releasing said standing pressure from the bores of the motor.

7. In a system for operating and controlling a winding gear driven by a rotary hydraulic motor of the kind including a first member having a plurality of radial bores, a motor element displaceable in each of the bores and each having an associated driving means, a cam ring having cam faces engaged by the driving means and means for selectively supplying hydraulic fluid to the bores to displace the motor elements radially in a predetermined sequence and by pressure engagement of the driving means with the cam faces to produce relative rotation between the cam ring and said first member, the system including pump means for supplying hydraulic fluid to the hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, the improvement comprising; free-run means including fluid communication means for applying to the motor elements of the hydraulic motor a hydraulic pressure differential to displace the motor elements radially inwardly and withdraw the associated driving means from contact with the cam faces of the cam ring whereby the cam ring can rotate freely, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said pressure differential has been developed to condition said motor elements and associated driving means to move radially inwardly away from contact with said cam faces of said cam ring, valve means for actuating the free-run means, a casing for hydraulic motor and wherein said valve means are adapted, on actuating, to connect a source of hydraulic pressure to the interior of said casing, means for maintaining a standing pressure in the bores when the motor is idle and wherein said valve means, on actuation, operate means for releasing said standing pressure from the bores of the motor, said valve means, on restoration to its normal position after actuation, acting to connect a source of hydraulic pressure to the bores of the motor to restore the standing pressure.

8. The invention of claim **7** wherein said valve means, on restoration of its normal position after actuation, connect a source of hydraulic pressure to the bores of the motor to restore the standing pressure, said means for preventing brake means release being also provided for ensuring that the brake means is applied before the standing pressure is restored.

9. In a system for operating and controlling a winding gear driven by a reversible rotary hydraulic motor, driving means for selectively supplying hydraulic fluid to said rotary hydraulic motor to rotate said hydraulic motor and said winding gear, said driving means including first supply means for supplying hydraulic pressure fluid to said hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, free-run means including fluid communication means for applying to a portion of the hydraulic motor a hydraulic pressure to allow said hydraulic motor to rotate freely without load, said free-run means including second supply means for supplying said hydraulic motor portion, said second supply means including a source of hydraulic fluid separate from the source of hydraulic fluid for said drive means, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said hydraulic pressure has been supplied to said portion of said motor to condition said motor to rotate freely without load, said driving means for said reversible rotary hydraulic motor further including a motor control valve for controlling flow of hydraulic fluid to said hydraulic motor for driving rotation thereof, said control valve having a first portion for supplying fluid to cause said motor to rotate in a first direction, a second position for supplying fluid to cause said motor to rotate in the reverse direction, and a neutral position in which fluid flow to and from said hydraulic motor is blocked and a hydraulic fluid lock is created which retards rotation of said hydraulic motor in either of said first or reverse directions, said free-run means further including a secondary valve means separate from said motor control valve for controlling the supply of hydraulic fluid pressure to said motor portion.

10. In a system for operating and controlling a winding gear driven by a rotary hydraulic motor, driving means for selectively supplying hydraulic fluid to said rotary hydraulic motor to rotate said hydraulic motor and said winding gear, said driving means including first supply means for supplying hydraulic pressure fluid to said hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, free-run means including fluid communication means for applying to a portion of the hydraulic motor a hydraulic pressure to allow said hydraulic motor to rotate freely without load, said free-run means including second supply means for supplying said hydraulic motor portion, said second supply means including a source of hydraulic fluid separate from the source of hydraulic fluid for said drive means, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said hydraulic pressure has been supplied to said portion of said motor to condition said motor to rotate freely without load, said free-run means further including tertiary valve means for preventing said rotary hydraulic motor from returning from the freely rotating condition to the driving condition prior to the reapplication of said brake means.

11. In a system for operating and controlling a winding gear driven by a rotary hydraulic motor of the kind including a first member having a plurality of radial bores, a motor element displaceable in each of the bores and each having an associated driving means, a cam ring having cam faces engaged by the driving means and means for selectively supplying hydraulic fluid to the bores to displace the motor elements radially in a predetermined sequence and by pressure engagement of the driving means with the cam faces to produce relative rotation between the cam ring and said first member, the system including pump means for supplying hydraulic fluid to the hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, the improvement comprising; free-run means including fluid communication means for applying to the motor elements of the hydraulic motor a hydraulic pressure differential to displace the motor elements radially inwardly and withdraw the associated driving means from contact with the cam faces of the cam ring whereby the cam ring can rotate freely, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said pressure differential has been developed to condition said motor elements and associated driving means to move radially inwardly away from contact with said cam faces of said cam ring, an operator's control for the motor wherein the free-run means includes means coupled to the operator's motor control for ensuring that the free-run means can only be actuated when the motor control is in the off position.

12. In a system for operating and controlling a winding gear driven by a rotary hydraulic motor, driving means for selectively supplying hydraulic fluid to said rotary hydraulic motor to rotate said hydraulic motor and said winding gear, said driving means including first supply means for supplying hydraulic pressure fluid to said hydraulic motor, normally applied brake means for said winding gear, fluid pressure means including fluid communication means for releasing said brake means, free-run means including fluid communication means for applying to a portion of the hydraulic motor a hydraulic pressure to allow said hydraulic motor to rotate freely without load, said free-run means including second supply means for supplying said hydraulic motor portion, said second supply means including a source of hydraulic fluid separate from the source of hydraulic fluid for said drive means, said free-run means including means for preventing said fluid pressure means from releasing said brake means until said hydraulic pressure has been supplied to said portion of said motor to condition said motor to rotate freely without load.

13. The invention of claim **12** wherein said rotary hydraulic motor is reversible and said hydraulic motor drive means further includes a motor control valve for controlling flow of hydraulic fluid to said hydraulic motor for driving rotation thereof, said control valve having a first position for supplying fluid to cause said motor to rotate in a first direction, a second position for supplying fluid to cause said motor to rotate in the reverse direction, and a neutral position in which fluid flow to and from said hydraulic motor is blocked and a hydraulic fluid lock is created which retards rotation of said hydraulic motor in either of said first or reverse directions.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,815,478 Dated June 11, 1974

Inventor(s) EVALD G. AXELSSON et al

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

In Fig. 3 of the drawing, numerals 90, 91, 92, 93, 94, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105 and 106 are added along with lead lines where indicated;

In Fig. 4 of the drawing, letters A, B, a, b, P, p and T are added along with lead lines where indicated.

Column 10, line 3, change "1" to --2--.

Column 10, line 6, change "2" to --1--.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents