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## (54) WINCH AND FLUID CONTROL SYSTEM THEREFOR


(71) We, CATERPILLAR TRACTOR COMPANY, a corporation organized and existing under the laws of the State of California, United States of America, of 100 N. E. Adams Street, State of Illinois 61629, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—


This invention relates to winches of the kind having a rotatable drum, which in use is power-driven, for winding in and releasing a cable or like flexible member, the rotation of the drum being controlled by means of a fluid pressure-operated clutch and brake.

One such winch, has its drum driven by an engine through a drive train having a normally disengaged input clutch which engages in response to fluid pressure to wind in the cable. The drive train also includes a normally engaged brake for immobilizing the winch drum but which is released in response to fluid pressure in other modes of operation. In addition to the "Brake-On" and "Reel-In or Wind-In" modes of operation, the brake alone may be pressurized to effect a Brake-Off mode of operation in which tension in the cable turns the drum to unwind cable against the limited resistance created by the drag of the drive train components. This limited resistance prevents excess unwinding of cable by tension in the cable produced by a load, owing to drum momentum or other causes, but is sufficiently strong to make it difficult or impossible to withdraw cable manually while the resistance is present. Accordingly, the drive train is itself connected to the winch drum through a disconnect clutch which is normally engaged but which may be disengaged by fluid pressure to allow manual unwinding of the cable from the drum without working against a substantial resistance. This is called a "Free-Spool" mode of operation. This form of winch is highly useful on a log skidder vehicle, for example, which is used to drag logs from the site of a lumbering operation and also has substantial advantages in other contexts.

U.S. Patent No. 3,841,608 discloses a hydraulic control system for a winch of the kind described above in which a manually operated control valve may be shifted between a series of positions to pressurize and depressurize as appropriate clutches and a brake of the drive train in order to accomplish the several operational modes described above. The valve settings include Reel-In, Brake-On, Brake-Off and Free-Spool and are achieved by movement of a control lever or the like. For safety reasons as well as for convenience of operation, centering springs urge the control valve towards the Brake-On position so that if the operator releases the control lever or the like, the winch is automatically immobilized.

The operator of these winches must pay careful attention to the position of his control lever of the like in order to control movement of a load in a safe and efficient manner. It is particularly important to avoid movement of the lever into the Free-Spool position through misjudgment while a load is pulling on the cable since momentum of the drum and over-travel may cause an excessive amount of cable to be released, creating unwanted slack, when dropping of the load stops or slows. Diversion of the operator's visual attention in order to guard against this occurrence is undesirable in many cases, particularly in such uses as on a log skidder where the operator must pay attention to controlling the vehicle itself in addition to operating the winch.

In order to guard against inadvertent movement of the control lever into the Free-Spool position, the lever has been

heretofore constrained to pivot along a slot in a console which includes an angled section whereby sideways movement of the lever is needed before the lever movement can be continued into the Free-Spool position. While this arrangement accomplishes the object of alerting the operator when the lever approaches the Free-Spool position, it also undesirably complicates lever manipulations and delays shifting into the Free-Spool mode at times when fast action may be required.

The aim of the present invention is to provide a winch of the kind described having a plurality of modes of operation, including a Free-Spool mode in which there is little resistance to turning of the winch drum, the modes of operation being initiated by movement of a single control lever and means being provided to enable the operator to determine when the control lever is approaching the Free-Spool position without having to rely on visual observation for this purpose and without complicating the lever movement pattern. In this way the operation of such hydraulically controlled winches is facilitated.

According to this invention, a winch having a drum which is arranged to be power-driven and released for winding in or releasing a cable or like flexible member comprises drive means for supporting the drum and for selectively transmitting a rotary drive thereto, the drive means having a normally disengaged input clutch, which is engaged to drive the drum in response to application of fluid pressure thereto, and a normally engaged brake for stopping rotation of the drive means and of the drum, the brake being releasable by application of fluid pressure thereto, a normally engaged disconnect clutch, which disengages the drum from the drive means and hence the input clutch and the brake in response to fluid pressure, means for supplying fluid under pressure, a control valve having an inlet chamber communicating with the fluid supply means, a brake fluid outlet, an input clutch fluid outlet and a disconnect clutch fluid outlet connected to the brake, the input clutch and the disconnect clutch respectively, the control valve having a valving element which is movable between at least four positions including a Brake-On position in which the inlet chamber is isolated from all of the outlets, a Reel-In position at which the inlet chamber is in communication with the input clutch outlet and the brake outlet while the disconnect clutch outlet is vented, a Brake-Off position in which the inlet chamber is in communication with the brake outlet while the input clutch outlet and the disconnect clutch outlet are vented, and a Free-Spool position in which the inlet chamber is in communication with the disconnect clutch outlet, resilient means for biassing the valving element into the Brake-On position and for creating resistance to movement of the valving element away from the Brake-On position, and means for creating additional resistance to further movement of the valving element as the valving element approaches the Free-Spool position.

An example of a winch in accordance with the invention, incorporated in a log skidder vehicle will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a side elevation of the log skidder vehicle;

Figure 2 is a circuit diagram of a control system of the winch in the vehicle shown in Figure 1, the diagram showing the interconnection of drive train and control mechanism elements between a drum of the winch and a driving engine;

Figure 3 is a sectional view of a control valve for controlling the supply of fluid under pressure to the control system of Figure 2 in response to movement of an operator's control lever, the valve being shown in a Brake-On position in which the winch drum is immobilized. Figure 3 may be juxtaposed at the left-hand end of Figure 2 to form a single figure in which fluid conduit interconnections between the control valve and the control system are readily apparent; and,

Figure 4 is a sectional view of the control valve of Figure 3 shown shifted to a Free-Spool position in which there is no significant resistance to turning of the winch drum so that cable may readily be withdrawn from the winch drum.

The winch system of the present invention was initially developed for use on a log skidder vehicle and will therefore be described in that particular context for purposes of example, it being apparent that the apparatus may also be employed on diverse other forms of load-manipulating equipment. Referring initially to Figure 1, a log skidder vehicle 11 is normally used in lumbering operations primarily for dragging heavy logs away from the site of tree-felling operations. For this purpose, the vehicle is provided with a rotatable winch drum 12 having a length of cable 13 wound thereon.

As is understood by those skilled in the art, it is necessary at times to immobilize the winch drum 12 so that the vehicle may be used to drag a log while at other times cable 13 must be reeled in by driving the drum from a suitable engine such as the vehicle engine 14. At other times it is necessary to release cable from the winch drum 12. If the cable is to be withdrawn from the drum by the weight of the load

pulling on the cable, it is desirable that there be some limited resistance to drum rotation. Such resistance prevents overly fast or erratic release of cable and prevents momentum from causing an excess amount of cable to be released when load movement slows or stops. However, there is another cable release mode of operation in which any sizable resistance to rotation of the winch drum 12 is undesirable. This occurs when there is no load fastened to the cable 13 and it is necessary to manually withdraw cable from the drum 12. Under those circumstances, it is desirable that the operator not have to pull against any significant resistance.

The above-identified United States Patent 3,841,608 discloses a winch mechanism construction and a hydraulic control system therefor and the present system may be essentially similar except for the control valve modifications to be hereinafter described. In this form of winch system, an operator may manipulate a single control lever 16 to establish any of the above-described modes of winch operation. The control lever 16 is pivotable along an arc 16' and has a centered position which is the Brake-On position at which the winch drum is immobilized. The lever 16 may be pivoted backward to a Reel-In position and may be pivoted forward to a Brake-Off position at which cable may be withdrawn by load forces pulling on the cable although substantial resistance to such withdrawal must be overcome for reasons to be hereinafter described. In order to free the winch drum from any significant resistance so that cable may readily be withdrawn manually, the control lever may be shifted through the Brake-Off position to an extreme forward setting which is the Free-Spool position. As will hereinafter be described the present invention provides means which substantially increases the resistance to forward lever movement just prior to entering the Free-Spool position to assure that the operator is aware that the lever is about to go to that position.

Referring now to Figure 2, the winch drum 12 may be supported on a rotatable drive shaft 21 by bearings 22. Except in the Free-Spool mode of operation, the drum 12 is caused to rotate with the drive shaft by a normally engaged jaw clutch 23. The clutch 23 may be of the known form in which an annular member 24 carrying teeth 26 is coupled to the drum while another member 27 is coupled to a drive shaft 21 through splines 28 which enable axial movement relative to the drive shaft. A member 27 carries teeth 29 and is spring-biased to a position at which the teeth 29 engage the teeth 26. The jaw clutch 23 may be selectively disengaged by pressurization of a fluid actuator 31 which then forces the member 27 out of engagement with the member 24 to disconnect the drum from the drive shaft.

To transmit drive from the engine 14 to the drum 12 when it is desired to reel in cable, the engine turns a winch system input member 32 which is secured on an input shaft 33 that is in turn supported by bearings 34. The shaft 33 also carries a transfer gear 36 which engages another transfer gear 37 to transmit drive to an input member 38 of a normally disengaged input clutch 39 of the friction disc type. The clutch 39 has one or more output discs 41 which are spline-connected to an output shaft 42 for axial movement thereon and which are spring-biased towards a position at which the disc or discs are free of engagement with the input member 38. The input clutch 39 may be selectively engaged by pressurizing a fluid actuator 43 which then urges output disc 41 towards the input member 38 to effect engagement.

The shaft 42, supported by another bearing 44, carries a transfer gear 46 which engages another transfer gear 47 secured to a shaft 48 which is supported by still another bearing 49. Drive is transmitted from the shaft 48 to the winch drum drive shaft 21 through a bevel gear 51 on the shaft 48 which engages another bevel gear 52 on the shaft 21.

To provide for immobilizing the winch drum when necessary, a normally engaged brake mechanism 53 is coupled to the shaft 42 through a rotatable brake shaft 54 that is supported by a bearing 56. The shaft 54 carries a gear 57 which engages another gear 58 carried on the shaft 42. The brake mechanism 53 may be of the friction disc type which includes one or more brake discs 59 spline-coupled to the brake shaft 54 for axial movement thereon and spring-biased towards a position at which each disc 59 is urged against a stationary brake disc 61. The brake mechanism 53 may be selectively disengaged by pressurization of a fluid actuator 62 which then urges the disc 59 away from the disc 61.

With all the actuators 31, 43 and 62 unpressurized, the system is in the Brake-On mode of operation at which the winch drum 12 is immobilized by the brake 53. By pressurizing the actuators 43 and 62, the Reel-In mode is established at which drive is transmitted to the drum 12 to reel in cable. When a load is pulling on the cable 13, cable may be released by pressurizing only the actuator 62 to disengage the brake 53. In this mode of operation, there is a limited degree of resistance to release of the cable due to the drag created by the frictional resistance and inertia of the gearing system coupled to the drum through the disconnect clutch 23. That resistance is typically sufficiently high that

it is very difficult or impossible to manually withdraw cable from the drum when there is no load pulling on the cable. To facilitate such manual withdrawal of cable, the actuator 31 may be pressurized to establish the Free-Spool mode at which the drum is uncoupled from the drum drive shaft 21 and the other elements of the drive train.

Referring now to Figure 3, there is shown a control valve 63 through which the clutch and brake actuators 31, 43 and 62 may be selectively pressurized by movement of the operator's control lever 16 to effect any of the above modes of winch operation, the control valve being shown at the Brake-On position at which all actuators are unpressurized. The control valve 63 has a valve body 64 with a bore 66 in which a valving element formed by a spool 67 is disposed. The spool 67 is shiftable along the axis of the bore 66 by pivoting of the control lever 16.

The valve body 64 has a fluid inlet chamber 68 and an additional bore 69 in which a pressure-modulating relief valve assembly 71 is disposed. A groove 72 in the bore 66 is communicated with the inlet chamber 68 and receives pressurized fluid from a pump 73 through a conduit 74. The pump 73, which may be driven by the previously described vehicle engine or other means, draws fluid from a tank 76 through a filter 77.

The modulating relief valve assembly 71 functions to establish a fluid pressure in the inlet chamber 68 which is normally at a predetermined level sufficient to fully actuate the previously described clutches and brake through the associated actuators but also functions to drop the pressure in the inlet chamber 68 to a lower level when the spool 67 is shifted to the Brake-On position and thereafter to produce a gradual rise of the pressure back up to the maximum level following movement of the spool away from the Brake-On position in either direction. This modulating action causes a gradual engagement or disengagement of the clutches and brake and thereby reduces shocks and stresses in the drive system.

The modulating relief valve assembly may include a spool 78 having a pair of lands 79 and 79′ separated by a groove 81, the spool being disposed for axial movement in a reduced-diameter extension 82 of the bore 69. The bore extension 82 is communicated with the inlet chamber 68 and, in conjunction with an edge of the spool land 79′, forms a flow metering passage through which fluid from the inlet chamber may be released to a discharge conduit 83 to regulate system pressure. A pair of coaxial springs 84 and 86 extend within the bore 69 between the end of the spool 78 and a load piston 87 at the opposite end of the bore 69 to urge the spool to a position at which the land 79′ blocks the release of fluid from the bore extension 82. The force of the springs 84 and 86 on the spool 78 is opposed by fluid pressure in another chamber 88 which receives fluid from the inlet chamber 68 through a check valve 89. Fluid may be gradually released from the chamber 88 back into the inlet chamber 68 through a restricted flow orifice 91.

Thus the position of the valve spool 78 is determined by the extent to which fluid pressure in the chamber 88 acting on the spool is able to overcome the opposed force of the springs 84 and 86 on the spool and thereby permit a controlled release of fluid from the inlet chamber 68. The springs are selected to establish a predetermined base pressure within the inlet chamber 68 which is low in relation to the pressure required to fully actuate the previously described clutches and brake. Thus, with the load piston 87 fully to the left as viewed in Figure 3, the fluid pressure within the chamber 88 is able to shift the spool 78 sufficiently to discharge fluid from the inlet chamber 68 at a rate which keeps the inlet chamber pressure at a low value. If the load piston 87 is then shifted rightwardly to increase the spring force on the valve spool 78, the pressure within the inlet chamber 68 and in the chamber 88 must rise to a higher value in order to force the spool 78 to the position at which fluid can continue to be released. Thus system pressure may be raised in a modulated manner by shifting the load piston 87 progressively to the right as viewed in Figure 3.

To control the load piston 87 so that system pressure is minimal at the Brake-On setting of the lever 16 and rises in a modulated manner when the lever is moved away from that position in either direction, a chamber 92 behind the load piston at the end of the bore 69 is communicated with the tank 76 through a passage 93 which extends across the valve spool bore 66. The valve spool 67 has a land 94 which blocks flow through the passage 93 at any position of the spool 67 other than the Brake-On position. At the Brake-On position, a groove 96 on the land 94 enables fluid to discharge from the load piston chamber 92 through the passage 93.

The load piston chamber 92 receives fluid from the inlet chamber 68 through a flow orifice 97. This flow of pressurized fluid into the load piston chamber 92 does not move the load piston 87 when the control spool 67 is in the Brake-On position since the load piston chamber is vented at that time through the drain passage 93 and the spool groove 96. However, if the control spool 67 is shifted away, in either direction, from the Brake-On position, the drain passage 93 is blocked. The flow of pressurized

fluid through the orifice 97 then gradually raises the pressure in the chamber 92 causing the load piston 87 to move to the right as seen in Figure 3 thereby gradually raising the system pressure within the inlet chamber 68 as described above. Accordingly, a shift of the control lever 16 in either direction away from the Brake-On position is followed by a modulated rise of system pressure within the inlet chamber 68. The pressure then remains at a high level until the control spool 67 is again shifted to the Brake-On position at which the pressure behind the load piston 87 is relieved.

Considering now the action of the valving element spool 67 in distributing pressurized fluid to appropriate ones of the clutches and brake at the various positions of the spool, the bore 66 has a pair of spaced-apart interconnected grooves 98 and 98' which are communicated with the brake actuator 62 of Figure 2 through a brake line 99. Referring again to Figure 3, the bore 66 has an additional groove 101 situated between grooves 98 and 98' and which receives pressurized fluid from the inlet chamber 68 through a check valve 102. The spool 67 has a series of flow-metering grooves 103 located to increasingly release pressurized fluid from the groove 101 into the groove 98 or 98' when the control spool is shifted in either direction away from the Brake-On position to pressurize the brake actuator and thereby release the brake at all other valve settings. An adjacent set of metering slots 104 on the spool 67 communicate the groove 98 with an adjacent drain groove 106 when the spool is at the Brake-On position thereby depressurizing the brake actuator and engaging the brake.

To pressurize a line 107 communicated with the input clutch actuator 43 at the Reel-In position of the lever 16 while venting that actuator to tank at all other positions of the lever, the bore 66 has still another groove 108 communicated with the line 107 and situated between the previously described fluid supply groove 72 and the drain groove 106. The spool 67 has an additional land 109 positioned to block the groove 108 from the supply groove 72 while communicating the groove 108 with the drain groove 106 at the Brake-On position of the spool 67 and also at the Brake-Off and Free-Spool positions which are realized by rightward movement of the spool 67 from the Brake-on position as viewed in Figure 3. When the control spool 67 is shifted leftwardly to the Reel-In position, the land 109 blocks the groove 108 from the drain groove 106 and then communicates the groove 108 with the inlet groove 72 to pressurize the input clutch line 107.

The disconnect clutch pressurization line 111 is communicated with still another groove 112 of the bore 66. Another land 113 of the control spool 67 is positioned to block the groove 112 from the supply groove 72 while communicating the groove 112 with an adjacent drain groove 114 at all positions of the spool 67 other than the Free-Spool position which is realized by moving the spool to the extreme rightward position as viewed in Figure 3. Accordingly, the disconnect clutch actuator is pressurized to release the winch drum for unresisted rotation only at the Free-Spool position of the control valve.

If the pump 73 which supplies pressurized fluid to the system should stop operating because of malfunction of the driving engine or for some other reason, the loss of pressure in the several actuator lines 99, 107 and 111 will automatically bring about the Brake-On condition at which the winch drum is immobilized. However, under this condition there may be circumstances at which the operator desires to controllably release cable from the winch to relieve the force of the load on the cable. To enable release of the brake for this purpose, another check valve 116 transmits fluid from the pump 73 to an accumulator 117 which is communicated with still another groove 118 of the bore 66. Metering slots 119 are positioned on the spool land 94 to transmit pressurized fluid from the accumulator to the groove 98' only when the spool 67 is shifted fully to the right, as seen in Figure 3, to the Free-Spool position. This does not interfere with operation of the system when the pump 73 is delivering pressurized fluid since the groove 98' is already pressurized at the Free-Spool position by other means as described above. Although the control valve is shifted to the Free-Spool position for the above-described special purpose, it should be observed that a true Free-Spool mode of operation does not result in the absence of system pressure since the disconnect clutch line 111 cannot be pressurized under that circumstance.

From the foregoing it may be seen that the clutch and brake pressurizations and depressurizations needed to effect the several described modes of winch operation may be realized by simply shifting the operator's control lever 16 between the appropriate one of the four positions of the lever. In order to restore the valving element spool 67 and the lever 16 to the Brake-On position automatically when the lever is released a centering spring assembly 121 is situated in a chamber 122 adjacent the end of bore 66. The chamber 122 is of larger diameter than the adjacent end of the bore 66 and contains a sleeve 123 having a flange 123' at the end adjacent the bore 66, the end of the spool 67 being extended through the sleeve

in coaxial relationship therewith. The chamber 122 also contains an annular element 124 through which the end of the spool 67 extends and a centering spring 126 which extends between the flange of the sleeve 123 and the annular element 124 in coaxial relationship with the spool end. A sub-chamber 122' forms a lesser-diameter extension of the chamber 122 and a bolt 127 extends axially from the end of the spool 67 within the sub-chamber 122' and has a washer 128 disposed coaxially thereon adjacent the end of the spool. The spring 126 urges the sleeve 123 and the annular member 124 in opposite directions. Movement of the sleeve 123 is limited by abutment of the flange 123' against one end of the chamber 122 while movement of the annular member 124 is limited by abutment against the other end of the same chamber. As the annular member 124 bears against the washer 128 while the sleeve flange 123' may exert a force against an adjacent land 129 of the spool 67 the effect of the centering spring assembly is to continually urge the spool 67 towards the Brake-On position. If the spool 67 is shifted rightwardly as viewed in Figure 3, the land 129 acting through the sleeve 123 tends to compress the spring 126 while if the spool is shifted in the opposite direction, the washer 128 acting through the annular member 124 again tends to compress the spring. Spool travel is limited in either direction by abutment of the sleeve 123 against the annular member 124 as shown in Figure 4.

Considering now the means which acts to produce an abrupt increase in the resistance to movement of the spool 67 and the control lever 16 as the Free-Spool position is approached, with reference again to Figure 3, a sleeve 131 is disposed coaxially around the bolt 127 and extends from the washer 128 to another washer 132 which in turn abuts an enlarged head 133 on the end of the bolt. An annular element 134 is disposed coaxially on the sleeve 131 adjacent the washer 132 and a plurality of annular belleville springs 136 of conical section shape are disposed coaxially on the sleeve 131 between the washers 128 and 134 to resist movement of one washer towards the other with a resilient force. It will be apparent that other forms of spring may extend between the two washers 128 and 134 if desired.

The chamber extension 122' has an internal step 137 positioned to be contacted by the annular element 134 upon movement of the valve spool 67 toward the Free-Spool position just prior to the time that position is reached. Accordingly, further movement of the valve spool 67 and the control lever 16 into the Free-Spool position can only be accomplished by compressing the belleville springs 136 as illustrated in Figure 4. This additional resistance to spool movement enables the operator to sense when the winch drum is about to be freed from any significant resistance against rotation so that he may terminate further control lever movement if he does not in fact desire to establish that condition.

WHAT WE CLAIM IS:—

1. A winch having a drum which is arranged to be power-driven and released for winding in or releasing a cable or like flexible member, the winch further comprising drive means for supporting the drum and for selectively transmitting a rotary drive thereto, the drive means having a normally disengaged input clutch, which is engaged to drive the drum in response to application of fluid pressure thereto, and a normally engaged brake for stopping rotation of the drive means and of the drum, the brake being releasable by application of fluid pressure thereto, a normally engaged disconnect clutch, which disengages the drum from the drive means and hence the input clutch and the brake in response to fluid pressure, means for supplying fluid under pressure, a control valve having an inlet chamber communicating with the fluid supply means, a brake fluid outlet, an input clutch fluid outlet and a disconnect clutch fluid outlet connected to the brake, the input clutch and the disconnect clutch respectively, the control valve having a valving element which is movable between at least four positions including a Brake-On position in which the inlet chamber is isolated from all of the outlets, a Reel-In position at which the inlet chamber is in communication with the input clutch outlet and the brake outlet while the disconnect clutch outlet is vented, a Brake-Off position in which the inlet chamber is in communication with the brake outlet while the input clutch outlet and the disconnect clutch outlet are vented, and a Free-Spool position in which the inlet chamber is in communication with the disconnect clutch outlet, resilient means for biassing the valving element into the Brake-On position and for creating resistance to movement of the valving element away from the Brake-On position, and means for creating additional resistance to further movement of the valving element as the valving element approaches the Free-Spool position.

2. A winch according to claim 1, wherein the means for creating additional resistance to movement of the valving element includes resilient means so located that it is distorted by movement of the valving element into the Free-Spool position.

3. A winch according to Claim 2, in which the control valve has a valve body with a bore therethrough and the valving

in coaxial relationship therewith. The chamber 122 also contains an annular element 124 through which the end of the spool 67 extends and a centering spring 126 which extends between the flange of the sleeve 123 and the annular element 124 in coaxial relationship with the spool end. A sub-chamber 122' forms a lesser-diameter extension of the chamber 122 and a bolt 127 extends axially from the end of the spool 67 within the sub-chamber 122' and has a washer 128 disposed coaxially thereon adjacent the end of the spool. The spring 126 urges the sleeve 123 and the annular member 124 in opposite directions. Movement of the sleeve 123 is limited by abutment of the flange 123' against one end of the chamber 122 while movement of the annular member 124 is limited by abutment against the other end of the same chamber. As the annular member 124 bears against the washer 128 while the sleeve flange 123' may exert a force against an adjacent land 129 of the spool 67 the effect of the centering spring assembly is to continually urge the spool 67 towards the Brake-On position. If the spool 67 is shifted rightwardly as viewed in Figure 3, the land 129 acting through the sleeve 123 tends to compress the spring 126 while if the spool is shifted in the opposite direction, the washer 128 acting through the annular member 124 again tends to compress the spring. Spool travel is limited in either direction by abutment of the sleeve 123 against the annular member 124 as shown in Figure 4.

Considering now the means which acts to produce an abrupt increase in the resistance to movement of the spool 67 and the control lever 16 as the Free-Spool position is approached, with reference again to Figure 3, a sleeve 131 is disposed coaxially around the bolt 127 and extends from the washer 128 to another washer 132 which in turn abuts an enlarged head 133 on the end of the bolt. An annular element 134 is disposed coaxially on the sleeve 131 adjacent the washer 132 and a plurality of annular belleville springs 136 of conical section shape are disposed coaxially on the sleeve 131 between the washers 128 and 134 to resist movement of one washer towards the other with a resilient force. It will be apparent that other forms of spring may extend between the two washers 128 and 134 if desired.

The chamber extension 122' has an internal step 137 positioned to be contacted by the annular element 134 upon movement of the valve spool 67 toward the Free-Spool position just prior to the time that position is reached. Accordingly, further movement of the valve spool 67 and the control lever 16 into the Free-Spool position can only be accomplished by compressing the belleville springs 136 as illustrated in Figure 4. This additional resistance to spool movement enables the operator to sense when the winch drum is about to be freed from any significant resistance against rotation so that he may terminate further control lever movement if he does not in fact desire to establish that condition.

WHAT WE CLAIM IS:—

1. A winch having a drum which is arranged to be power-driven and released for winding in or releasing a cable or like flexible member, the winch further comprising drive means for supporting the drum and for selectively transmitting a rotary drive thereto, the drive means having a normally disengaged input clutch, which is engaged to drive the drum in response to application of fluid pressure thereto, and a normally engaged brake for stopping rotation of the drive means and of the drum, the brake being releasable by application of fluid pressure thereto, a normally engaged disconnect clutch, which disengages the drum from the drive means and hence the input clutch and the brake in response to fluid pressure, means for supplying fluid under pressure, a control valve having an inlet chamber communicating with the fluid supply means, a brake fluid outlet, an input clutch fluid outlet and a disconnect clutch fluid outlet connected to the brake, the input clutch and the disconnect clutch respectively, the control valve having a valving element which is movable between at least four positions including a Brake-On position in which the inlet chamber is isolated from all of the outlets, a Reel-In position at which the inlet chamber is in communication with the input clutch outlet and the brake outlet while the disconnect clutch outlet is vented, a Brake-Off position in which the inlet chamber is in communication with the brake outlet while the input clutch outlet and the disconnect clutch outlet are vented, and a Free-Spool position in which the inlet chamber is in communication with the disconnect clutch outlet, resilient means for biassing the valving element into the Brake-On position and for creating resistance to movement of the valving element away from the Brake-On position, and means for creating additional resistance to further movement of the valving element as the valving element approaches the Free-Spool position.

2. A winch according to claim 1, wherein the means for creating additional resistance to movement of the valving element includes resilient means so located that it is distorted by movement of the valving element into the Free-Spool position.

3. A winch according to Claim 2, in which the control valve has a valve body with a bore therethrough and the valving

element is a valve spool which is disposed coaxially in the bore and is axially movable therein between said positions, said valve spool being movable in a first direction from the Brake-On position to the Reel-In position and being movable in an opposite direction from the Brake-On position first to the Brake-Off position and subsequently to the Free-Spool position, and the means for creating additional resistance comprises spring means positioned so that it is compressed by movement of the valve spool in said opposite direction only after the valve spool has passed through the Brake-Off position.

4. A winch according to claim 3, wherein the spring means is annular and is disposed in a spring chamber of the valve body situated at one end of the spool bore, the spring means being disposed coaxially with the spool.

5. A winch according to claim 4, wherein the spring means is carried on an extension of the spool within the spring chamber so that it moves axially with the spool and means are provided within the spring chamber for stopping further axial movement of the spring means with the spool in said opposite direction as the spool is about to reach the Free-Spool position and thus preventing further movement of the spring means with the spool in said opposite direction whereby the spring means is compressed upon the further movement of the spool taking place.

6. A winch according to claim 4, wherein the valve spool has a reduced-diameter extension within the spring chamber and wherein an annular element is disposed coaxially on the extension for axial movement relative thereto and the spring means is an annular compression spring disposed coaxially on the extension and having an end bearing against the annular element, the spring chamber having an annular abutment therein in a position in which it stops further movement of the annular element with the spool extension as the spool is moved from the Brake-Off position towards the Free-Spool position whereby the spring means is compressed by the further movement to the Free-Spool.

7. A winch according to claim 6, wherein the spring means comprises a plurality of resilient washers disposed coaxially along the spool extension.

8. A winch according to claim 1, substantially as described with reference to Figures 2 to 4 of the accompanying drawings.

9. A log skidder vehicle incorporating a winch in accordance with any one of the preceding claims.

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