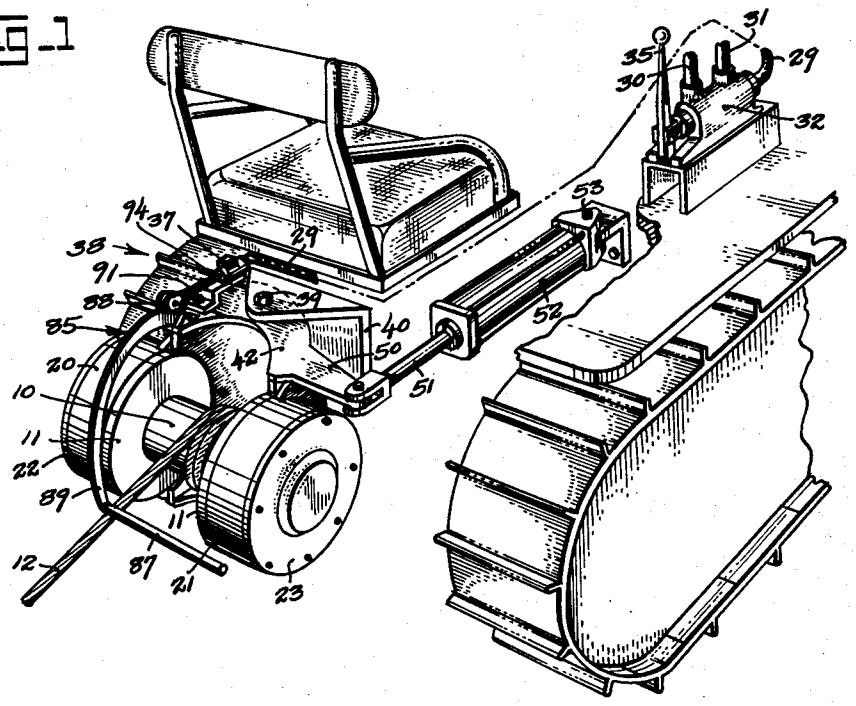
Nov. 8, 1960 F. L. LAWRENCE 2,959,396

REVERSIBLE HYDRAULIC WINCH

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Fig. 1



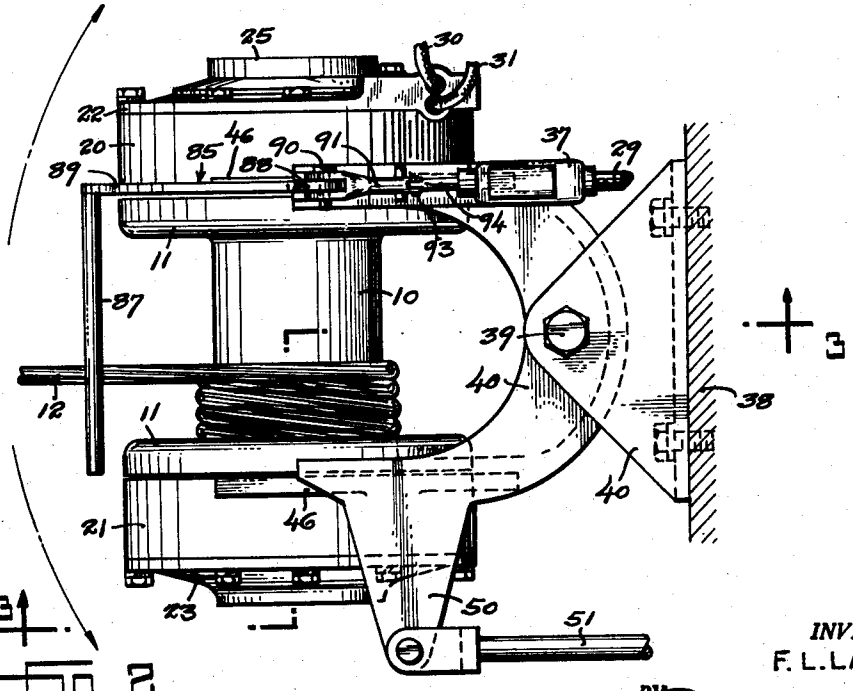


Fig. 2

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Fig. 3

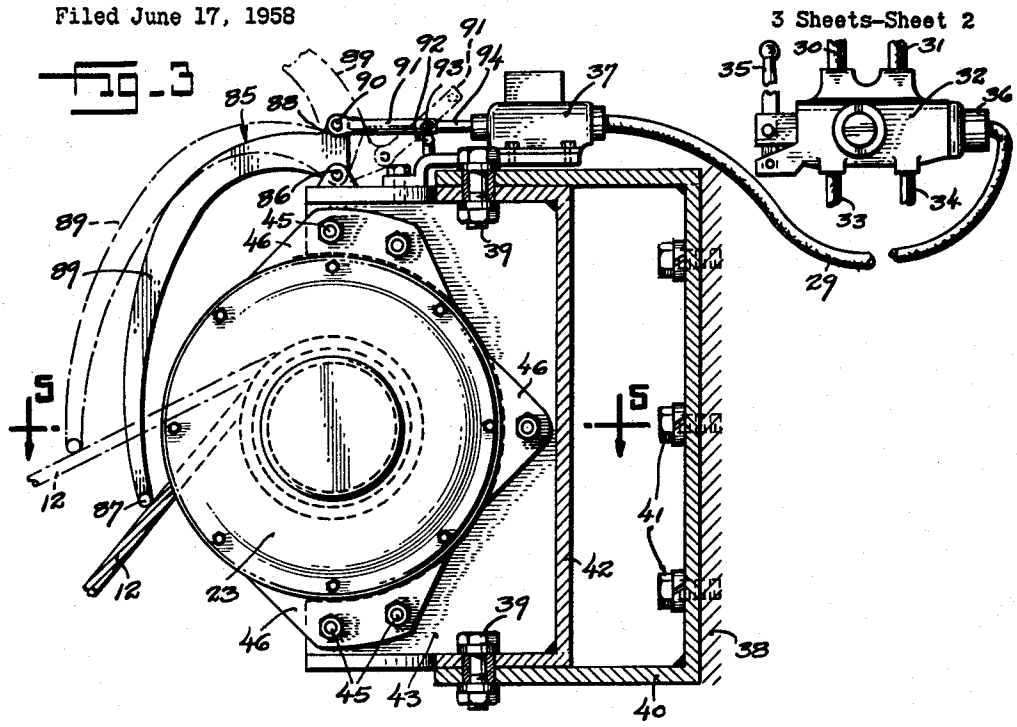
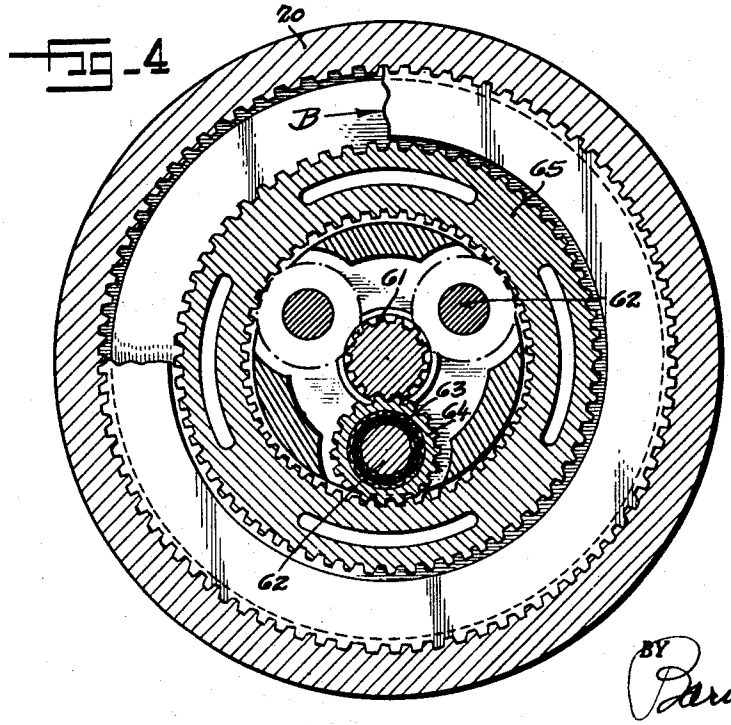


Fig. 4



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REVERSIBLE HYDRAULIC WINCH

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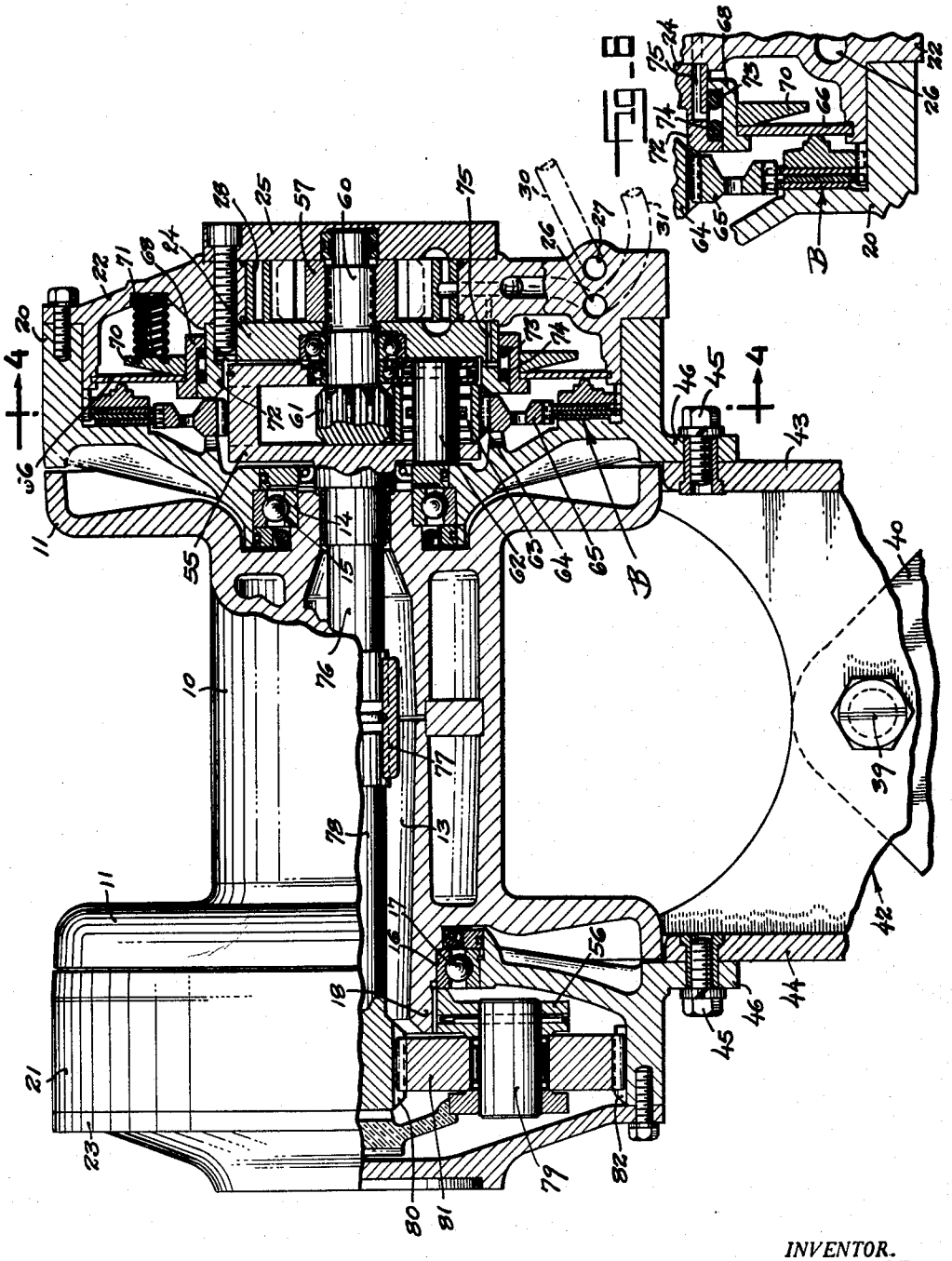


Fig. 5

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REVERSIBLE HYDRAULIC WINCH

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17 Claims. (Cl. 254—172)

This invention relates to a hydraulic winch, and namely a winch whose winding drum is driven by a fluid motor. For its general object the invention aims to provide a ruggedly constructed reversible winch of this nature which is unusually efficient in operation and which has its fluid motor contained within one of two cheek housings presenting bearings for the journal mounting of the winding drum.

As a further object the invention aims to provide a winch of the described nature embodying reduction gearing between the fluid motor and the drum.

It is a still further and particular object to devise a reversible hydraulic winch including planetary gearing in its reduction system, and characterized in that two separate but compounding planetary systems are employed with one said system being contained in the cheek housing at one end and the other said system being contained in the cheek housing at the other end of the drum.

The invention has the yet further particular object of passing the drive for both forward and reverse directional travel through much the same path between the power motor and the drum but in the instance of reverse drive establishing an automatic lock-up of one of the two planetary systems so that the concerned planet gears will move bodily with the related sun gear and responsively provide, between the fluid motor and the drum, only the reduction afforded by the other planetary system.

As a further object still the invention aims to provide a reversible hydraulic winch especially adapted for use in conjunction with a logging tractor and having a means by which the speed at which cable is paid out from the drum is regulated automatically so as to conform to the speed at which such cable is required.

A yet additional particular object is to provide a winding drum journaled for rotation about a horizontal axis with the journal mounting swingable about a vertical axis, and having associated hydraulically powered means for shifting said mounting at will into selected adjusted positions whereat the drum's journal axis lies normal or approximately normal to the line along which the cable is being drawn from the drum.

Other objects and advantages will, with foregoing, appear and be understood in the course of the following description and claims, the invention consisting in the novel construction and in the adaptation and combination of parts hereinafter described and claimed.

In the accompanying drawings:

Figure 1 is a fragmentary perspective view portraying a hydraulic reversible winch constructed to embody the preferred teachings of the present invention mounted upon the back of a logging tractor.

Fig. 2 is a fragmentary enlarged-scale plan view of said winch.

Fig. 3 is a fragmentary transverse vertical sectional view on broken section line 3—3 of Fig. 2.

Fig. 4 is a transverse vertical sectional view drawn on line 4—4 of Fig. 5, employing a scale enlarged from that of Figs. 2 and 3.

Fig. 5 is a fragmentary view shown partly in plan and partly in horizontal section with the section line designated by 5—5 in Fig. 3; and

Fig. 6 is a detail blow-up of a fragmentary part of the structure shown in Fig. 5.

Referring to said drawings the reference numeral 10 designates a winding drum provided with flanged ends 11 and having suitable means (not shown) by which the root end of a cable 12 may be affixed thereto. The drum has a through-opening 13 along its axial center and an annular hub surrounds this opening at each of the two ends. For ease of description one of the two ends of the drum will be termed the front end and the other the rear end. The hub which lies at the front end is provided upon its external surface with a seat 14 for the inner race of a ball bearing 15. The hub which lies at the rear end provides a seat 16 for the inner race of a ball bearing 17, and also presents an externally splined neck 18 prolonged rearwardly beyond the seat. Said bearings derive support from a front and rear gear housing, as 20 and 21, respectively.

These gear housings have somewhat of a bell shape, facing outwardly in each instance, and the gear compartments provided thereby are each fitted with a boltably attached closure, as 22 and 23. The front closure 22 additionally acts with inner and outer headers 24 and 25 to form the cylinder for a reversible rotary-type fluid motor and is suitably cored to provide separated flow passages 26 and 27 leading to the cylinder and connecting by flexible pressure-type hoses 30 and 31 with a 2-way control valve 32. A hose 33 connects the valve body with the high pressure side of an associated pump (not shown) while a hose 34 leads from the valve body to a supply reservoir for the pump. A handle 35 permits the valve proper to be shifted axially from a vertical position into either of two operating positions in one of which the high-pressure hose 33 connects with hose 30 while bringing hose 31 into connection with hose 34 and in the other of which hose 33 is brought into connection with hose 31 while connecting hose 30 with hose 34.

Upon one end of the body for said control valve 32 there is provided a cylinder 36 functioning as the slave complement of a master cylinder 37. In a manner hereinafter to be described a mirrored reaction by this slave cylinder to a given graduated motion of the master cylinder responsively shifts the control valve into correspondingly modified positions within the latter's limits of reverse travel.

The winch of the present invention has been here illustrated as being mounted upon the back end of a crawler-type tractor 38 for use, say, in a logging operation where the tow-line 12 passes from the winding drum over a trailing arch. For this purpose a mounting yoke 40 is secured by bolts 41 to the aft end of the tractor, and a swing-frame 42 is connected by king pins 39 for lateral swinging motion between the arms of this yoke. The frame provides cheek-sections 43 and 44, and secured by bolts 45 to these cheek-sections are ears 46 projecting from the gear housings 20 and 21 at spaced intervals of the perimeter. The front edges of said cheek-sections have re-entrant openings which correspond to the profile configuration of the gear housings.

50 represents an arm projected laterally from the swing-frame. Attached to this arm for swinging the frame is a piston rod 51 having its piston working in an oil cylinder 52 pivoted, as at 53, to the frame of the tractor. While not illustrated in the drawings, oil lines from a manually-operated control valve connect with opposite ends of the oil cylinder so that the operator

may swing the winch laterally at will, about the center of the king-pins **39** as an axis, into positions whereat the journal axis of the winding drum will occupy a position normal, or approximately normal, to the vertical plane in which the tow-cable **12** runs in its travel from the drum to the arch.

Reverting now to the reversible drive for the winding drum it will be seen that within each of the gear compartments of the forward and rear gear housings **20** and **21** there is received a respective cage, as **55** and **56**. Each such cage is journaled to turn about the longitudinal center of the winding drum as an axis, this axis coinciding with the center about which the rotor **57** of the fluid motor turns. A drive shaft **60**, keyed to the rotor, extends rearwardly therefrom into the forward gear compartment and upon its aft end presents a sun gear **61**. The cage **55** carries mounting spindles **62** for a set of planetary affairs, with each such spindle being pinned or otherwise secured to the cage so as to hold the same against rotation. The planetary affairs include over-running cam clutches **63** between each said spindle and a respective outer race ring **64**. External gear teeth on said race rings mesh the teeth of the sun gear **61**. A surrounding annular internal gear for these planetary gears **64** is denoted by **65** and a multiple-disc brake designated generally by the letter B is provided for said annular gear. The friction plates of the brake are splined to the gear and the reaction plates are splined to the surrounding wall of the gear housing. A diaphragm **66** is anchored by its outer edge and bears upon the front face of the multiple-disc brake. The inner edge of such diaphragm is caught between a spring retainer **70** and the out-turned peripheral flange provided at the rear end of a ring-shaped piston **68**, the spring retainer lying to the front and being urged rearwardly by compression springs **71**. The piston has an inturned peripheral flange at its front end which takes a slide journal upon the external surface of a lip section **72** carried rearwardly as a rim prolongation of the header **24**. This lip section terminates in an out-turned peripheral flange so spaced from the inturned flange of the piston as to define a cylindrical chamber therebetween, and compressed moderately between inner and outer walls of this chamber with the one bearing against one end wall and the other spaced therefrom and bearing against the other end wall are two neoprene O-rings **73** and **74**. Connecting ducts **75** bored in the header **24** and the closure **22** lead to the space between said O-rings from the flow passage **26**. It will thus be seen that when oil under pressure is fed through passage **26** to the fluid motor to turn the latter in one direction the pressure of such oil is simultaneously passed through ducts **75** to urge the piston **68** forwardly counter to the thrust of the springs **71**, or which is to say away from the brake, responsively retracting the diaphragm. When this is done the annular internal gear **65** perforce runs free. As the control valve is moved to the opposite extreme of its reciprocal travel so as to deliver oil under pressure through the other flow passage **27** of the closure, dropping off the pressure in passage **26**, the springs **71** reassert their power so as to set the brake and responsively lock the annular gear **65** against rotation.

A stud shaft **76** is made rigid with the cage **55** and extends rearwardly therefrom into the hollow center **13** of the winding drum, whereat connection is made by a coupling sleeve **77** with a co-axial shaft **78**. The rear end of this shaft projects rearwardly beyond the splined neck **18** into the gear compartment of the rear gear housing **21**. A sun gear **80** formed upon said projecting end meshes a set of planet gears **81** carried by the cage **56**, with such planet gears tracking upon an annular internal gear **82** formed integral with the gear housing **21**. The cage **56** connects with the winding drum by means of the splined neck **18**.

Let it be here stated that delivery of oil under pressure through flow passage **27** causes the rotor of the fluid motor to turn in a clockwise direction as viewed from the aft end of the motor, and that this action gives a "forward" drive and occurs in consequence of moving the control handle **35** toward the right from the neutral position in which it is shown in Fig. 3. As a further premise, let it be understood that the over-running clutches free-wheel when the race rings **64** are turned in a counter-clockwise direction and that the drum **10** performs its cable-winding function when turned in a clockwise direction. With these directional movements understood, and in each following reference to clockwise or counter clockwise direction considering that the concerned part is being viewed from the rear, let it be assumed that the control handle has been moved into said "forward" position. The fluid motor thereupon turns the sun gear **61** in a clockwise direction. The race rings **64** responsively turn in the opposite direction, free-wheeling upon their spindles, and as they track about the brake-arrested internal ring gear **65** the orbital travel given to the planetary gears causes the cage **55** to turn in a clockwise direction. The speed reduction, at this stage of the power transfer, is 5 to 1. Carried by coupled shafts **76** and **78** to the rear gear compartment, the driven sun gear **80** imparts clockwise planetary motion through planet gears **81** to the cage **56**. The reduction from the sun gear **80** to its planetary cage is 8¼ to 1, wherefor the winding drum, to which said cage is splined, turns in a cable-winding clockwise direction at the compounded reductions of the two planetary systems, namely 41¼ to 1. The actual reduction is perforce not critical, the significance lying in the magnitude which the compounded systems produce.

Now, let it be presumed that the control lever is shifted to the opposite extreme of its permitted movement, namely to the left as viewed in Fig. 3, responsively bringing said flow passage **27** into communication with the return line **34** leading to the reservoir, and connecting the pump's high-pressure side with the flow passage **26**. The fluid motor now rotates in a counter-clockwise direction, and pressure of the pumped oil is coincidently imposed upon O-ring **73** to push the piston **68** forwardly and responsively release the brake so that the annular internal gear **65** runs free. The turning moment imposed by the sun gear **61** upon the race rings **64** of the over-running clutches is directionally such that the clutches take hold to inactivate the planetary process and the planet gears then turn bodily in unison with the sun gear. The turning motion passed to the rear sun gear **80** and thence through planetary gears **81** to the winding drum is the same as above described, albeit of opposite rotation, at a moderate speed reduction—fluid motor to winding drum—of 8¼ to 1, in other words the 1 to 1 direct drive carried by the gears of the forward compartment compounded with the 8¼ to 1 reduction in the aft compartment.

A feature of the present invention is the provision of a means for automatically controlling the run-out of the cable, the arrangement being one in which the fluid motor's speed, while reversing, is increased and decreased, respectively, according as the line becomes taut or slack. For this purpose a bell-crank **85** is pivoted, as at **86**, in surmounting relation to the swing-frame **42** for rocker motion about a transverse horizontal axis with one arm **89** of this bell-crank being goose-necked and in its normal position extending forwardly and downwardly from the pivot in a position to the rear of and to one side of the winding drum. At its lower end this arm presents a horizontal extension **87** located parallel to the rotary axis of the winding drum in a position such as to bear upon the cable as the latter is unwound from the drum. The other arm **88** of the bell-crank is a short arm which rises vertically from the pivot, and pivoted, as at **90**, to this arm is a push-rod **91** which is operative or inoperative at will and which is adapted,

when operative, to point rearwardly on a generally horizontal plane. The push-rod articulates by a removable pin **93** with a generally co-axial plunger **94** which operates upon the aforementioned master cylinder **37** to transfer operating movements through the responding slave cylinder **36** to the control valve **32**. The action is one in which a slack condition of the cable, indicating a run-out from the drum faster than the cable is being hauled back over the trailing arch, drops the arm **89** of the bell-crank and thus causes an automatic reduction of the drum's pay-out speed. A taut condition lifts the arm **89** to responsively speed up the pay-out of cable. Upon removal of the pin **93**, the bell-crank can be lifted into the out-of-the-way position shown by broken lines in Fig. 3 so as not to interfere with the working of the control valve **32** when the cable is being taken in. The push-rod, when inoperative, is sustained upon a rest **92**.

As one of many different applications, it is to be noted that the described winch is especially adapted for use as a hoist, permitting a load to be either lowered or raised at any desired speed within the full operating range from zero to maximum, depending on the quantity of oil which is allowed to reach the hydraulic motor by metering the control valve. The winch provides positive brake action completely devoid of the wear customarily associated with winch and hoist brakes. With the usual relief valves employed in hydraulic systems, it is impossible to overload the winch and cause failure of any mechanical part.

It is thought that the invention will have been clearly understood from the foregoing detailed description of my now-preferred illustrated embodiment. Structural changes will suggest themselves and may be resorted to without departing from the spirit of the invention, wherefore it is my intention that no limitations be implied and that the hereto annexed claims be given a scope fully commensurate with the broadest interpretation to which the employed language admits.

What I claim is:

1. In a transmission, the combination of input and output shafts, a carrier, a planetary gear set including a sun gear fast to the input shaft, having an annular gear, and having planet gears between and in mesh with said sun gear and said annular gear mounted on spindles which are fixedly carried by the carrier, each of said planet gears comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to its mounting spindle and caused to be engaged when the ring gear turns in a given one direction of rotation, a brake acting when engaged to arrest the rotation of said annular gear, connection from the carrier to the output shaft, means for driving the sun gear in either of two directions, selectively, and means acting automatically to free said brake when the sun gear turns in said given one direction of rotation and to set the brake when the sun gear turns in the opposite direction of rotation.

2. In a transmission, the combination of input and output shafts, a carrier, a planetary gear set including a sun gear fast to the input shaft, having an annular gear, and having planet gears between and in mesh with said sun gear and said annular gear mounted on spindles which are fixedly carried by the carrier, each of said planet gears comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to the related mounting spindle and caused to be engaged when the ring gear turns in a given one direction of rotation, a brake acting when engaged to arrest the rotation of said annular gear, a spring acting to set said brake, connection from the carrier to the output shaft, means for driving the sun gear in either of two directions, selectively, and a fluid cylinder and piston assembly acting automatically to retract the brake-setting spring to responsively free the brake when the sun gear turns in such a direction as rotates the ring gears in said given one direction of rotation.

3. Structure according to claim 2, said cylinder and piston assembly being comprised of an annular piston member slidable endwise to the axis of the input shaft on a cylindrical member lying concentric to said shaft, the annular piston member having an inturned flange on which a surface of the cylindrical member slides and said cylindrical member having an out-turned flange on which a surface of the annular piston member slides, said flanges being axially spaced and said slide surfaces being radially spaced so as to define a closed chamber of sectionally rectangular form surrounding the cylindrical member, and two O-rings received at opposite ends of said chamber sealing said ends as fluid is supplied to the chamber.

4. Structure according to claim 3, said brake being of multiple-disc construction, the pressure of the spring imposing its brake-setting thrust by means of a ring-shaped diaphragm having its outer edge anchored and its inner edge caught between the spring and an out-turned flange formed on the annular piston member.

5. In a transmission, the combination of an input shaft, an output shaft, a first carrier, a second carrier, a first planetary gear set including a sun gear fast to the input shaft, having an annular gear, and having planet gears between and in mesh with said sun gear and said annular gear mounted on spindles which are fixedly carried by the first carrier, each of said planet gears comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to the mounting spindle and caused to be engaged when the ring gear turns in a given reverse direction of rotation, a brake acting when engaged to arrest the rotation of said annular gear, a second planetary gear set including a sun gear driven by the first carrier, having an annular gear, and having planet gears between and in mesh with said sun gear and said annular gear and carried by the second carrier, means for holding the last-named annular gear against rotation, a driving connection from the second carrier to the output shaft, means for driving said input shaft in either a forward or a reverse direction and means for setting and releasing said brake automatically according as the input shaft is driven in said forward or reverse direction, respectively.

6. The transmission of claim 5 in which the driving means is comprised of a reversible fluid motor.

7. A transmission according to claim 6 in which the means for setting and releasing said brake includes a piston movable reciprocally endwise to the rotary axis of the input shaft, urged by a spring in one direction of its travel, and movable in the opposite direction by force of the hydraulic pressure imposed upon the fluid motor to rotate the latter in its said reverse direction.

8. A transmission according to claim 6 in which the means for setting and releasing said brake includes a piston movable reciprocally endwise to the rotary axis of the input shaft and in at least one direction of its reciprocal travel activated by force of the hydraulic pressure imposed upon the fluid motor to rotate the latter in one of its directions of rotation.

9. In a reversible hydraulic winch, a winding drum having a through-opening in its center, front and aft cheek bitts for the drum each presenting a gear chamber communicating with said through-opening, a first carrier received in the front gear chamber for rotation about an axis coinciding with the rotary center of the drum, a second carrier received in the aft gear chamber and splined to the drum, a first planetary gear set in the front chamber including a sun gear and having planet gears in mesh with said sun gear and carried by the first carrier, a driven shaft extending as an axial prolongation of the first carrier through said center opening of the drum into the aft gear chamber, a second planetary gear set including a sun gear fast to the aft end of said driven shaft and having planet gears in mesh with the last-named sun gear

and carried by the second carrier, a reversible fluid motor supported by the front cheek bitt and having its rotor driving the sun of the first planetary gear set, and means for supplying fluid under pressure to the fluid motor so as to drive the latter in either direction, selectively, each of said planetary gear sets including a respective annular gear meshed by the related planet gears.

10. Structure according to claim 9, each of the planet gears of the first planetary gear set comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to a respective mounting spindle which is fixed to the first carrier and caused to be engaged when the ring gear turns in a given reverse direction of rotation, a brake acting when engaged to arrest the rotation of the annular gear of the first planetary gear set, and means acting to set and release the brake automatically as the motor is driven in a forward and in a reverse direction, respectively.

11. Structure as recited in claim 9 having a manually operated valve functional to control directional travel and speed of the fluid motor, and means associated with said valve employed when a line is being paid out from the drum acting to decrease and increase the speed automatically as the line slacks and tautens, respectively.

12. The structure recited in claim 9 having a manually operated valve functional to control directional travel and speed of the fluid motor, and means associated with said valve employed when a line is being paid out from the drum acting to decrease and increase the speed of pay-out automatically as the line slacks and tautens, respectively, the means last recited including a slave cylinder controlling the valve, a master complement of said slave cylinder surmounting the drum, and a bell-crank one arm of which overlies the run-out of line immediately adjacent the drum in a position to be raised and lowered as the line rises and falls and the other arm of which connects with the master cylinder so as to activate the latter in response thereto.

13. In a reversible hydraulic winch, a winding drum, front and aft cheek bitts providing journal mountings for the ends of the drum, one of said cheeks bitts having a gear chamber therein and providing a center opening in its inner wall giving access from the gear chamber to an end of the drum, a carrier received in said gear chamber for rotation about an axis coinciding with the rotary center of the drum and presenting an axial prolongation extending into said opening and operatively interconnected with the drum so as to drive the latter, a planetary gear set in said chamber including a sun gear and an annular gear and planet gears between and in mesh with said sun gear and said annular gear, said planet gears being mounted on spindles fixedly carried by the carrier, a brake acting when engaged to arrest the rotation of said annular gear, each of said planet gears comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to the mounting spindle and caused to be engaged when the ring gear turns in a given reverse direction of rotation, a reversible fluid motor supported by said chambered bitt at the end thereof opposite the center opening and having its rotor driving the sun gear of said planetary set, separated passage-ways leading to opposite sides of the fluid motor, means for supplying fluid under pressure to either of said passage-ways, selectively, while at the same time bringing the other passage-way into communication with a fluid reservoir so as to drive the motor in either a forward or a reverse direction at will, and means acting to set and release the brake automatically according as the fluid under pressure is supplied to the side of the motor giving a forward drive or the side of the motor giving a reverse drive.

14. In a reversible winch, the combination of a driven member, and means operatively connected with said driven member for driving the same in either a forward or reverse direction and including two planetary gear systems each including planet gears between and in mesh with a respective sun gear and a respective annular gear and each of which functions both in forward and reverse and with one compounding the reduction provided by the other when in forward and being automatically locked up so that its planet gears move bodily with the related sun gear when in reverse.

15. The structure recited in claim 14 employing as the prime mover a reversible fluid motor having driving connection with said sun gear of the planetary system which is locked up when in reverse.

16. In a reversible power unit, a driven member, a reversible driving member, and operative interconnection from the drive member to the driven member for driving the driven member in either a forward or reverse direction, said drive passing successively both in forward and reverse through two reduction gear trains which compound the reductions when in forward to give maximum power and incorporating means for automatically locking up one of said trains when in reverse so that the same will then move bodily as a unit and provide, between the drive member and the driven member, only the reduction afforded by the other said gear train.

17. In a reversible winch, the combination of a winding drum, and means operatively connected with said drum for driving the same so as to wind cable thereon and including a planetary gear system having planet gears between and in mesh with a sun gear and an annular gear, a source of power for driving said sun gear, said planet gears each comprising a ring gear formed as the outer race of a respective over-running clutch acting when engaged to couple the ring gear to a respective spindle serving as the inner race and fixed to a carrier for the planet gears, said clutches being caused to overrun when the planetary gear system, by power received from the power source, drives the drum so as to wind cable thereon, means normally arresting the rotation of said annular gear so that the planet gears will walk circumferentially thereof when such power is applied to drive the drum in said cable-winding action, the application by the cable to the drum of a counter-direction force which tends to unwind cable when power is not being transmitted from the power source operating to produce an automatic lock-up by engagement of the over-running clutches, and means for releasing the annular gear for free rotation thereof to permit the drum to turn in a cable-unwinding direction.

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