ABSTRACT
A cable winch for helicopter installation which has a guide sheave assembly utilizing a trunnion and carriage assembly for the guide pulley including a reaction bar and rollers to transmit the horizontal component of cable tension into the reaction bar, a reaction strut for supporting the guide sheave assembly and which is pivoted to follow traversing motion of the guide sheave assembly, a levelwind mechanism having a two-speed drive for traversing of the guide sheave assembly and automatic means for changing traversing speed during cable deploy or retrieval, and a load cell in the guide sheave assembly support for measuring cable tension.

12 Claims, 8 Drawing Figures
WINCH SYSTEM FOR HELICOPTER

The invention herein described was made in the course of or under a contract or subcontract thereunder with the Naval Air Development Center.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a winch for use with a helicopter to deploy and retrieve a towed array assembly including a cable consisting of sections of two different diameters, and more particularly to the levelwind feed speed control, guide sheave assembly, and tow cable tension sensing features of the winch.

2. Description of the Prior Art

Various winching devices have been employed with helicopters to raise and lower cargo loads carried by the helicopter, for rescue operations, or to deploy and retrieve towed devices such as those used in submarine surveillance or antinimining operations. Different uses and functions of the winching devices do, of course, involve different winching structures and operations and, accordingly, winch structures employ various features depending upon the particular use of the winch as well as the degree of sophistication of the total system. For example, Smallz U.S. Pat. No. 2,862,673 discloses a speed drive arrangement for paying out a cable at a different rate than that used to draw in the cable. Hanson U.S. Pat. No. 2,900,145 is directed to a variable speed levelwind mechanism for a winch system which includes control of the traversing speed of the levelwind mechanism in accordance with several factors including cable diameter. However, a speed change is not accomplished during the winding of any one reel or drum.

SUMMARY OF THE INVENTION

An object of this invention is to provide an improved winching system for use with a helicopter.

Another object of the invention is to provide a helicopter winching system which has an improved guide sheave assembly utilizing the axial and lateral forces imposed upon the levelwind feedscrew.

Another object of the invention is to provide a levelwind traversing automatic two-speed control for a helicopter winching system which deploys and retrieves a cable consisting of sections of two different diameters.

Still another object of the invention is to provide an improved winching system for a helicopter which effectively develops a reliable signal of cable tow force.

In accordance with the present invention, a winch device for a helicopter is provided for deploying and retrieving a cable having two sections of different diameter. In the system, the levelwind guide pulley is caused to traverse its feedscrew at a rate according to the diameter of the cable being payed and the selection of the traversing speed is automatically controlled. Further, the guide pulley is mounted on both a feedscrew and a reaction bar by a trunnion and carriage assembly which transmits the horizontal component of cable tension into the reaction bar with minimum frictional resistance to lateral motion along the feedscrew. The guide pulley sheave assembly is supported from below by a reaction strut to reduce to an insignificant amount the axial and lateral forces on the feedscrew and hence the power required to drive the feedscrew, and a load cell is mounted at the strut attachment so as to sense the vertical component of the force applied by the cable as it passes over the guide pulley.

The foregoing and other objects, features and advantages of the invention become more apparent in the light of the following detailed description of the preferred embodiment thereof, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified representation of a helicopter showing the location of the winching system within the helicopter fuselage.

FIG. 2 is a perspective view of the winching system.

FIG. 3 is a diagrammatic representation of the winching system showing the various drum and guide sheave pulley drives and the automatic control of the traversing speed of the guide pulley.

FIG. 4 is a schematic front view of the guide sheave assembly showing the guide pulley's trunnion mounting and the guide sheave's reaction strut.

FIG. 5 is a schematic side view of the guide sheave assembly.

FIG. 6 is a schematic top view of the trunnion and carriage assembly for the guide sheave pulley.

FIG. 7 is a view along line 7-7 in FIG. 6.

FIG. 8 is a view along line 8-8 in FIG. 6.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, helicopter 10 is shown and a portion of the sidewall of fuselage 12 is broken away to show the relative location of the winching system 14 therein. Winch controls are located within the helicopter fuselage and operated by a crew member 16 stationed therein, although various of the winch controls and indicators are also located within pilot compartment 18.

As shown in FIG. 2, the winching system generally includes frame 20 attached to cargo deck 22, drum 24, drum drive 26, guide sheave assembly and levelwind mechanism 28, and swivel fairlead 30 mounted within opening 32 in the cargo deck. A cable having two sections of different diameter, the larger diameter portion of which is indicated at 34, is wound on drum 24 and passes over guide pulley 36 in guide sheave assembly 28 and through swivel fairlead 30 to the outside.

FIG. 3 is a diagrammatic showing of the drum and guide sheave assembly and levelwind mechanism illustrating the various drum and guide sheave pulley drives and the automatic control of the traversing speed of the guide sheave assembly. Drum 24 is shown with large cable 34 and small cable 38 wrapped thereon, in this embodiment the large cable being laid on with substantially fewer wraps per layer than the small cable. The drum is driven by reversible hydraulic drive motor 40 through gearbox 42 which is directly connected to the drum and drivingly connected by chain 44 to intermediate shaft 46 supported by frame 20. The intermediate shaft has sprockets 48 and 50 at opposite ends thereof and these sprockets in turn are selectively drivingly connected to feedscrew 52. Sprocket 48 is connected by chain 54 to sprocket 56 freely mounted on one end of the feedscrew and sprocket 50 is connected by chain 58 to sprocket 60 freely mounted on the other end of the feedscrew. Each of sprockets 56 and 60 is secured to one element of a saw tooth type clutch, sprocket 56
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being connected to clutch element 62 and sprocket 60 being connected to clutch element 64.

Push rod 66 is located within feed screw 52 and is slidable connected thereto by splines. Clutch elements 68 and 70 are mounted on opposite ends of the push rod, clutch element 68 being designed to cooperate with clutch element 62 adjacent sprocket 56, and clutch element 70 being designed to cooperate with clutch element 64 adjacent sprocket 60. The push rod is slid back and forth within feed screw 52 by hydraulic actuator 72, as will be explained below, so that either clutch elements 62 and 68 are in engagement and sprocket 48, chain 54, and sprocket 56 drive the feed screw at one speed dependent upon the sprocket combination, or clutch elements 64 and 70 are engaged and sprocket 50, chain 58 and sprocket 60 drive the feed screw at a second speed dependent upon the sprocket combination.

Feed screw 52 has double helical groove 74 machined therein with a transition curve at each end. Guide pulley 36 is mounted on trunnion and carriage assembly 76 which in turn is mounted on feed screw 52 and reaction bar 78 as will be explained. The trunnion and carriage assembly and in turn the guide pulley and guide sheave assembly traverse back and forth along feed screw 52 at a rate determined by the particular sprocket and chain drive which is operative in accordance with the position of piston 80 within hydraulic actuator 72. The piston is connected to an extension of push rod 66 by bearing 82 permitting relative rotational movement of the push rod and feed screw with respect to the piston rod. Hydraulic pressure is admitted to chamber 84 below the piston by line 86 or to chamber 88 above the piston by line 90. When pressure fluid is admitted to either chamber, the other chamber is connected by a return line to a reservoir. The admission of pressure to hydraulic actuator 72 is controlled by two-position solenoid valve 92. When hydraulic pressure is admitted to chamber 84, push rod 66 is moved in a direction to engage clutch elements 64 and 70 so that feed screw 52 is driven by sprockets 50 and 60 and chain 58. When hydraulic pressure is admitted to chamber 88, push rod 66 is moved to disengage clutch elements 64 and 70 and engage clutch elements 62 and 68 so that feed screw 52 is driven by sprockets 48 and 56 and chain 54.

Solenoid valve 92 is operated by auto-control unit 94. This unit provides the electrical signals to activate the levelwind feed rate change and a tractive drive (not shown) for guide pulley 36. The tractive drive is a motor which tends to drive the guide pulley faster than the moving cable would turn it during paying out of the cable so as to maintain cable tension between drum 24 and the guide pulley to pay out the cable properly. The auto-control unit includes screw 96 which is driven through gears 98 by gear 100 on drum shaft 102. Nut and striker plate 104 is mounted on screw 96 and travels from one end of the screw to the other, actuating a plurality of microswitches, 106, 108 and 110, during its travel. Micro switches 106 and 110 at opposite ends of screw 96 are on-off switches which shut down the drum drive when the extremes of motion are reached. Micro switch 108 is electrically connected to solenoid valve 92 and is actuated when the nut and striker plate travels along the right end (as shown) portion of screw 96. The relative position of microswitch 108 is determined by the need to start wrapping the larger-smaller diameter junction of the cable at one extreme side of drum 24. The position of each of the microswitches along the screw is adjustable, and additional microswitches can be used for other control purposes.

Feed screw 52 and reaction bar 78 are mounted in and supported, as is the whole guide sheave assembly and levelwind mechanism 28, by levelwind frame 112 and 114. These arms are pivotally connected to frame 20, as can be seen in FIG. 5, at the point of support for intermediate shaft 46. The arms serve to transmit the horizontal component of cable tension into winch frame 20.

Guide pulley 36 and trunnion and carriage assembly 76 on which the guide pulley is mounted are part of guide sheave and levelwind assembly 28 which is shown in FIGS. 4 and 5. As shown in FIG. 4, guide pulley 36 is mounted between side plates 116 and 118, and the side plates are connected to the upper end of reaction strut 120. The lower end of the reaction strut is pivotally connected to swivel fairlead 30 by link 122 (FIG. 5). The trunnion mounting of the guide sheave assembly 28 on trunnion and carriage assembly 76 permits the guide sheave to tilt from side to side about the longitudinal axis of reaction bar 78 when the guide sheave assembly traverses feed screw 52 as can be seen in FIG. 4.

Trunnion and carriage assembly 76 are shown in detail in FIGS. 6, 7 and 8. FIG. 6 is a top, partial sectional view of the guide pulley and carriage assembly. Carriage 124 has bores 126 and 128 therein for feed screw 52 and reaction bar 78, respectively. It also has projections 130 and 132 at opposite ends which constitute the base for the trunnion bearing connection with the guide sheave. The trunnion is comprised of two halves 134 and 136 to permit ready assembly as can be seen in FIG. 7 which is a sectional view along line 7-7 in FIG. 6. The halves are held together by bolts 138 and 140 to form a unitary member which is journaled to carriage projections 130 and 132 by bearings 142 and 144. The outer surface of the trunnion is circular and forms the base for bearing 146 on which guide pulley 36 is mounted and which permits the guide pulley to rotate about the trunnion and carriage assembly. Further, circular flanges 148 and 150 on the trunnion join with side plates 116 and 118, respectively.

Carriage 124 has chamber 152 therein for feed screw follower 154 as can be seen in FIG. 6, and FIG. 8 which is a section view along line 8-8 in FIG. 6. The follower has finger 156 thereon which is adapted to fit into helical groove 74 on feed screw 52 so that the carriage assembly will follow the track of the groove, moving back and forth as the feed screw. The follower is free to rotate in chamber 152, and thus reverse its position at each end of the helical groove, and is loaded by spring washer 158 which is held in place by chamber cover 160.

Hat shaped brackets 162 and 164 are attached to the face of carriage 124. Each bracket serves as a mounting for a shaped roller which rolls on reaction bar 78 along its longitudinal axis. Bracket 162 supports roller 166 on pin 168 and bracket 164 supports roller 170 on pin 172. The rollers are grooved as can be seen in FIG. 8 at 174 on roller 170. They are mounted to transmit cable loading to the reaction bar and to minimize the power needed for traversing of the guide sheave.

In FIG. 5, other details of the guide sheave assembly are depicted. For example, load cell 176 is shown
mounted between the upper end of reaction strut 120 and a base bracket supported by side plates 116 and 118. The load cell is essentially an electrical strain gage which reacts the vertical component of cable tension. In addition, pressure roller 178 imposes loading of the cable on the guide pulley at all times, and guide roller 180 helps to maintain the cable on the guide pulley. Also, two cable cutters, 182 and 184, are installed in the guide sheave below the pulley. The cutters are operated by explosive charges electrically fired and each is capable of severing either the larger diameter or the smaller diameter cable sections. In order to insure that at least one cutter will avoid any connector along the cable, the cutters are spaced apart. To eliminate the possibility of jamming after partial cutting, they are sequentially fired, the lower cutter being fired after the upper cutter. Guide rollers 186, 188, 190 and 192 serve to keep cable alignment as the cable passes through the two cutters, and rollers 194 serve to guide the cable into swivel fairlead 30.

Although the invention has been shown and described with respect to preferred embodiments thereof, it should be understood by those skilled in the art that the foregoing and other changes and omissions in the form and detail thereof may be made therein without departing from the spirit and scope of the invention, which is to be limited and defined only as set forth in the following claims.

We claim:

1. A cable winch for use with a helicopter, the winch including a drum and a guide sheave assembly mounted in a frame and a swivel fairlead; means for traversing said guide sheave assembly on said frame; means permitting tilting of said guide sheave assembly in a vertical plane as it traverses said frame; means for transmitting the horizontal loading on said guide sheave assembly into the guide sheave mounting; and means for absorbing the vertical loading on said guide sheave assembly.

2. A cable winch for use with a helicopter, the winch including a drum and a guide sheave assembly mounted in a frame and a swivel fairlead; means for traversing said guide sheave assembly on said frame; means permitting tilting of said guide sheave assembly in a vertical plane as it traverses said frame; means for changing traversing speed of said guide sheave assembly during cable deploy or retrieval; means for transmitting the horizontal loading on said guide sheave assembly into the guide sheave assembly mounting; and means for absorbing the vertical loading on said guide sheave assembly.

3. A cable winch for use with a helicopter, the winch including a drum and a guide sheave assembly mounted in a frame and a swivel fairlead; means for traversing said guide sheave assembly on said frame; means permitting tilting of said guide sheave assembly in a vertical plane as it traverses said frame; means for changing traversing speed of said guide sheave assembly during cable deploy or retrieval; means separate from said traversing means for absorbing the horizontal loading on said guide sheave assembly; and means for absorbing the vertical loading on said guide sheave assembly.

4. A cable winch for use with a helicopter, the winch including a drum and a guide sheave assembly mounted in a frame and a swivel fairlead, said guide sheave assembly mounting including:

means for traversing said guide sheave assembly; trunnion mounting means permitting tilting of said guide sheave assembly in a vertical plane as it traverses said frame; and means for absorbing the horizontal and vertical cable loading on said guide sheave assembly.

5. A cable winch for use with a helicopter, the winch including a drum and a guide sheave assembly mounted in a frame and a swivel fairlead, said guide sheave assembly mounting including:

means separate from said traversing means for absorbing the horizontal loading on said guide sheave assembly; trunnion mounting means permitting tilting of said guide sheave assembly in a vertical plane as it traverses said frame; and means for absorbing the horizontal and vertical cable loading on said guide sheave assembly.

6. A cable winch for a helicopter installation, said winch including a guide sheave assembly having a guide pulley subject to horizontal and vertical loads imposed by the cable; a trunnion and carriage assembly for mounting of the guide pulley; reaction means in said trunnion and carriage assembly for absorbing the horizontal component of cable load; reaction means connected to said guide sheave assembly for absorbing the vertical component of cable load; a level wind mechanism having a two-speed drive for traversing of the guide pulley; and automatic means for changing traversing speed during cable deploy or retrieval.

7. A cable winch for a helicopter installation, said winch including a guide sheave assembly having a guide pulley subject to horizontal and vertical loads imposed by the cable; a trunnion and carriage assembly for mounting of the guide pulley; reaction means in said trunnion and carriage assembly for absorbing the horizontal component of cable load; reaction means connected to said guide sheave assembly for absorbing the vertical component of cable load; a level wind mechanism having a two-speed drive for traversing of the guide pulley; automatic means for changing traversing speed during cable deploy or retrieval, and means connected to said guide sheave assembly for sensing cable tension.
8. A cable winch for use with a helicopter, the winch including a drum, a reversible drum drive, a guide sheave assembly including a guide pulley and levelwind mechanism, and a swivel fairlead;
said levelwind mechanism including a feed screw and reaction bar;
a trunnion and carriage assembly for mounting said guide sheave assembly on said feed screw and reaction bar,
said feed screw having a helical groove for traversing said guide sheave assembly,
said trunnion and carriage assembly including bearing means permitting rotation of said guide sheave assembly in a vertical plane about said feed screw and reaction bar as said guide sheave assembly traverses said feed screw; driving and associated clutching elements for driving said feed screw at two different speeds;
actuator means for operating said clutching elements for selectively changing feed screw speed during cable deploy and retrieval;
switch means for operating said actuator;
said switch means being operated by rotation of said drum,
rollers in said trunnion and carriage assembly for transmitting the horizontal component of cable tension into said reaction bar;
a reaction strut for supporting vertical loading on said guide sheave assembly; and
means mounted between said guide sheave assembly and said reaction strut for producing a signal of cable tension.

9. A cable winch for use with a helicopter, the winch including a drum, a reversible drum drive, a guide sheave assembly including a guide pulley and levelwind mechanism, and a swivel fairlead;
said levelwind mechanism including a feed screw and reaction bar,
a trunnion and carriage assembly for mounting said guide sheave assembly on said feed screw and reaction bar,
said feed screw having a helical groove for traversing said guide sheave assembly,
said trunnion and carriage assembly including bearing means permitting rotation of said guide sheave assembly in a vertical plane about said feed screw and reaction bar as said guide sheave assembly traverses said feed screw;
rollers in said trunnion and carriage assembly for transmitting the horizontal component of cable tension into said reaction bar; and
a reaction strut for supporting vertical loading on said guide sheave assembly,
said reaction strut being pivotally connected to said swivel fairlead to permit said reaction strut to follow traversing motion of said guide sheave assembly.

10. A cable winch for use with a helicopter, the winch including a drum, a reversible drum drive, a guide sheave assembly including a guide pulley and levelwind mechanism, and a swivel fairlead;
said levelwind mechanism including a feed screw and reaction bar,
a trunnion and carriage assembly for mounting said guide sheave assembly on said feed screw and reaction bar,
said feed screw having a helical groove for traversing said guide sheave assembly,
said trunnion and carriage assembly including bearing means permitting rotation of said guide sheave assembly in a vertical plane about said feed screw and reaction bar as said guide sheave assembly traverses said feed screw; driving and associated clutching elements for driving said feed screw at two different speeds;
rollers in said trunnion and carriage assembly for transmitting the horizontal component of cable tension into said reaction bar;
a reaction strut for supporting vertical loading on said guide sheave assembly,
said reaction strut being pivotally connected to said swivel fairlead to permit said reaction strut to follow traversing motion of said guide sheave assembly; and
means mounted between said guide sheave assembly and said reaction strut for producing a signal of cable tension.

11. A cable winch for use with a helicopter, the winch including a drum, a reversible drum drive, a guide sheave assembly including a guide pulley and levelwind mechanism, and a swivel fairlead;
said levelwind mechanism including a feed screw and reaction bar,
a trunnion and carriage assembly for mounting said guide sheave assembly on said feed screw and reaction bar,
said feed screw having a helical groove for traversing said guide sheave assembly,
said trunnion and carriage assembly including bearing means permitting rotation of said guide sheave assembly in a vertical plane about said feed screw and reaction bar as said guide sheave assembly traverses said feed screw;
rollers in said trunnion and carriage assembly for transmitting the horizontal component of cable tension into said reaction bar;
a reaction strut for supporting vertical loading on said guide sheave assembly,
said reaction strut being pivotally connected to said swivel fairlead to permit said reaction strut to follow traversing motion of said guide sheave assembly; and
means mounted between said guide sheave assembly and said reaction strut for producing a signal of cable tension.

12. A cable winch for use with a helicopter, the winch including a drum, a reversible drum drive, a guide sheave assembly including a guide pulley and levelwind mechanism, and a swivel fairlead;
said levelwind mechanism including a feed screw and reaction bar,
a trunnion and carriage assembly for mounting said guide sheave assembly on said feed screw and reaction bar,
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9 feedscrew and reaction bar as said guide sheave assembly traverses said feedscrew;
chain drive and associated clutching elements for driving said feedscrew at two different speeds;
a hydraulic actuator for operating said clutching elements for selectively changing feedscrew speed during cable deploy and retrieval;
an electrically actuated switch for operating said hydraulic actuator,
said switch being operated by rotation of said drum,
transmitting the horizontal component of cable tension into said reaction bar;
a reaction strut for supporting vertical loading on said guide sheave assembly,
said reaction strut being pivotally connected to said swivel fairlead to permit said reaction strut to follow traversing motion of said guide sheave assembly; and a load cell mounted between said guide sheave assembly and said reaction strut for producing a signal of cable tension.

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