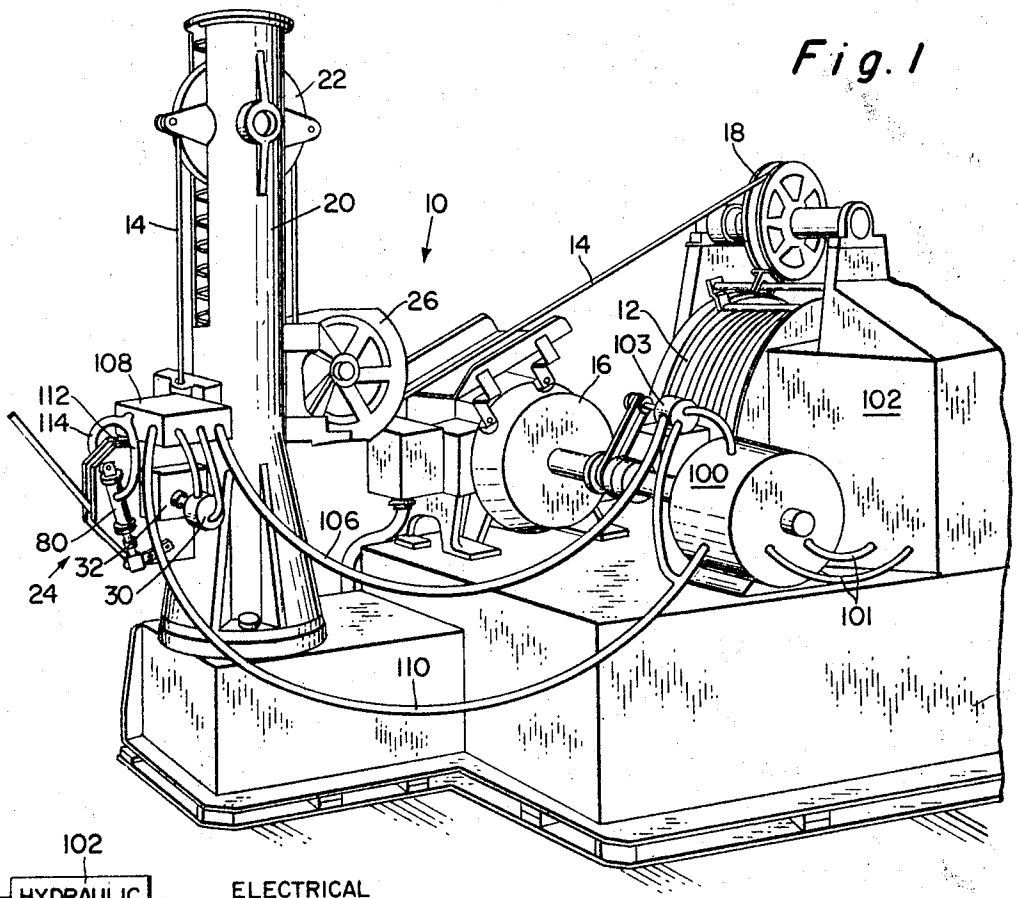
June 10, 1969 M. O. MILLER 3,448,962

CABLE TENSIONING DEVICE FOR WINCHES

Filed July 11, 1967 Sheet 1 of 3

Fig. 1



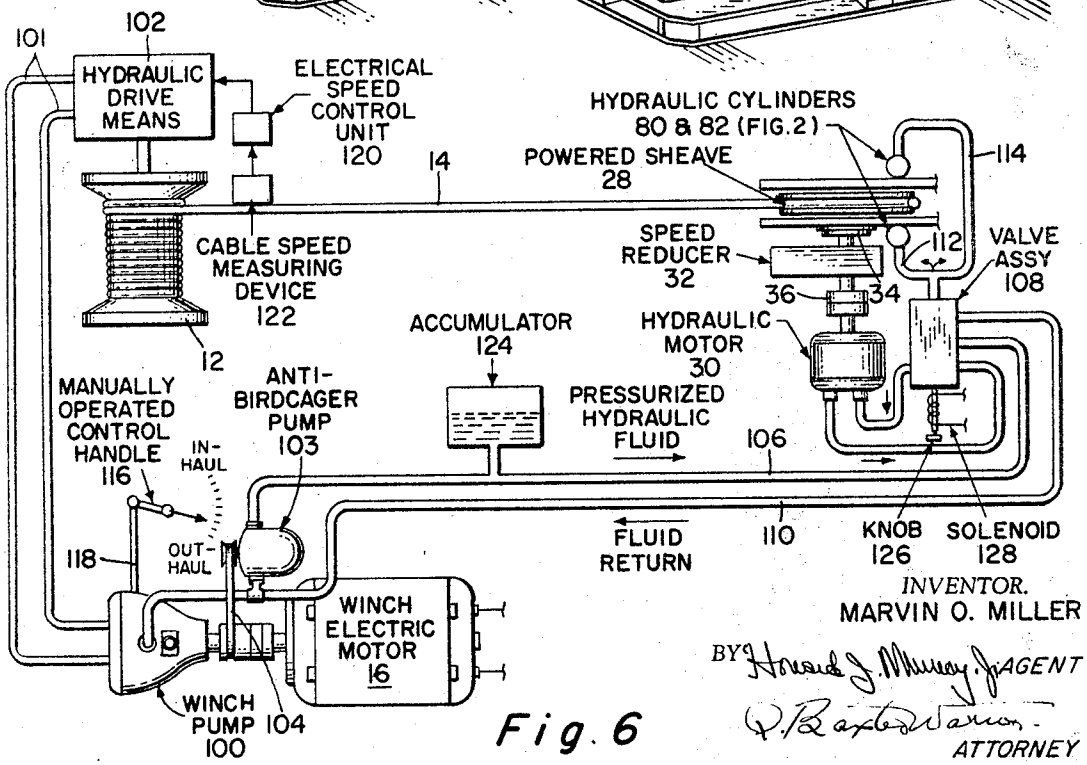


Fig. 6

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W. Raybold Warren
ATTORNEY

CABLE TENSIONING DEVICE FOR WINCHES

Filed July 11, 1967 Sheet 2 of 3

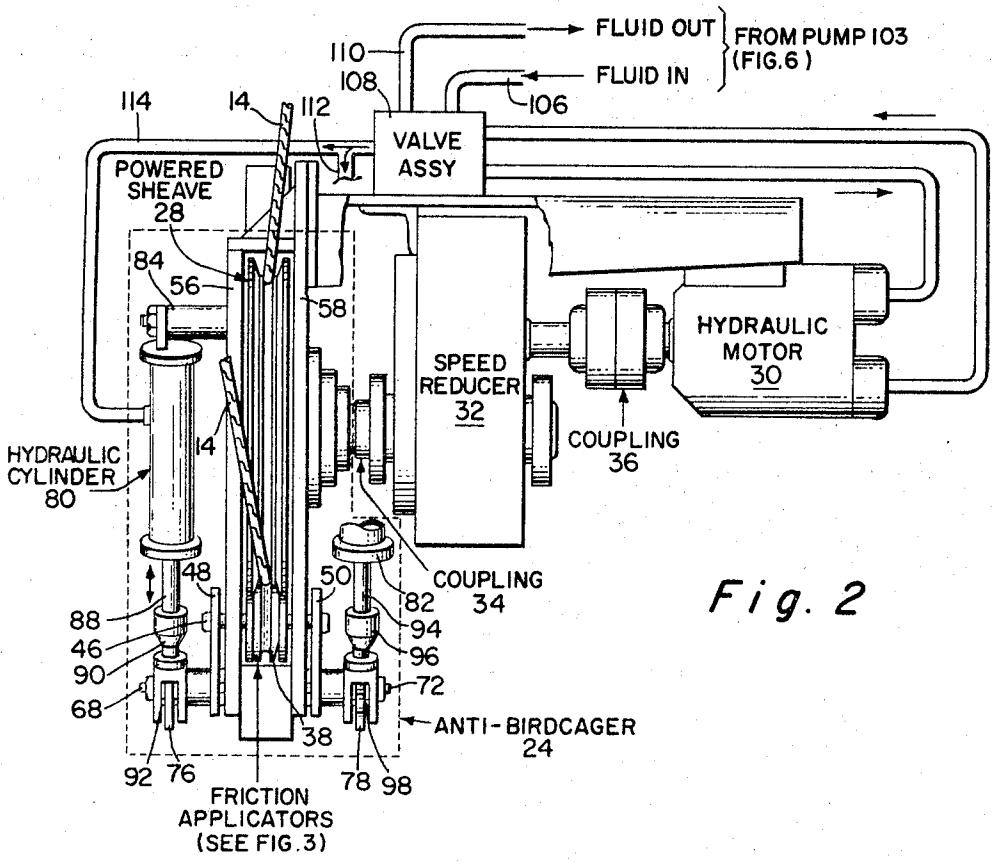


Fig. 2

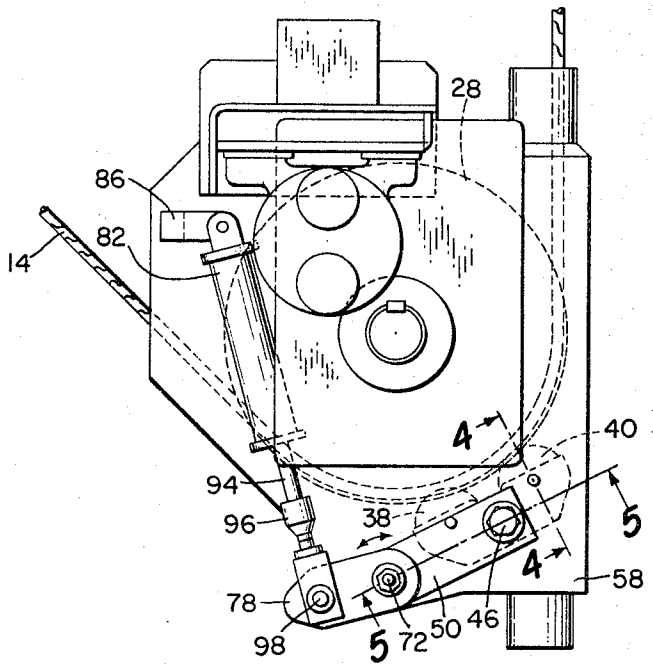


Fig. 3

CABLE TENSIONING DEVICE FOR WINCHES

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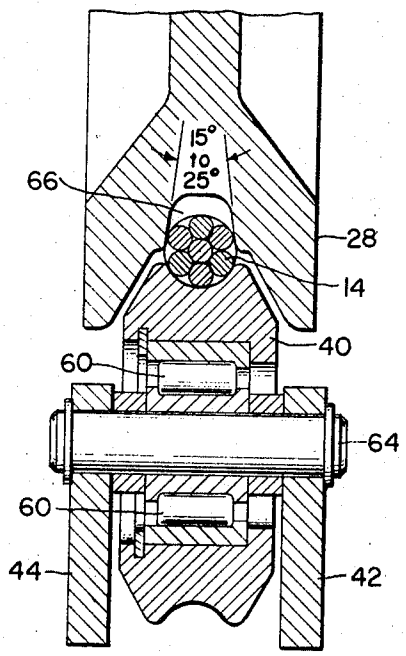


Fig. 4

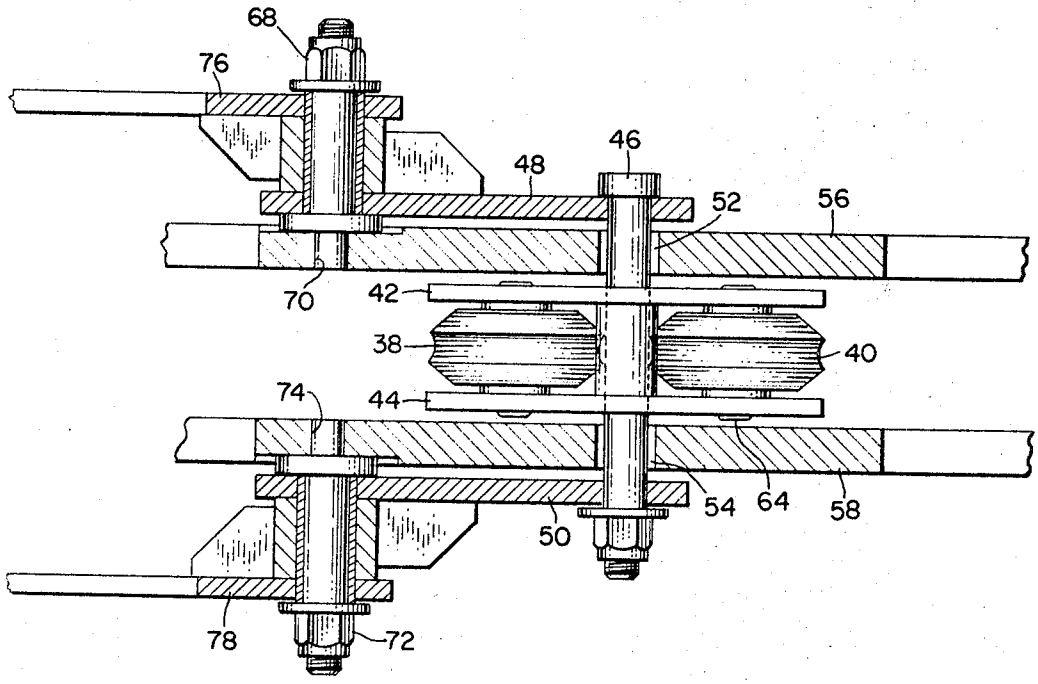


Fig. 5

United States Patent Office 3,448,962
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3,448,962

CABLE TENSIONING DEVICE FOR WINCHES

Marvin O. Miller, Oxnard, Calif., assignor to the United States of America as represented by the Secretary of the Navy

Filed July 11, 1967, Ser. No. 652,633
Int. Cl. B66d 1/76, 1/00; B65h 59/00
U.S. Cl. 254—175.7 11 Claims

ABSTRACT OF THE DISCLOSURE

A device for continually applying a selected degree of tension to a wire rope or cable during paying out or taking in of the latter by a winch in order to prevent the turns of the wire rope from becoming "birdcaged" (that is, twisted or jammed) on the winch drum. The tensioning is accomplished by means of a unit termed an "anti-birdcager" (ABC) which includes a sheave over which the cable passes. Pressure-loaded and spring-retracted rollers are mounted adjacent the sheave to force the cable against it so that no slippage can occur therebetween. By applying power to the sheave so that it tends to pay out wire at a speed faster than that at which the wire is actually paying out, tension is maintained on the latter in the region between the sheave and the winch drum. This precludes any overriding turns from occuring and creating a fouled winch drum which can prevent additional wire rope from paying out and must be corrected before winch operation can resume.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The present invention relates to a device for maintaining tension on a wire rope or cable as it pays on and off a winch drum.

An operational malfunction to which all cargo winches are susceptible is commonly known by the term "birdcaging." This describes a condition when slack wire rope has fouled on the winch drum with overriding turns, locking the wire rope and preventing further pay out thereof. It is usually caused by the absence of an overhauling load on the wire rope during some phase of winch operation.

Birdcaging is a hazard to equipment during all winch operations, and is a serious hazard to personnel during replenishment activities at sea when the wire rope is connected between two vessels. A "birdcage" on the winch drum will preclude further pay out of wire rope, and any increase in separation distance between the two ships may result in the placing of such a high amount of tension on the rope that it will part and endanger the entire replenishment operation.

The above will be better understood when it is recognized that the winch operator ordinarily cannot see the drum of the winch under his control, as his attention is primarily required elsewhere. Under these conditions, the operator may turn the winch in the pay out direction, or the winch may "creep," causing loose turns to form on the drum. Heaving in on the winch while there are loose turns on the drum will cause a loose turn over the leading part of the wire to form what is known as an "overriding" turn. Such a turn will lock the leading part in such a way that it will be impossible to pay out the wire (which is required during replenishment at sea operations by an increase in ship separation distance) and a "tight-line" situation is brought into being. The winch operator will be unable to rectify the situation,

since releasing the automatic brake on the winch will have no effect, and turning the drum in either direction will cause the winch to haul in on the wire rope. In other words, the wire rope is entirely at the mercy of the relative motion between the two vessels.

When spooling a wire rope onto a winch drum, the turns will lay tight and smooth if tension is maintained on the wire and an adequate fleet angle or spooling device is provided. Under these conditions, each layer of turns will form a solid base for the succeeding turns. The solid base prevents the outer turns from "burying" into the turns below during high loads on the wire rope. This "burying" action frequently damages the wire rope, and can result in a tight line in the same manner as an overriding turn.

It is recognized that to prevent "birdcaging" a proper degree of tension must be applied to the wire rope at the winch drum as it pays in and out. The "anti-birdcaging" device of the present concept is designed to preclude fouling of the turns of the wire rope or cable on the winch drum by maintaining such a tension on the rope under all conditions of winch operation.

The essential features of the device herein disclosed include a sheave located directly in front of the winch drum and powered so that the sheave attempts constantly to pay out the wire rope at speeds faster than the winch can achieve. Also included in that embodiment of the present concept herein disclosed is a pair of small rollers that press the wire rope against the powered sheave with sufficient force to prevent slippage between the rope and sheave under all conditions of winch operation. The "anti-birdcager" or tensioning device of the present invention is activated when the operator engages the winch. This causes the powered sheave of the anti-birdcager to attempt to pay out wire rope. However, until the winch is actuated by the operator, the winch drum brake remains engaged and the anti-birdcager cannot pay out wire rope. Consequently, the anti-birdcager remains in stalled condition, holding tension in the wire rope between the powered sheave and the winch drum. A significant feature of the ABC is that the wire rope cannot slip when the ABC is stalled. Such slippage would cause a rapid and dangerous wearing effect on the wire rope. When the operator now actuates the winch in the pay out position, the anti-birdcager is still attempting to pull wire rope outward up to its maximum speed. However, because the winch cannot pay out wire rope at the speed of the anti-birdcager, the latter is forced to throttle down while continuing to maintain tension between the powered sheave and the winch drum. On the other hand, when the winch operator actuates the winch in the haul-in position, the anti-birdcager is still attempting to pull the wire rope outward although it is now going in reverse. The winch hauls in the wire rope despite the anti-birdcager's effort to pay out the wire rope. Tension is thus always maintained on the wire rope, resulting in tight, even spooling on the winch drum.

SUMMARY OF THE INVENTION

A device for use in conjunction with powered winches and designed to maintain a constant tension on the wire rope in order to prevent the latter from becoming loose on the winch drum. An essential feature of the concept is the employment of a powered sheave located adjacent the winch drum, together with a pair of rollers located directly under the powered sheave. Means are included for applying pressure to these rollers so that the latter forces the wire rope hard against the powered sheave in such fashion that no slippage occurs therebetween, thus minimizing wear on the wire rope. A drive mechanism is connected to the shaft of the sheave to rotate the latter at a speed higher than that of the winch drum

so that the sheave attempts to pull wire rope off the drum at a higher velocity than the winch is capable of achieving, thereby providing a tensioning effect on the wire between the ABC and the drum. Also, when wire rope is taken in on the drum, the powered sheave is caused to rotate in reverse direction against its power source, again without slippage of the wire rope. Tension on the rope is thus maintained regardless of whether the winch is in a take-in or pay-out situation. The tensioning device is automatically activated when the winch operator turns on power to the winch, and deactivated when power to the winch is turned off. Other optional control features can be provided for special operations so that the ABC may be turned off when a steady overhauling load will be applied to the wire such as with some automatic tensioning winches.

One object of the present invention, therefore, is to provide a device for use in conjunction with the cable of a powered winch in order to maintain a constant tension on the cable as it is wound on, or taken off, the winch drum.

Another object of the present invention is to provide an "anti-birdcaging" unit which is activated as a function of the operation of the winch and which constantly attempts to pay out wire rope at a higher speed than the winch drum can achieve.

An additional object of the present invention is to provide a powered sheave over which the wire rope from a winch passes, the wire rope being forced into tight engagement with the powered sheave by means of a pair of friction applicators in the form of grooved rollers urged against the rope through the action of a pair of hydraulic cylinders pressurized as a function of the energization of the winch operating mechanism.

Other objects, advantages, and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a typical winch installation and illustrates the manner in which the "anti-birdcaging" device of the present concept may be utilized therewith;

FIG. 2 is a front view of the anti-birdcaging device of FIG. 1, showing certain constructional details thereof;

FIG. 3 is a side view of the anti-birdcaging device of FIG. 2;

FIGS. 4 and 5 are sectional views of FIG. 3 along the lines 4—4 and 5—5, respectively; and

FIG. 6 is a somewhat schematic illustration of a preferred arrangement for developing and supplying pressurized hydraulic fluid to the anti-birdcaging device of FIGURES 1 through 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Although the cable-tensioning unit of the present concept is suitable for utilization with many different types of powered winches, it is particularly adaptable in situations where the wire rope is subject to wide variations in magnitude of speed and load within relatively short periods of time. Such conditions exist, for example, on board ocean-going cargo vessels where a winch is used to maintain tension on a so-called "high-line" which couples two ships together during a replenishment-at-sea operation. Also employed in the process are out-haul and in-haul lines which are secured to a trolley designed to move back and forth from one ship to the other. Obviously, the two ships are subject to random motions which can become particularly severe when weather conditions are adverse. Consequently, the cable which winds onto and from the winch drum is subject to wide variations in tension, and it is these variations which often cause the loose turns and "birdcaging" effect discussed above. Although the ABC of the present concept has particular application to winch operations at sea between two ships where extreme safety hazards exist due to dynamic conditions, the invention is applicable for any winch operation in which the wire rope can become slack due to "no-load" or a light load condition.

Referring now to FIGURE 1 of the drawings, there is shown a perspective view of an anti-birdcager installation as incorporated into a conventional winch assembly. The latter, generally identified by the reference numeral **10**, includes a drum **12** over which is wound a wire rope or cable **14**. The drum **12** is driven by a motor **16** which may be of any suitable type but which is preferably electrically energized. A standard Lebus spooling device **18** is utilized in order that the turns of the wire rope **14** wound on the drum **12** be laid down side-by-side when the winch **10** is operated in an in-haul mode. Also associated with the winch **10** is the usual fairlead sheave **20** which includes a sheave **22** over which the wire rope or cable **14** passes.

The present invention contemplates the provision of means for maintaining a substantially constant tension on the rope **14** at the point where it is wound on, or unwound from, the drum **12**. This means comprises the "anti-birdcaging" unit generally identified in FIG. 1 of the drawings by the reference numeral **24**. Although this unit **24** will be described in detail in connection with FIGURES 2 through 5 of the drawings, it might be mentioned at the present point that the unit includes a powered sheave over which the rope **14** passes, this sheave replacing a free-running sheave which was previously mounted on the lower portion of the fairlead sheave **20**.

As best shown in FIG. 1, the wire rope **14** is reeved from the winch drum **12** over the Lebus spooling device **18** and under the freely-rotating sheave **26** supported by the unit **20**. The wire rope **14** is then reeved over the movable sheave **22** at the top of the fairleader **20**, and from that point to the anti-birdcaging device **24**, passing under the powered sheave which forms a part thereof. From this anti-birdcaging unit **24**, the wire rope **14** then passes to a load either directly or through a conventional rigging assembly. It should be mentioned at this point that all of the apparatus shown in FIG. 1 of the drawings (with the exception of the anti-birdcaging unit **24**) is entirely conventional in nature, and hence a detailed description thereof is believed to be unnecessary.

Referring now to FIG. 2 of the drawings, there is shown an assembly designed to perform the functions of the unit **24** of FIG. 1. A powered sheave **28** is driven by a hydraulic motor **30** through a speed reducer **32** and a pair of coupling members **34** and **36**. The wire rope **14** passes under this powered sheave **28** (see also FIG. 3) which preferably is in the form of a pulley having a deep groove therein as best shown in FIGURE 4 of the drawings. Also forming part of the anti-birdcager **24** is a pair of friction applicators **38** and **40** (see FIGS. 3, 4 and 5), these friction applicators **38** and **40** being in the form of a pair of free-running pulleys pivotally mounted upon a pair of arms **42** and **44** (FIG. 5) which are in turn pivotally mounted upon a pin **46**. The latter is in turn mounted on a pair of spaced-apart support arms **48** and **50**. As best shown in FIG. 5, the pin **46** passes through a pair of enlarged openings **52** and **54** respectively formed in a pair of spaced apart plates **56** and **58** which make up the housing for the anti-birdcager **24** of FIGS. 1, 2 and 3. As illustrated in FIGURE 4 of the drawings, the roller **40** is mounted through bearing **60** upon a pin **64** which is carried by the spaced-apart supports **42** and **44**. The roller **38** is similarly mounted. As best shown in FIGURE 4 of the drawings, the cable **14** rides in a groove **66** formed in the powered sheave **28**, and the cable **14** is wedged into this groove **66** by the action of the two rollers **38** and **40** (see FIGS. 3 and 5), the rollers being urged radially inwardly with respect to the powered sheave **28** by a pivotal action of the assembly mounted on and carried by the spaced-apart arms **48** and **50** of FIG. 5.

In order to insure that no slippage will occur between the cable **14** and the sheave **28** under all conditions of operation, the groove **66** formed in the sheave **28** should be generally U-shaped in cross-section, with the sides of this groove defining an angle preferably of between 15 and 25 degrees (see FIG. 4). It has been found that an angle of this magnitude yields a maximum "wedging" effect when the cable is forced into the groove by the action of the rollers **38** and **40**, while at the same time minimizing distortion of the cable and reducing internal wear on the individual cable strands.

To permit a movement of the assembly carried by the arms **48** and **50** of FIG. 5, the arm **48** is mounted on a pin **68** which is receivable in opening **70** in the support member **56**, as best shown in FIG. 5. The arm **50** is similarly mounted upon a pin **72** which is coaxial with pin **68** and is receivable in an opening **74** in the support member **58**. Also carried by the pin **68** is a further arm **76**, while in similar fashion a further arm **78** is carried by the pin **72**. The arms **48** and **76** are designed to rotate about the axis of pin **68** in integral fashion, while the arms **50** and **78** also move as a unit about the axis of pin **72**.

In accordance with a feature of the present disclosure, there is provided means for producing a rotation of the assembly carried by the arms **48** and **50** about the common axis of the pins **68** and **72**. Inasmuch as the arms **76** and **78** are designed to move concurrently, a rotation of these arms in a counter-clockwise direction (FIG. 3) about the common axis of pins **68** and **72** will produce a similar counter-clockwise movement of the arms **48** and **50**, directing the two rollers **38** and **40** carried by the pin **46** in a direction radially inwardly of the powered sheave **28**. Inasmuch as the cable **14** passes between these rollers **38** and **40** and the powered sheave **28** (see FIGS. 3 and 4), this inward movement of the roller assembly **38–40** will force the cable **14** into the groove **66** formed in the powered sheave **28** in a manner best brought out by FIG. 4 of the drawings. The design of the groove **66** in the sheave **28**, and the pressure applied to the cable **14** by means of the rollers **38** and **40**, is such that no slippage can occur between the cable **14** and the sheave **28** regardless of the conditions under which the winch assembly of FIG. 1 is operated.

In order to provide for a concurrent rotation of the arms **76** and **78** of FIG. 5 in a manner best brought out by FIG. 3 of the drawings, there is provided a pair of hydraulic cylinders **80** and **82** respectively mounted on opposite sides of the powered sheave **28** in a manner best brought out in FIGURES 2 and 3 of the drawings. In FIG. 2 of the drawings, however, the cylinder **82** has been partially broken away in order not to obscure the details of the coupling **34**. The cylinders **80** and **82** are intended to be selectively pressurized concurrently to produce a rotational movement of the arms **76** and **78**. As shown in FIG. 2, the cylinder **80** is pivotally mounted on an adapter **84** securely attached to the sheave housing plate **56**. The cylinder **82**, as shown in FIG. 3, is similarly mounted in pivotal fashion upon an adapter **86** securely attached to the housing plate **58**. The movable piston **88** of the cylinder **80** is connected through an adapter **90** to a pin **92** rotatably mounted in the arm **76**, while the movable piston **94** of the hydraulic cylinder **82** is connected through an adapter **96** to a pin **98** carried by the arm **78**. It will now be appreciated that concurrent pressurization of the hydraulic cylinders **80** and **82** to force the piston members **88** and **94**, respectively, to an extended position will cause the assembly including the rollers **38** and **40** to be rotated in a counter-clockwise direction (FIG. 3) about the common axis of pins **68** and **72** and hence force these rollers **38** and **40** against the cable **14** so as to urge the latter inwardly into the groove **66** formed in the powered sheave **28**, as brought out in FIG. 4.

In FIGURE 6 of the drawings is shown a preferred arrangement for supplying power to drive the sheave **28** of the anti-birdcaging unit **24** and also to pressurize the hydraulic cylinders **80** and **82**. The assembly of FIG. 6 includes a winch pump **100** coupled directly to the winch motor **16** of FIG. 1. This pump **100** operates in conventional fashion to supply pressurized fluid through the line **101** to the hydraulic motor **102** which drives the winch drum **12** of FIG. 1. The winch motor **16**, in addition to driving the winch pump **100**, also drives an anti-birdcager pump **103** through an auxiliary drive means **104**. As shown in FIG. 6, the pump **103** supplies pressurized hydraulic fluid through a conduit **106** to a valve assembly **108**. The fluid return line **110** completes the cycle.

Pressurized fluid arriving at the valve assembly **108** in FIGURE 6 is directed therefrom both to the hydraulic motor **30** and to the two hydraulic cylinders **80** and **82** shown in FIGURE 2 of the drawings. Inasmuch as the hydraulic motor **30** is designed to operate at relatively high speed, a gear reduction unit **32** is employed intermediate the motor **30** and the powered sheave **28** so that the speed of rotation of the latter is set to be in excess of that at which the winch drum **12** rotates, taking into account the difference in diameters of these two members. Expressed differently, the sheave **28** rotates at such a speed that it attempts to constantly pay out the wire rope or cable **14** at a speed faster than the winch **10** can achieve. When the winch motor **16** of FIG. 6 is energized, the anti-birdcage pump **103** is driven concurrently with the winch pump **100**, and thus the powered sheave **28** is energized at all times when the winch drum **12** rotates. As above stated, the speed of rotation of the sheave **28** is such that, when the winch is in the pay out position, the sheave **28** is attempting to pull the wire rope **14** outboard at its maximum speed. However, because the winch **10** cannot pay out wire rope at the speed of the anti-birdcaging unit, the latter is forced to throttle down while continuing to maintain cable tension between the powered sheave **28** and the drum **12**. A convention internal by-pass valve associated with motor **30** permits such fluid "slippage." When the winch is in the in-haul position, the anti-birdcager **24** is still attempting to pull the wire rope or cable **14** outboard. The winch **10** hauls in the cable, however, despite the efforts of the anti-birdcager **24** to pay out the wire rope. Tension is thus maintained on the cable **14**, resulting in tight, even spooling on the winch drum **12**. Furthermore, when the ABC is in "stalled" condition, the cable is prevented from slipping due to the pressure applied thereto by the friction applicators. If such slippage were permitted to occur, it would have a rapid and dangerous wearing effect on the cable.

When the anti-birdcager motor **30** is forced to throttle down below its normal speed during winch pay out, or to operate in a direction opposite to its normal direction of rotation during winch in-haul periods, a rise in temperature of the pressurized hydraulic fluid may be experienced. This effect may be minimized by using an accumulator with an unloading valve to unload the pump when hydraulic oil is not needed, or using a pressure-compensated or variable-volume ABC pump to reduce or match pump output to the needs of the ABC motor. Alternatively, the fluid can be passed through a conventional heat exchanger or cooling unit (not shown) interposed in the fluid line between the anti-birdcager **23** and the pump **103**. Such an expedient is well known in the art to which the invention relates.

Whenever the pump **103** of FIG. 6 is operating, pressurized fluid is also delivered by the valve assembly **108** to the two hydraulic cylinders **80** and **82** of FIG. 2 through the two conduits **112** and **114** of FIG. 6. As above brought out, this causes an extension of the cylinder piston rods **88** and **94** to force the two friction applicators or rollers **38** and **40** radially inwardly as shown in FIG. 3 and prevent any slippage of the wire rope **14** as it passes over the powered sheave **28**.

As illustrated in FIG. 6, the winch drum **12** and its associated anti-birdcager sheave **28** may be powered by the common motor **16** which drives the large hydraulic

winch pump **100** and, through lines **101**, actuates the winch drum **12** through hydraulic drive means **102**. The winch pump **100** may be of any suitable positive displacement type such as one having multi-cylinders with a separate piston in each, such pistons being capable of variable stroke which is changed by means of a wobble plate or tilt plate that is adjustable from a "no-stroke" to a "maximum-stroke" position. As shown, the operator may adjust a control handle **116** operating through linkage **118** to vary this tilt plate to establish a desired winch drum speed in either direction. By means of an electronic speed control unit **120** the cable speed sensed by unit **122** is employed to regulate the operation of hydraulic drive means **102**. However, manual actuation of handle **116** will shift the wobble plate and vary the displacement of pump **100** to thereby alter its speed of operation. As is common with such motors, reverse operation may be obtained by movement of the wobble plate beyond the center position.

The separate automatic birdcage control pump **103** may be provided with the output line **106** which interconnects with a suitable accumulator **124** which may maintain pressure in such outgoing line by the compression in the upper portion of the accumulator of a sufficient quantity of nitrogen gas. The high pressure line **106** extends to the control valve unit **108** which may be of the spool type if desired (as is conventional in hydraulic systems) and the spool may be shifted from ABC "on" position to an off or "by-pass" position. This may be done either through the movement of knob **126** or by means of an electric impulse acting through a solenoid **128**.

With the spool valve unit **108** in the "on" position, high pressure hydraulic fluid may be ported through line **106** to motor **30**, returning through the low pressure line **110** to the automatic birdcage pump **103**. The friction-applying rollers operated by cylinders **80** and **82** may be interconnected to the line **106** as shown, and, through suitable ports in the shiftable spool valve, may be subjected to high pressure when motor **103** is operating and may be ported to the low pressure line **110** when the ABC motor is not operating. It will be apparent that whenever the motor **103** is not operating, the friction-applying rollers are removed from cable engagement and the ABC sheave free-wheels. During this mode only, the ABC winch and associated fairleader **20** of FIG. 1 control the cable movement.

The ABC unit **24** may be journaled as previously described, and, by virtue of its compactness and ready portability, it may be utilized at any desired location in order to apply a predetermined tension to a cable.

It has been found in practice that the sheave **28** of the anti-birdcaging unit should preferably be provided with hardened working surfaces in the area of the groove **66** (FIG. 4) so as to minimize wear on the wire rope **14**. The corresponding working surfaces of the two rollers **38** and **40** should also be hardened in the same fashion.

Although the motor **30** and the cylinders **80** and **82** have been shown and described as being operated by hydraulic fluid under pressure, it is contemplated that various other methods of pressurizing these members may be employed if desired. For example, air pressure as a power source is feasible in many circumstances, inasmuch as it lends itself readily to remote control by solenoid valves and furthermore requires minimum day-to-day maintenance. Air pressure provides simple actuation of the friction applicators **38** and **40**, which must be quick-acting and capable of considerable force variations. It is also possible to utilize steam power by employing either reciprocating engines or turbines. The former have low r.p.m. and starting torque, and also will accelerate rapidly and will accept reverse rotation against supply pressure. Turbines require little space, and minimum maintenance. Electric power is not usually as attractive, since electric motors require a clutch or torque converter in the power train. As an alternative, a silicon-controlled rectifier can be included in the control circuitry to provide variable voltage to the motor and improve its stall characteristics.

It will now be recognized that the concept herein disclosed may be broadly expressed as the combination of any suitable means for applying pressure to the friction applicators (such as **38–40** of FIGS. 3, 4 and 5) so as to completely prevent slippage between the cable and the ABC sheave and thus reduce internal wear on the individual strands of the wire ropes, plus any suitable power distribution system for applying a rotational force to the ABC sheave, this power distribution system constantly attempting to overspeed the ABC sheave and incorporating means for permitting slippage between the power source and the ABC sheave when the latter is stalled and also during backdown or cable in-haul operation. In other words, it is important for successful performance of the invention apparatus that a slight differential torque be maintained at all times between the ABC drive means and the winch drive means so that a certain degree of tension is constantly present on the cable in the region between the ABC sheave and the winch drum. Since the cable never slips between the ABC sheave and the friction applicators **38–40**, and since the ABC sheave is powered in a single direction of rotation, slippage must be provided for in the power distribution network between the ABC power source and the ABC sheave. For the hydraulic power distribution network illustrated and described in the specification, such "slippage" is achieved by proper design of the hydraulic valve and by-pass assemblies. In a system employing compressed air to power the ABC sheave, there is usually a sufficient amount of inherent or "built-in" slippage in the air motor for normal operation. However, other arrangements, such as those utilizing an electric motor as a power source or those employing a direct mechanical connection to the sheave (such as a chain drive, for example) require the addition of an extra unit intermediate the sheave and the energy source to develop the necessary power differential. One conventional mechanism for carrying out this function may take the form of a slip clutch. It is accordingly emphasized that the present disclosure is to be interpreted as being generic insofar as these alternative power distribution networks is concerned, limited only to their ability to provide the essential degree of slippage between the ABC sheave and its power source so that the required differential torque between the sheave and winch drum be maintained under all conditions of winch operation when the ABC is engaged.

Air and hydraulic powered ABC designed in accordance with the present concept have been installed on board ocean-going vessels of the U.S. Navy where they handle ½" diameter, ¾" diameter and 1" diameter wire rope. The anti-birdcaging unit, constructed in the manner hereinabove described, operates during the out-haul mode to maintain a tension on the cable which varies from 400 pounds at low speed to approximately 100 pounds at full speed. The cable tension maintained while the winch is in an in-haul mode is in the neighborhood of 600 pounds, which tension has been found to be fully adequate to achieve a proper spooling of the cable on the winch drum without the development of an overriding turns or other fouled condition.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

I claim:

1. Apparatus for continually applying tension to a cable during both payout out and taking in of the latter by a winch in order to preclude the turns of the cable on the drum of the winch from becoming fouled due to cable slack caused by random load variations, said apparatus comprising:

a powered sheave over which said cable passes, said sheave being located between the drum of the winch and the load to which said cable is attached;

means for applying power to said sheave to cause the latter to tend to pay out cable at a speed faster than that at which the cable is being payed out by said winch when the latter is operated in an "out-haul" condition;

further means for controlling the operation of said first-mentioned means so that the sheave also tends to pay out cable when said winch is operated in an "in-haul" condition; and

actuatable means for maintaining frictional engagement between said sheave and said cable so as to preclude slippage therebetween during the time that power is being applied to said sheave by said first-mentioned means.

2. Apparatus according to claim **1** in which said sheave is formed with a peripheral groove into which said cable is receivable, and in which said actuatable means is effective to force said cable into said groove.

3. Apparatus according to claim **2** in which the groove in said sheave is V-shaped in cross-section, said actuatable means being effective to wedge said cable into said groove.

4. Apparatus according to claim **3** in which the sides of said V-shaped groove define an angle of between 15 and 25 degrees.

5. Apparatus according to claim **4**, in which said means for applying power to said sheave includes a motor energized as a function of the operation of said winch in either an in-haul or an out-haul mode.

6. The combination of claim **5** in which said motor is of the hydraulic type, and in which said means for applying power to said sheave includes a source of pressurized fluid and means for supplying pressurized fluid from said source to said hydraulic motor.

7. The combination of claim **6** in which said actuatable means includes at least one roller arranged to contact said cable in the region where the latter passes over said sheave, and means for urging said roller toward said sheave to force said cable into said groove and thus preclude slippage between said sheave and said cable.

8. The combination of claim **7**, in which said means for urging said roller toward said sheave includes a hydraulic cylinder actuatable by the reception thereby of pressurized fluid from said source concurrently with the reception of such fluid by the hydraulic motor powering said sheave.

9. The combination of claim **6** in which said actuatable means includes a pair of rollers arranged to contact said cable in the region where the latter passes over said sheave, and means, including a pair of hydraulic cylinders respectively positioned on opposite sides of said sheave, for urging said pair of rollers toward said sheave to force said cable into said groove, said hydraulic cylinders being simultaneously actuatable by the concurrent reception thereby of pressurized fluid from said source as a function of the reception of such fluid by the hydraulic motor powering said sheave.

10. Apparatus for continually imparting tension to a cable connected to a load as the cable is being wound on to, or off of, a winch drum, said apparatus comprising:

a sheave engaging the cable between the drum and the load;

means for preventing slippage between the sheave and the cable;

means for powering the sheave so that the latter is urged to rotate in a pay-out direction during cable movement in either direction; and

means for controlling the application of power to the sheave.

11. Apparatus for continually applying tension to a cable during both payout out and taking in of the latter by a winch in order to preclude the turns of the cable on the drum of the winch from becoming fouled due to cable slack caused by random load variations, said apparatus comprising:

a rotatable member located between said drum and the load and over which said cable passes in frictional non-slipping engagement; and

means for energizing said rotatable member so that the latter continually tends to pay out cable during both in-haul and out-haul modes of winch operation, at a speed higher than that at which cable is payed out from said drum when said winch is operated in an out-haul mode.

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