United States Patent

Leonard

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[54] WINCH APPARATUS FOR FAIRED TOWLINE

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[52] **U.S. Cl.** .....**242/158 R,** 114/235 B, 114/235 F, 242/117, 242/157.1, 254/190 R

[51] **Int. Cl.** **B65h 54/28,** B63b 21/56

[58] **Field of Search** .....242/158 R, 158.4 R, 158.2, 242/157.1, 117; 254/190 R; 114/235 R, 235 B, 235 F

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[57] **ABSTRACT**

To protect a faired towline against adverse loading, a winch apparatus is provided with a helically grooved drum which is mounted on an assembly that can rotate automatically about a vertical axis upon command from a towline fleet angle sensor means. The helical drum groove has a cross-sectional configuration which allows for lateral bending of the towline, tangentially away from the groove within a predetermined arc, which feature, in combination with the fleet angle sensor control, will minimize lateral loads to the towline during towing and winching procedures.

10 Claims, 5 Drawing Figures

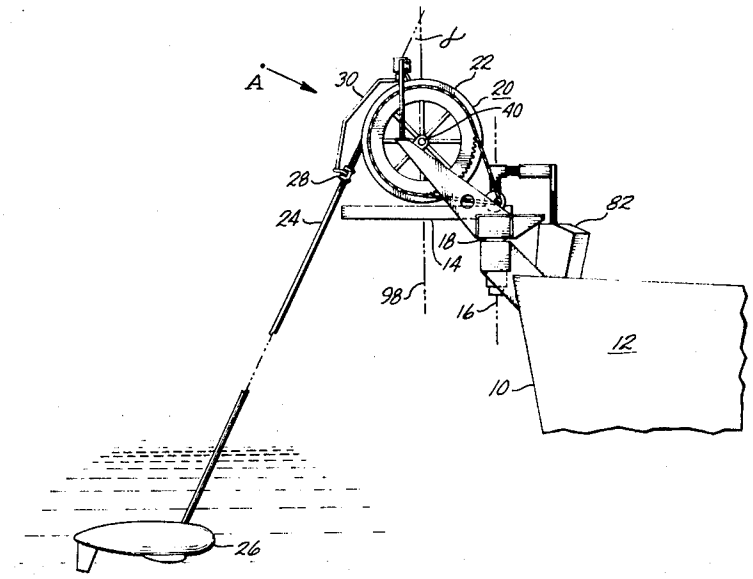
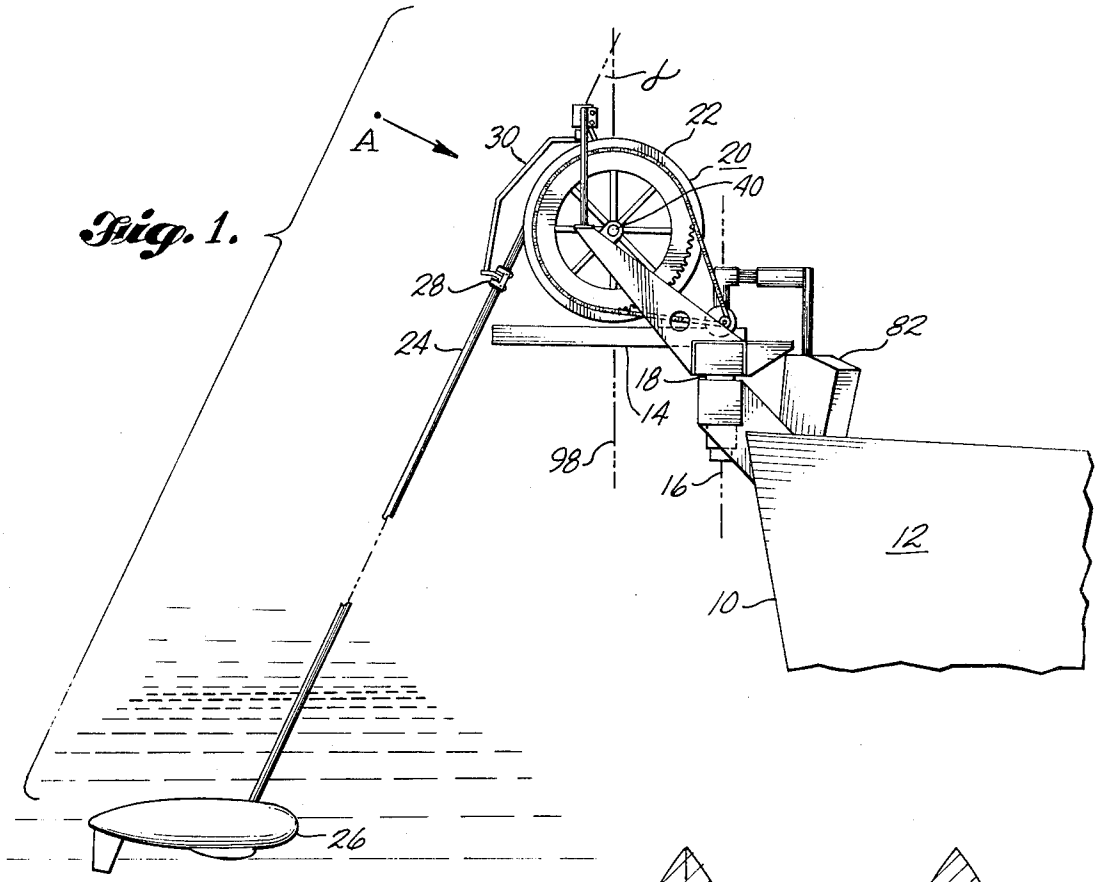


Fig. 1.



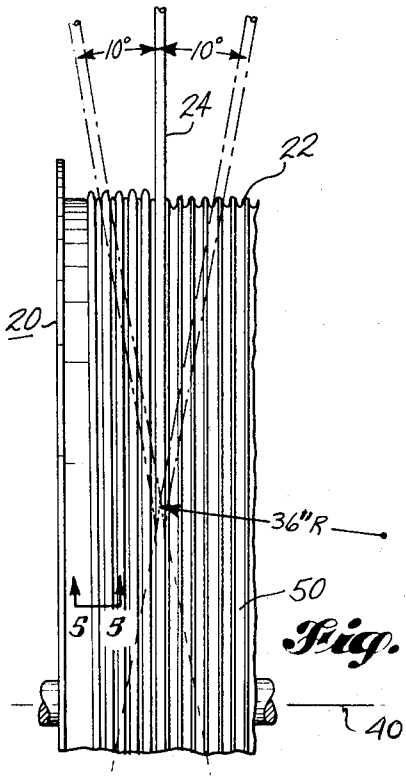


Fig. 4.

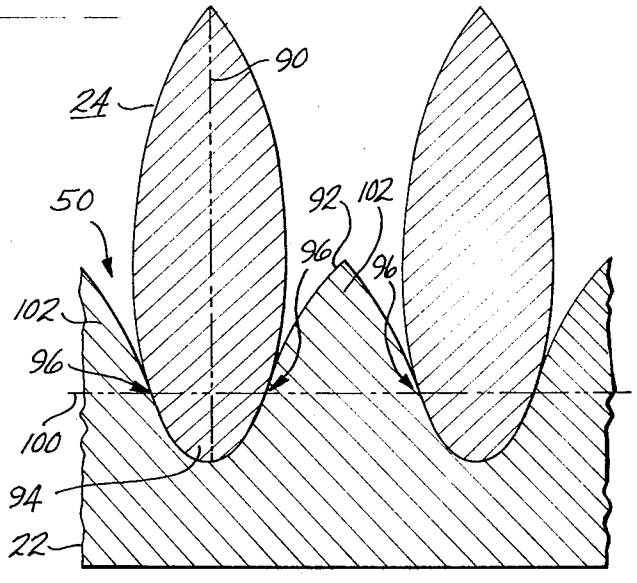


Fig. 5.

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Fig. 2.

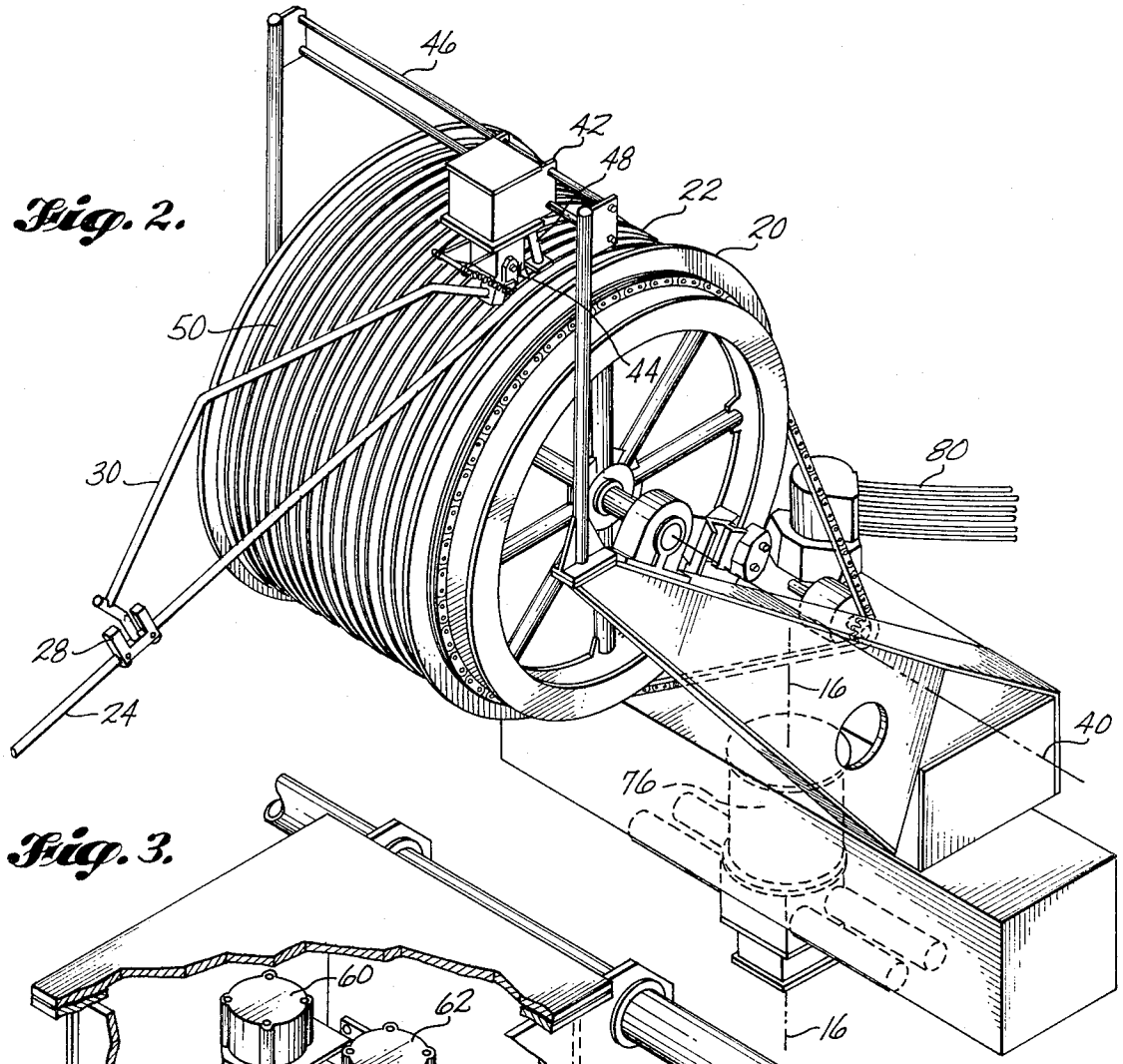
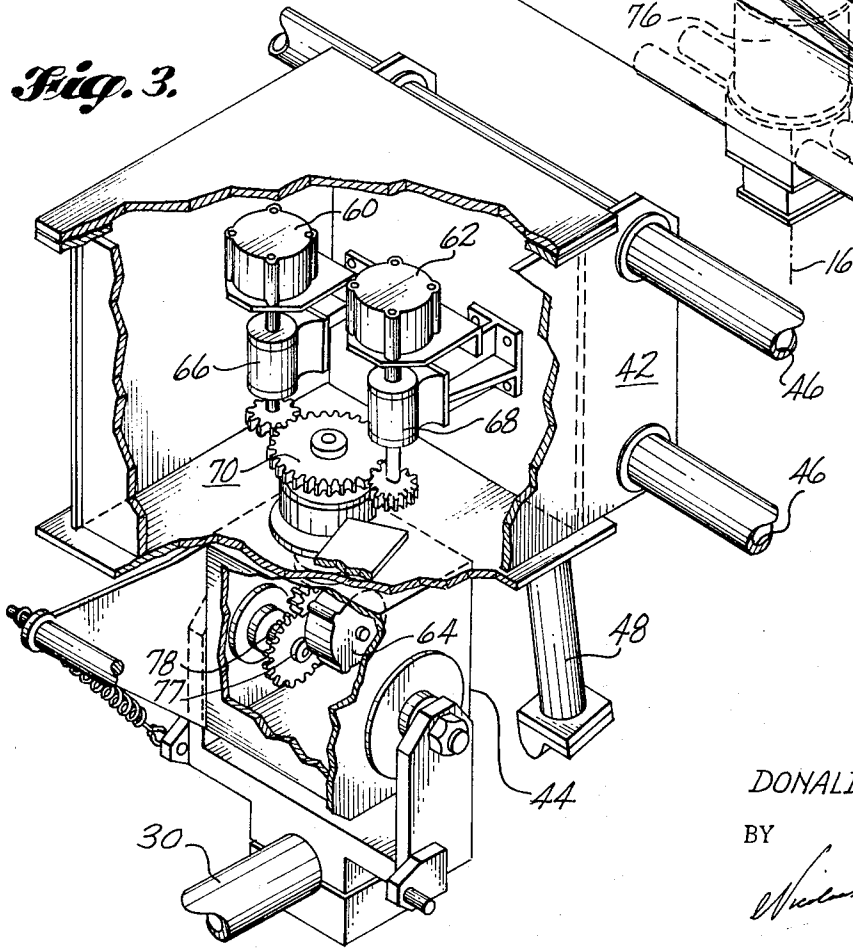


Fig. 3.



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WINCH APPARATUS FOR FAIRED TOWLINE

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 royalities thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to winches designed to handle faired towlines and more particularly to a winch having means for protecting the towline against adverse loading.

In general, the present invention relates to a ship winch apparatus that is equipped with features for handling faired low-drag towlines and towed bodies, such as depressors or sonar hydrophones used for many naval operations. For Navy purposes the towing of the depressor has to be accomplished at a high speed and therefore, the least amount of drag is sought. Accordingly, low drag towlines have been developed and it is intended to pull the low drag towline through the water with the depressor deployed at any predetermined depth. The towline currently planned for use in this operation is a fiberglass and rubber composite having a symmetrical constant chord and aerodynamic shape. A complete description of that particular towline appears in U.S. Pat. No. 3,613,627 by Kennedy. Although the fiberglass portion of the towline is capable of sustaining high tensile loads, loads normal to the towline must be kept small to prevent towline damage. To utilize the towline it is therefore necessary to have handling equipment which will protect the towline from adverse loading. The winch apparatus described hereinafter is specially designed and developed for such requirements.

2. Description of the Prior Art

There are various systems and apparatus in the prior art which handle the towing of objects under water. For instance, in the U.S. Pat. No. 3,347,526 by CYMMER et al. a winch with helical grooves in combination with a guiding system for a faired cable is disclosed. The guide system as well as the configuration of the grooves is different when compared with the features of the present invention.

In the U.S. Pat. to CHATTEN et al., No. 3,379,162 and the previously discussed patent to CYMMER et al., guide structures are shown for maintaining a proper fleet angle in winding a faired cable upon a drum, but the structure does not protect the cable during towing when sudden fleet angle changes are experienced.

The present invention provides for towline protection through a proper automatic alignment and through a proper nesting feature incorporating predetermined guiding means. Both the alignment and the nesting-guiding feature prevent in combination adverse loading of the specially constructed towline during winding, unwinding and towing procedures. The above development and combined cooperating uniqueness appear to be novel and new in the art.

SUMMARY OF THE INVENTION

The present invention relates to a special handling apparatus for a special type of towline used primarily for naval operations.

The towline to be used is a continuously faired towline which is wound upon the winch drum and seats or lays in specially contoured grooves provided on the drum surface. The 600 foot towline can be played out to any desired length for high speed towing operations. The towline achieves low drag by virtue of its small size attained by a fair cross-section. The towline's trailing edge is a continuous, smooth rubber fairing which contains two coaxial electrical cables for electrical power and signal transmissions. See U.S. Pat. No. 3,613,627.

The depressor to be towed in submerged condition by the towline employs an active control system which allows shipboard personnel to "fly" it in a wide variety of positions and depths relative to the towing ship. The depressor generates large downloads dynamically by means of a hydrofoil (wing-like) surface to enable it to be positioned steeply behind the ship. This steep angle towing capability at high speeds demands special handling equipment.

The winch apparatus for faired towline as disclosed hereinafter has the capability of handling such demands. The winch has a grooved drum for stowing the towline and a sensing means which feels variations in towline fleet angle.

In general, the winch apparatus for handling faired towlines comprises a winch and a platform. The winch includes a towline storage drum and a towline fleet angle sensing means. The platform includes a power means for rotating the winch about a vertical axis upon command from a control means connected to the sensing means. The sensing means detects any variations in the towline fleet angle. These variations produce via the control means a single which activates the power means for rotating the winch about its vertical axis so that the fleet angle variation becomes cancelled.

In view of the foregoing it is the object of the present invention to provide for a winch apparatus for faired towlines which apparatus is provided with means to prevent adverse loading to the towline during towing, winding and unwinding procedures through specially designed towline storage and automatic following means for keeping the towline and storage means in non-lateral stress relationship.

Other objects and advantages will appear from the following description taken in conjunction with the following drawings wherein:

FIG. **1** is a sideview of the winch apparatus mounted at the stern of a boat towing a depressor or sonar hydrophone.

FIG. **2** is an isometric illustration of the winch apparatus.

FIG. **3** is an isometric cut-away view of the control box and its inside mechanism which transfers towline input fleet angle changes to the winch apparatus actuating means for immediate alignment of the towline with the drum groove.

FIG. **4** is a plan view of the drum of the winch apparatus and the schematic lateral bending of the towline over a predetermined radius.

FIG. **5** is a cross-section of a pair of drum grooves and the therein nested faired towline.

DESCRIPTION OF THE INVENTION

In FIG. **1** the stern **10** of the boat **12** is provided with a platform **14** which carries, about a substantially vertically extending axis **16**, by means of a rotationally mounted arrangement or pivot **18**, a winch apparatus **20**. The winch apparatus **20** includes a drum **22** for carrying a faired towline **24**. The faired towline is connected to a hydrophone **26** or the like.

A towline fleet angle sensing means **28** with an arm member **30** is pivotally and slidably mounted on side winch apparatus **20**.

The preferred embodiment of the winch apparatus **20** as illustrated in FIG. **2** shows the towline fleet angle sensing means **28** connected about the towline **24**. However, this connection is a frictionless arrangement so that the towline passes substantially freely through the means **28**. When observing a plan view or FIG. **4**, a change of angle between the towline **24** and the drum axis **40** (used as reference line) will result in the towline **24** moving the sensing means **28** on a somewhat diagonal plane so that consequently the arm **30** rotates the lower box part **44** which is rotationally mounted via gear **70** inside of the control box **42** (see FIG. **3**). Assuming that the towline **24** moves off normal to the "right" (See FIG. **4**) then the box part **44** and gear **70** will rotate towards the right. Referring back to FIG. **3**, the rotation of gear **70** towards the "right" will rotate the small gear on transmission **66** and consequently a reduced rotation is effected inside of **66** so that a small rotation of potentiometer **60** takes place. Potentiometer **60** is electrically connected to power means **76** and the small electrical signal variation which results from the small rotation will produce immediate and automatic rotation of the platform **14** carrying the winch **20** on a horizontal plane about axis

16 so that the towline 24 deviation to the "right" is brought back to a normal angle with axis 40 due to the resulting automatic aligning of groove 50 with the towline 24. When the gear 70 turns to the "right" as per above assumption, then the small gear on transmission 68 will turn also to the "right"; however, an internal slip clutch (not shown) of transmission 68 will not cause any turning of the reducing rotating means inside of transmission 68. The same applies to transmission 66 when gear 70 turns to the left; thus, transmission 66 takes care of "right" towline 24 misalignment with the drum groove 50 and transmission 68 takes care of "left" towline 24 misalignment with the drum groove 50. Of course, the mechanism shown in FIG. 3 is a sophisticated and an actually existing device, and it should be understood that many variations for accomplishing the same result are known to persons skilled in the art and that a simplification would not include the transmissions 66 and 68 with slip clutches, and so on. Also, it should be understood that sudden moves of the towline to "right" or "left" are immediately corrected so that a bending of the towline at the groove as shown in FIG. 4 will seldom happen since the correction starts as soon as misalignment happens. Only when the towline 24 moves extremely far to port or starboard where the platform 14 rotation and towline 24 scope or rode interferes with ship's stern portion at port or starboard the extra amount of bending allowed by the specially designed grooves in the winch drum will still afford additional bending towline protection as per FIG. 4.

The control box 42 is slidably mounted on the bars 46. A follower or member 48 projects from the control box 42 and rides in the helical groove 50 of the drum 22.

During winding or unwinding of the cable 24 onto or from the drum 22 the control box 42 will, due to the follow-up of member 48 riding in the helical groove 50, follow and stay in constant alignment with the towline portion extending away from the drum 22.

In order to define the fleet angle terminology in conjunction with the accompanying drawings, it is understood that fleet angle variations are changes made to the normal or 90° angle which is observed between the towline 24, leaving tangentially the drum groove 50, and the axis 40 when viewing the towline 24 from point A, shown in FIG. 1. Point A is at a line leaving perpendicularly axis 40 via the towline 24 tangent or groove leaving point.

Referring now to FIG. 3 the open cut section of the control box 42 shows a plurality of potentiometers 60, 62 and 64. The shafts of the potentiometers 60 and 62 are connected via speed transmission gear boxes 66 and 68 respectively and a variety of gears 70 of different ratio to the lower part 44 of the control box 42 and the complete assembly thus forms a mechanism which upon movement of the arm 30 in any direction to the "left" or "right" produces a signal via one of said potentiometers, as explained above. A somewhat vertical movement of the arm 30, which will change angle α formed by axis 98 and the towline 24, will turn the pivot 77 and gear 78 and thus an up and down movement from arm 30 will rotate the pivot 77 and its attached gear 78 clockwise or anticlockwise, respectively. Assuming that the Navy personnel intend to fly the hydrophone or depressor 26 at a higher or deeper water level then the towline angle α will change also, and thus upon electrically steering the wings of the hydrophone 26 at a certain angle, the corresponding reaction to a steeper or less steep cable or towline 24 angle α is sensed and indicated on control console 82 via the signal change received by the potentiometer 64 setting. Thus a certain α goes together with a certain depth and also speed; however, since this part of the hydrophone operation is not essential to this invention, further explanation is not deemed necessary.

In other words, all movements of the arm in vertical as well as horizontal direction can be sensed by sensing means 28.

For the purpose of this application the changes of the fleet angle are most important.

The signal produced by the potentiometer 60 operates a power constitutes an electrical motor or the like and is capable of rotating the platform 14 about axis 16. Electrical connection between the potentiometer 60 and 62 and the power means 76 are not shown, but are made via the electrical conduits or sliding bars 46, for instance. Thus, in other words, the electrical signals received from each potentiometer 60 or 62 have each their own individual characteristics, either in direction, frequency, or value, which accordingly is received by the power means 76 and handled as input for turning the platform 14 carrying the wind 20 to the "left" of "right" about axis 16. The electrical signal change from potentiometer 64 relates to hydrophone action and towline 24 angle α change. Of course, all signals from each potentiometer 60, 62 or 64 are shown on the console 82 for certain required purposes. Consequently, the electrical information and signals thus received are led, together with the information from the hydrophone 26 via the towline internal electrical cables and via the output and input cables 80 to a control means or console 82 located at the stern of the boat 12 as shown in FIG. 1.

It will be obvious to anyone familiar with the art of designing instrumentation of the type shown in FIG. 3 that various variations and alterations can be made for producing a signal which is of a value that is in direct relationship to the towline fleet angle variations that have been experienced by the sensing means 28.

Anybody familiar with the art of towing objects under water realizes that due to currents and other causes a towed object may change its position drastically. In other words, a sudden immediate direction change of the object will increase the fleet angle. Also during winding and unwinding procedures of the towline 24 on the drum sudden bending or adverse loading to the towline 24 may occur. Most likely this adverse loading will take place at a point where the nested towline 24 leaves the helical groove 50.

Therefore, as part of the total protection system for the towline 24 against adverse loading, the helical groove 50 is of a special design as shown in FIG. 5 which is a cross-section 5—5 taken from the view in FIG. 4. As shown in FIG. 5 the drum surface corrugated curvature 92 appears to be smooth at the portion where the nose section 94 of the towline 24 nests into the helical groove 50. However, at point 96 the direction of the concave curve or nesting surface changes. For explanatory purposes the points 96 are connected so that an imaginary line 100 is created. This line 100 divides the drum concave curvature from the convex curvature. The convex curvature forms lands or amplitudes 102, and the surface of the convex curvature is so plotted or curved that a guiding and support is formed for the towline 24 when the towline 24 leaves the drum groove 50 when a sudden misalignment of the towline with the leaving groove 50 takes place. Thus, as shown in FIG. 4 the towline 24 leaves groove 50 and in dashed-dot line fashion cannot bend sharply, but is supported and maintained at a predetermined bend radius of 36 allowing for a predetermined fleet angle degree variation at either side of the aligned or normal towline drum-groove takeoff.

As explained before, the fleet angle sensing means 28 will sense fleet angle variations, which variations will produce a signal in the control box 42 which consequently activates the power means 76 so that the fleet angle variation is cancelled or eliminated. The purpose of cancelling the variations is to prevent the towline 24 from bending about the imaginary plane 90. As mentioned before the towline 24 is of a specially designed structure having its strength in the nose section only and adverse loading of the towline 24 will result in breakage thereof.

Other forms and modifications of the present invention, both in respect to its general arrangement and the details of its respective parts, which may occur to those skilled in the art after reading the present description, are intended to come within the scope and spirit of this invention as more particularly defined in the appended claims.

Now, therefore, I claim:

1. A handling apparatus for a faired towline with adverse towline loading protection means, comprising:

a. a winch apparatus carrying said associated faired towline;

b. a platform carrying said winch apparatus;
c. a power means;
d. said power means connected to said platform for turning said platform about a vertical axis;
e. a towline fleet angle sensing means;
f. said towline fleet angle sensing means linked about said towline at a predetermined distance from said winch apparatus for sensing towline fleet angle variations information, and
g. control means connected between said fleet angle sensing means and said power means for receiving said sensed fleet angle variation information and for activating said power means for turning said platform carrying said winch apparatus about said vertical axis so that said fleet angle variation is eliminated.

2. A handling apparatus as claimed in claim **1** wherein said winch apparatus has a drum provided with a helical groove for supporting and nesting said towline.

3. A handling apparatus as claimed in claim **2** wherein said helical groove comprises a cross-sectional configuration of a substantially corrugated shape and wherein said drum surface inner portions between two of said drum surface consecutive outer portions or amplitudes of said corrugated shape has a smooth concave curvature which complements said towline nose section for achieving said nesting feature and wherein said amplitudes describe a convex curve compared to said concave curvature.

4. A handling apparatus as claimed in claim **3** wherein said convex curve determines a predetermined curved surface to said groove outer portion for supporting said towline about a predetermined radii when said towline departs substantially transversely from said groove.

5. A ship towline handling apparatus having means for preventing adverse loading to a faired towline during winding, unwinding and towing procedures comprising, in combination,

a. a platform mounted for rotation to said ship's deck;
b. a winch apparatus including a towline drum mounted on said platform;
c. said drum provided with a helical groove having towline complementing supporting features;
d. a fleet angle sensing means, said fleet angle sensing means linked about said associated towline at a predetermined distance from said drum for sensing said towline fleet angle information;
e. a control means connected to said fleet angle sensing means for receiving sensed fleet angle variation information;
f. a power means mounted on said ship and connected to said rotational platform for rotating said platform about a substantially vertically extending axis, and
g. said control means connected to said power means and adapted for activating said power means upon receipt of said angle variation information so that said platform turns and said drum groove aligns itself longitudinally with said towline leaving said drum, whereby said fleet angle is being eliminated.

6. A ship towline handling apparatus as claimed in claim **5** wherein said fleet angle sensing means comprises an arm having a first and second end, said first end pivotally and rotationally mounted to said control means, and said second end provided with a means loosely engaging about said towline at said predetermined distance from said drum.

7. A ship towline handling apparatus as claimed in claim **6** wherein said control means is slidably mounted along a bar arrangement mounted to said winch and extending parallel to said drum axis and wherein said control means is provided with a follower member contacting said helical groove for moving said control means freely along said bar arrangement so that said control means and said pivotally and rotationally mounted arm of said sensing means are in substantial alignment with said towline departing said drum groove.

8. A ship towline handling apparatus as claimed in claim **7** wherein said control means adapted to receive fleet angle variation information is provided with potentiometer means for converting said variation information into a signal for subsequently energizing said power means for rotating said platform about said vertical axis an equal distance in an opposite direction to said received angle variation so that said fleet angle variation becomes nullified.

9. A ship towline handling apparatus as claimed in claim **8** wherein said helical groove comprises a cross-sectional configuration of a substantially corrugated shape and wherein said drum surface inner portions between two or said drum surface consecutive outer portions or amplitudes of said corrugated shape has a smooth concave curvature which complements said towline nose section for achieving said nesting feature and wherein said amplitudes describe a convex curve compared to said concave curvature.

10. A ship towline handling apparatus as claimed in claim **9** wherein said convex curve determines a predetermined horizontal curved surface to said groove outer portion for supporting said towline about a predetermined radii when said towline departs substantially transversely from said groove.

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