United States Patent

[11] 3,576,295

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[54] **MEANS FOR STORING CRUSH-SENSITIVE CABLE CONFIGURATIONS**
8 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **242/54,** 242/77.1, 242/117, 254/184
[51] **Int. Cl.** **B65h 75/00**
[50] **Field of Search** 242/54, 67.1, 117, 77.1; 254/184, 185

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ABSTRACT: Apparatus for storing a cable with fairing sections consists of a pair of spaced-apart drums, the outer surfaces of both having a helix, the helix on one drum being in the opposite direction to that on the other drum. The cable is wound on the inner drum and then passed through an opening in the outer drum for winding thereon.

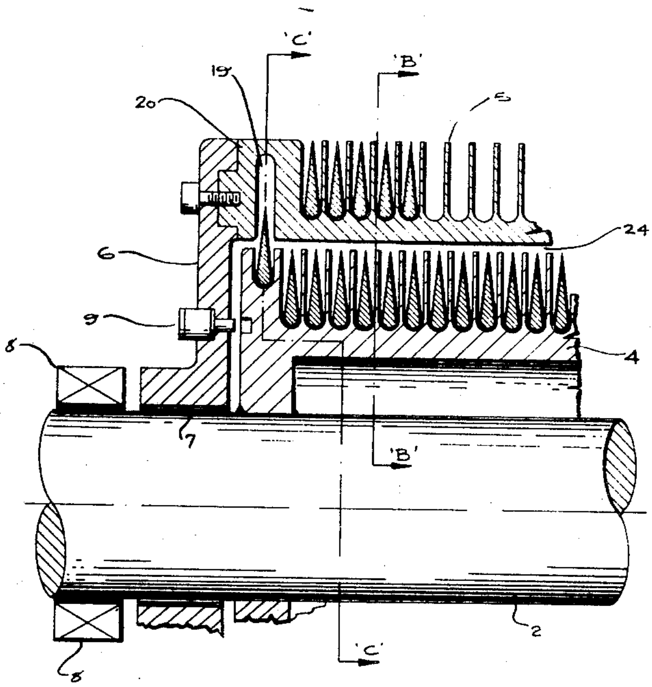


FIG 2

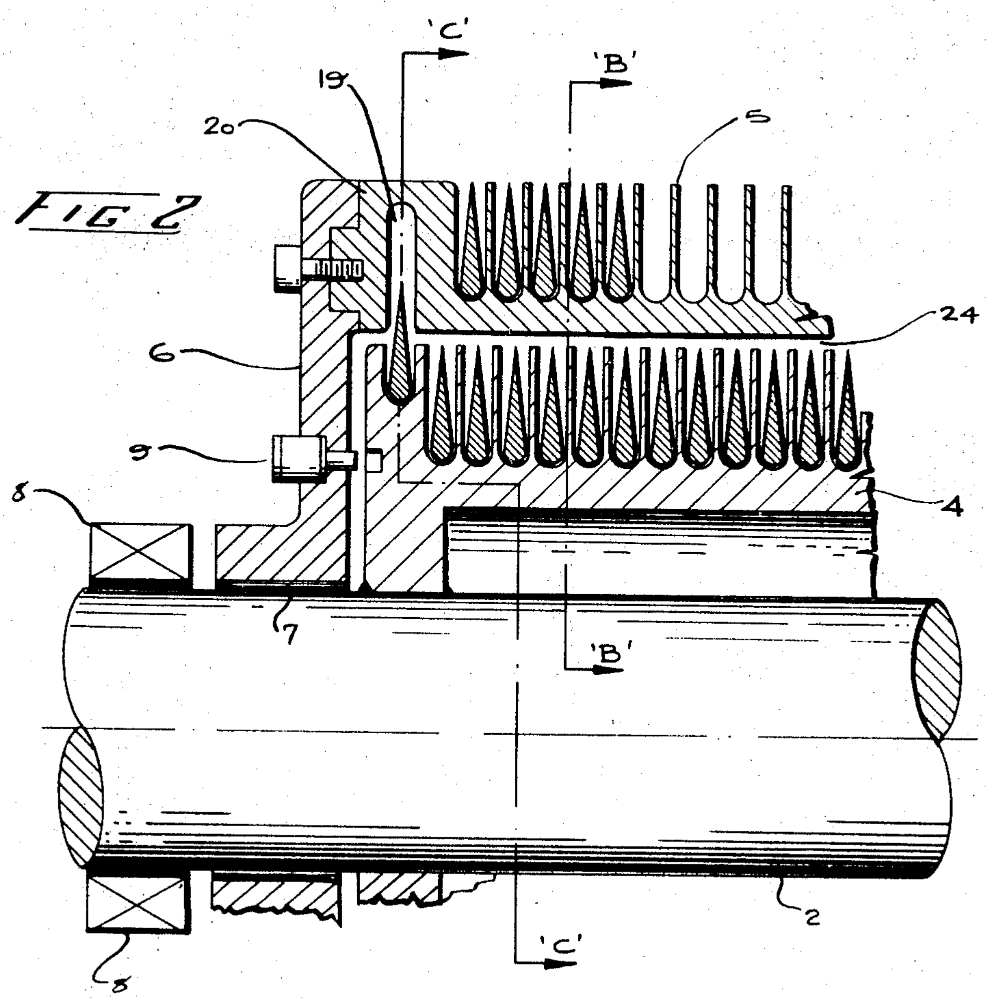
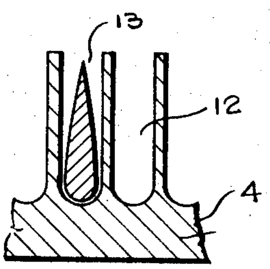


FIG 6



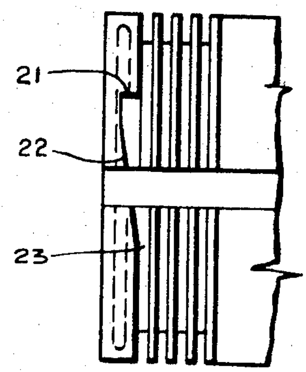


FIG 5

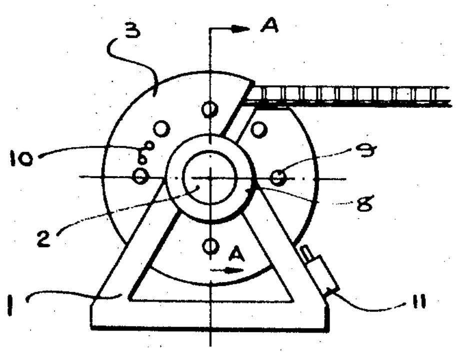


FIG 1

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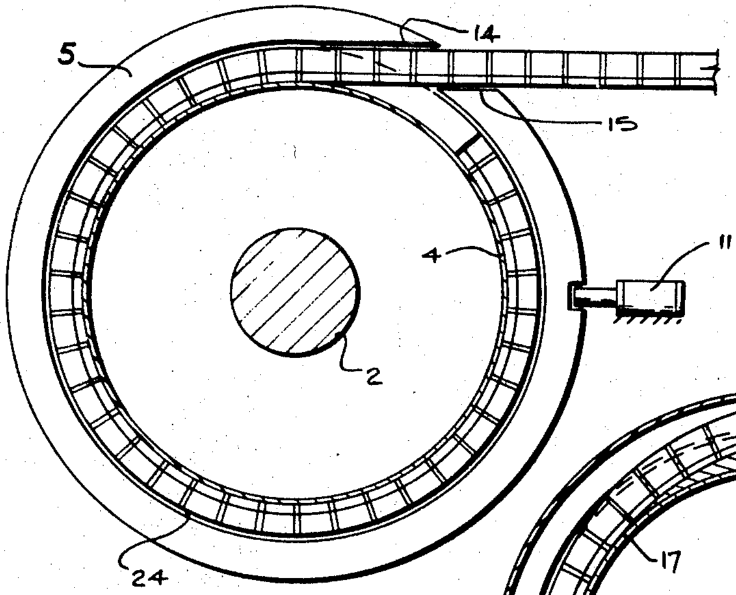

FIG 3

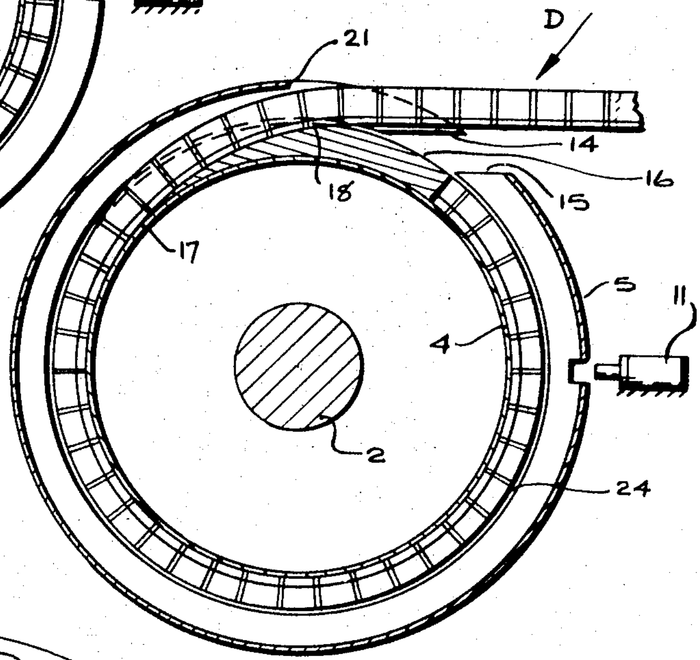

FIG 4

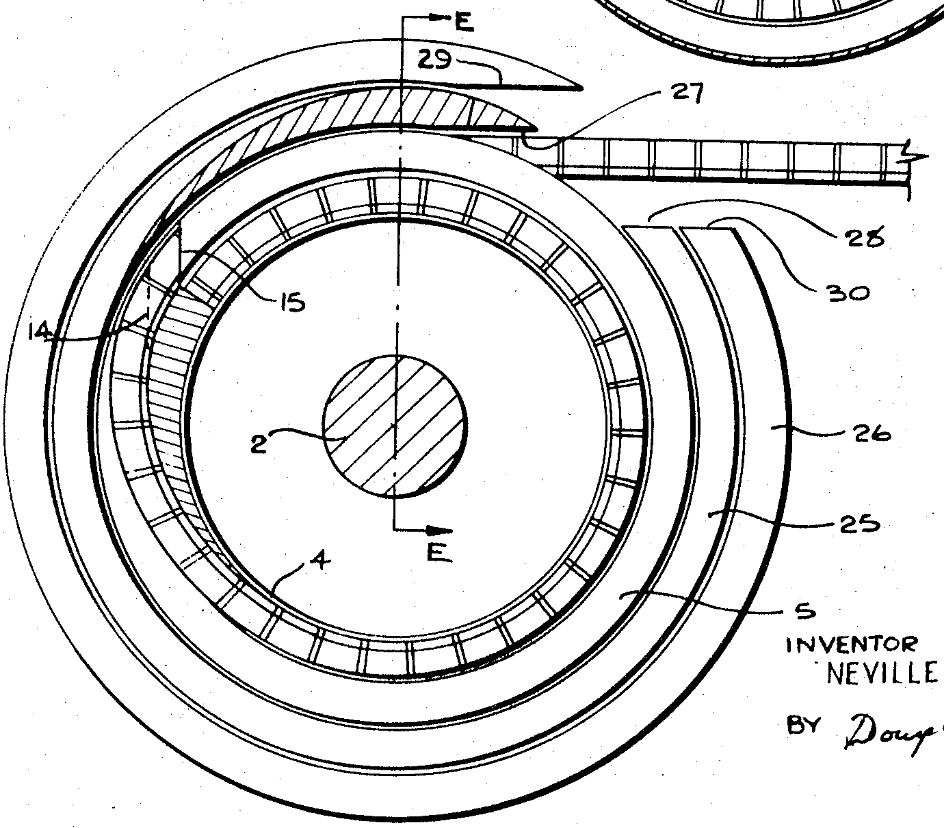

FIG 7

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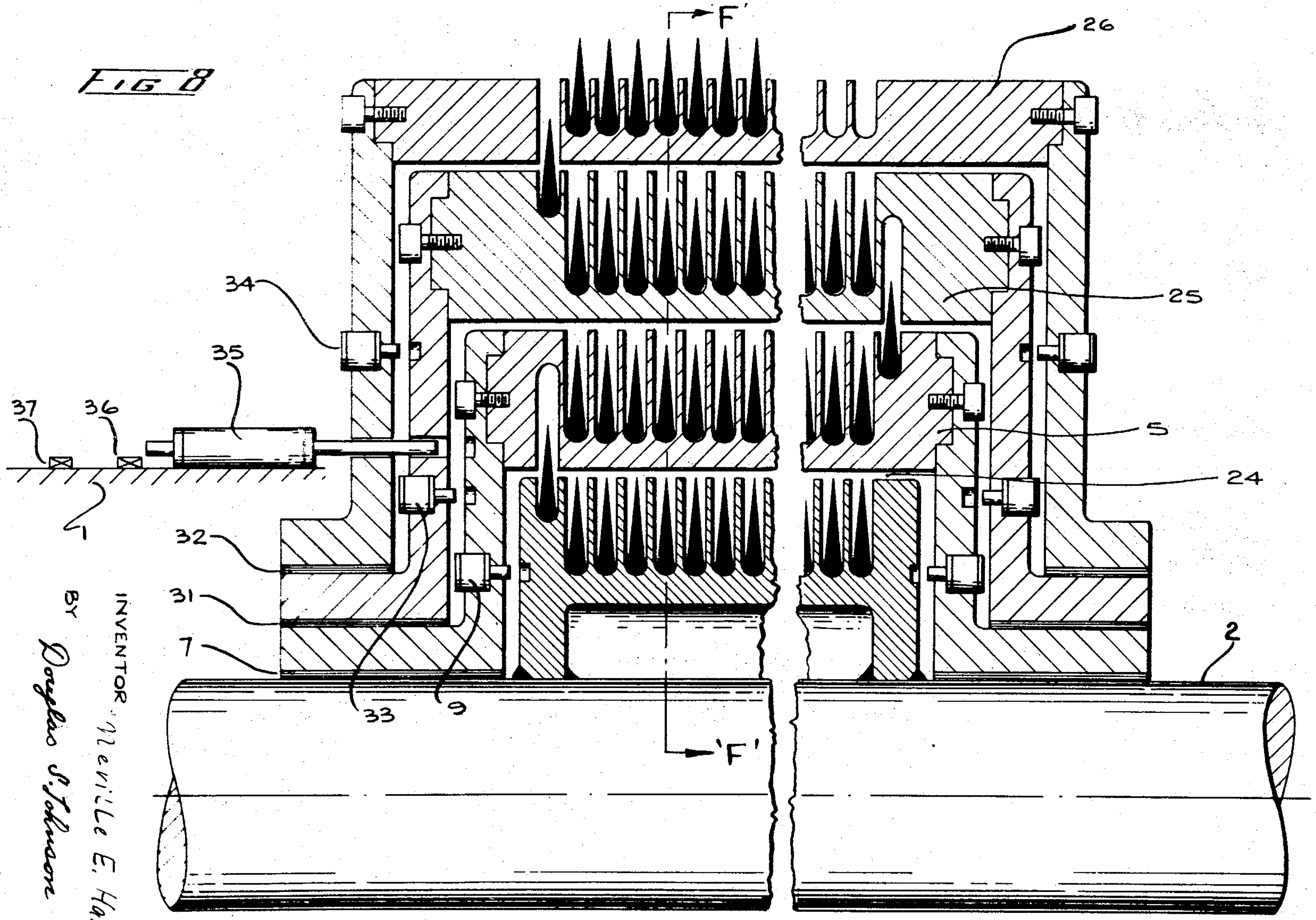
FIG 8



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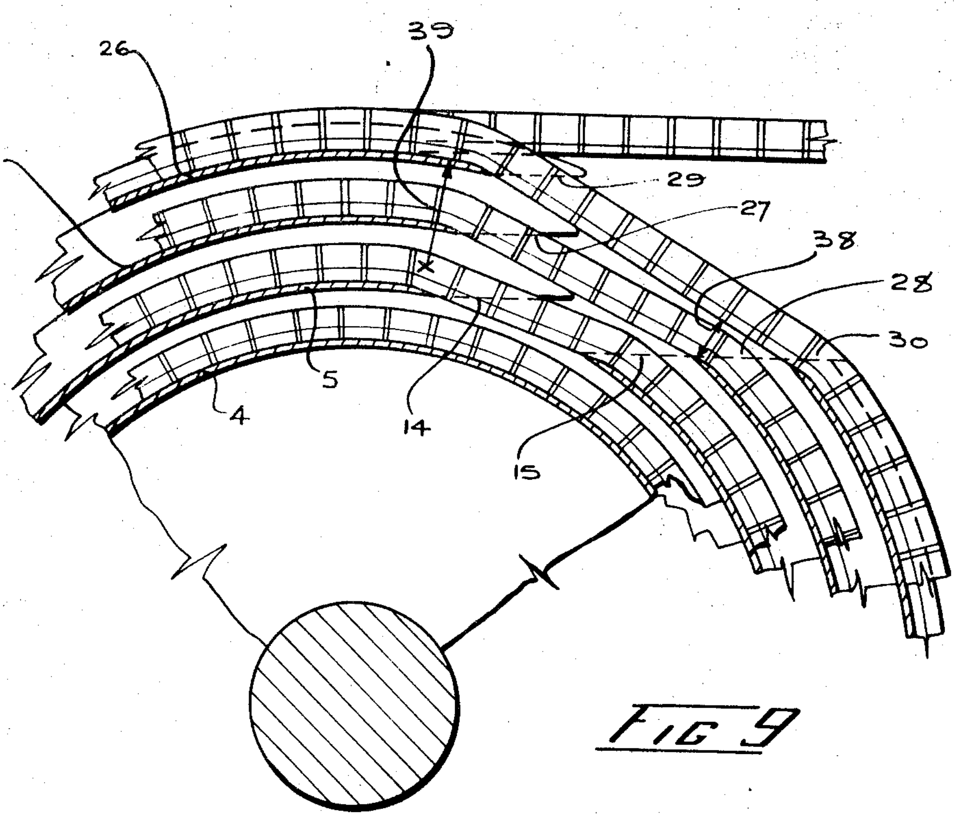

FIG 9

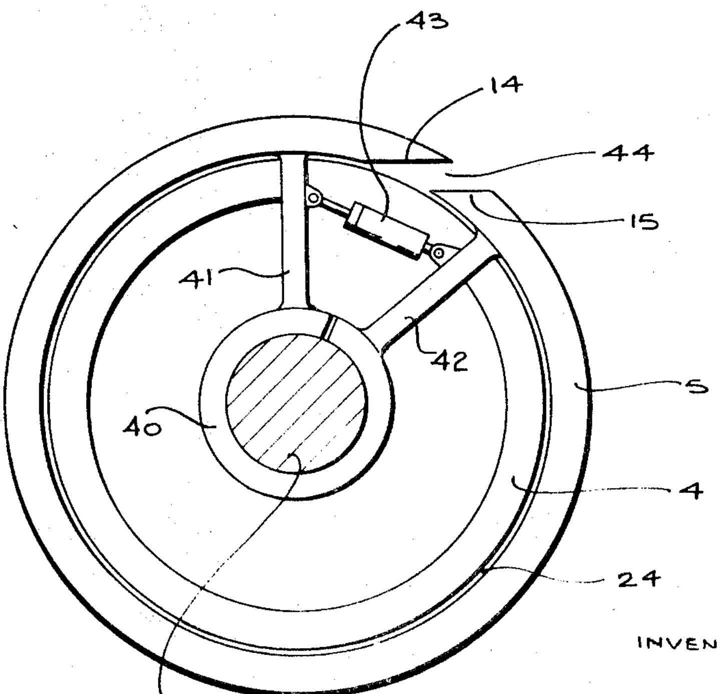

FIG 10

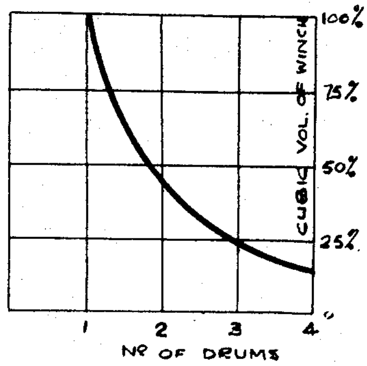

FIG 13

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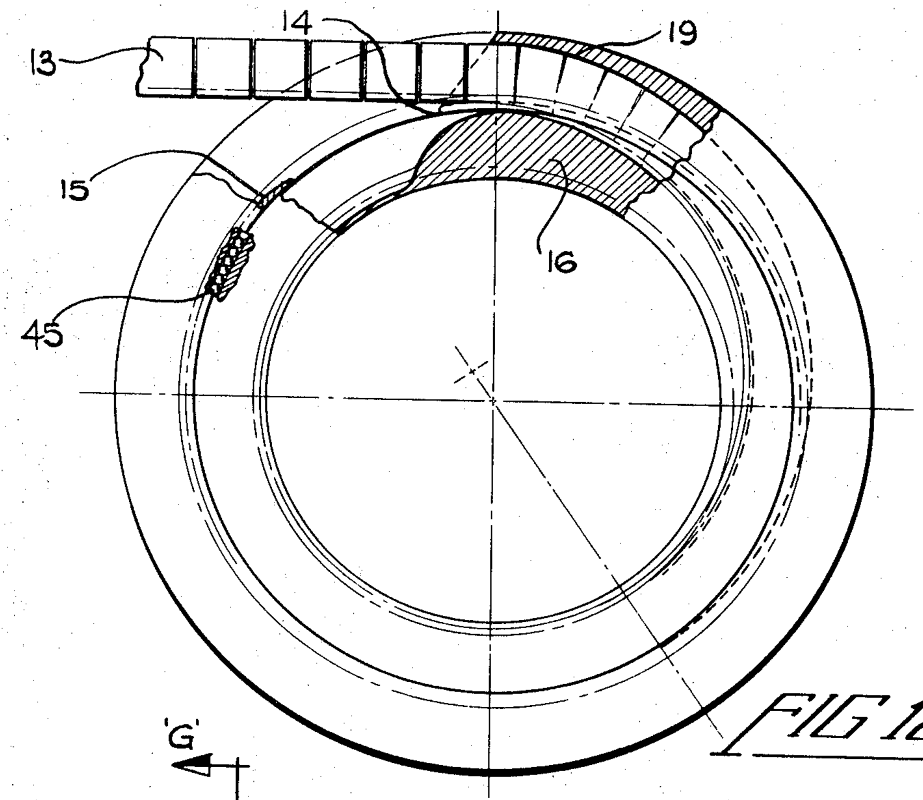

FIG 12

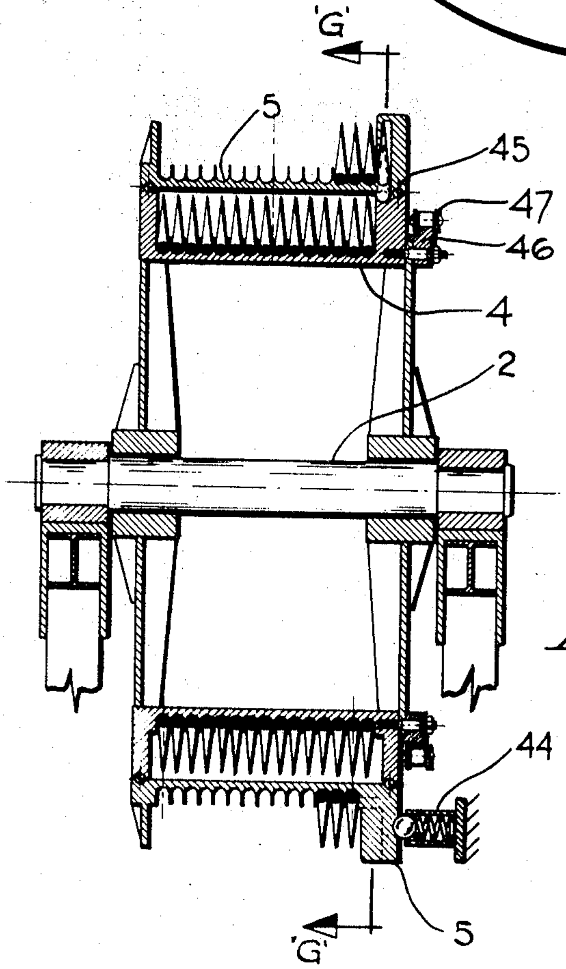

FIG 11

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MEANS FOR STORING CRUSH-SENSITIVE CABLE CONFIGURATIONS

FIELD OF THE INVENTION

This invention relates to the storage of a faired cable in multiple layers to prevent crushing of the fairings.

DESCRIPTION OF PRIOR ART

In oceanographic applications and the like, a cable with hydrodynamically-shaped fairing sections is employed, said fairing sections being used to reduce cable drag. On all systems presently known to me, the towing winch stores this cable in a single multiple-turn layer and usually with the fairing sections radially oriented about the drum in order to keep the turns as compact as possible. Heretofore, it has generally been assumed impractical to wind more than a single layer of faired cable on a cable drum since the winding tension on the cable of subsequent layers would crush the fairings of the underlying layers of cable.

The trend, however, is towards greater operating depths in deep sea oceanographic systems. This trend raises substantial problems of cable storage when the system is housed, because with the single layer storage system, the winch tends to become of unmanageable size. This is particularly aggravated by the fact that the winch is usually situated in the aftermost area of the ship's deck where excessive weight can in some instances cause problems of vessel trim.

This situation can be radically improved with the introduction of a means for storing the faired cable in multiple layers on a single winch.

The primary object of my invention is to reduce the bulk of the winch by providing a system of storing faired cable in multiple layers. For simplicity, the basic description will be contained to a two-layer system followed by a somewhat more brief description of a four-layer system.

BRIEF DESCRIPTION OF THE DRAWINGS

In describing my invention, I will make reference to the following FIGS. in which:

FIG. 1 is an end elevation of my winch configuration;

FIG. 2 is a fragmented section of the dual winch drum assembly taken on line AA of FIG. 1;

FIG. 3 is a cross section of my dual drum assembly taken on line BB of FIG. 2;

FIG. 4 is a cross section of my dual drum assembly taken on line CC of FIG. 2;

FIG. 5 is a fragmented plan view taken in the direction of arrow D on FIG. 4;

FIG. 6 is a fragmented cross section of a winch drum showing the helical groove and faired cable "in situ;"

FIG. 7 is a diagrammatic elevation of a four-layer system showing the drum orientation during the second layer of winding;

FIG. 8 is a cross section of a four-layer system winch taken on line EE of FIG. 7;

FIG. 9 is a fragmented cross section of a four-layer system winch taken on line FF of FIG. 8;

FIG. 10 is a diagrammatic representation of an alternative locking arrangement between adjacent winch drums;

FIG. 11 is a sectional view of an alternative embodiment of the winch drum which shows a second configuration for providing relative rotation between drums;

FIG. 12 is a sectional view taken on line GG of FIG. 11 which shows an alternative method for causing the outer drum to rotate with the inner drum when the innner drum is fully loaded with cable;

FIG. 13 is a graph which illustrates the relative saving in space brought about by the introduction of each additional drum.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

My winch configuration shown in FIG. 1 comprises a support frame 1, a shaft 2, a drum assembly 3 and conventional means for driving the shaft (not shown).

The winch drum assembly comprises a first or inner drum 4 and a second or outer drum 5 as shown in FIGS. 2 and 3. These two drums are concentrically mounted on shaft 2. Drum 4 is made integral with shaft 2, whereas drum 5 is supported from shaft 2 by end plates 6 and bearings 7. The shaft is rotatably mounted on main bearings 8 supported on frame 1. Thus shaft 2 and inner drum 4 are able to rotate irrespective of the outer drum. The outer drum 5 may be held stationary or may be locked to the primary drum 4 by means of a plurality of short-stroke hydraulic cylinders 9 located on end plates 6 as shown in FIGS. 1 and 2, the piston rods of which act as locking pins when extended into matching recesses in the sidewalls of the inner drum. It is visualized in its simplest form that these cylinders would be piped up in parallel and terminated in quick-disconnect ports 10, see FIG. 1, such that when the winch is stationary, the hoses may be momentarily connected to these ports to actuate the said cylinders.

Conversely, the outer drum 5 may be arrested and prevented from rotation by one or more cylinders 11 which may engage said drum (for example at the periphery) when the said cylinder is extended as shown in FIGS. 1 and 3.

Both inner and outer drums 4 and 5 may be plain but preferably grooved as shown in FIG. 2, the said groove being a continuous helix, the inner drum having a right-hand helix and the outer drum having a left-hand helix, or vice versa.

The section of the helical groove 12 is designed to partially or totally envelope the faired towing cable 13, the latter case being shown in FIG. 6.

The outer drum 5 only is transversely slotted between the faces 14 and 15 in FIG. 3. The perpendicular distance between faces 14 and 15 is slightly greater than the longitudinal axis of fairing section 13. Thus it is possible for cable to be wound on and off the innner drum 4 when the outer drum 5 is held stationary such that the cable can pass between faces 14 and 15 as illustrated in FIG. 3.

Near the completion of the first layer of winding on the inner drum 4, i.e., during the last half turn, the cable must be elevated to the height of the outer drum 5. This may be simply accomplished by fitting a filler "ramp" 16 in the quadrant of the last slot in the inner drum as shown in FIG. 4. This ramp commences its raise at point 17 and blends with a maximum tolerable radius within outer drum 5 at 18, said radius being substantially equal to the radius of the risers between the grooves as shown in FIG. 6.

The space for the rising cable may be accommodated by access means or clearance chamber 19 which is machined into the overlaying end mass 20 of the outer drum 5 as shown in FIG. 2. As the cable approaches its upper level, the roof of this chamber 19 is cut away at 21 to allow the cable to emerge. This is shown in FIGS. 4 and 5. The outermost sidewall of chamber 19 at 22 is retained to guide the cable into the start of the helical groove 23 of the outer drum 5, see FIG. 5. This wall is shown inwardly curved at 22 but on large drums where the helix angle is small this would not be necessary.

However, when the cable reaches the position shown in FIG. 4, namely at its point of contact with the ramp 16 at point 18, the drum is momentarily stopped to allow the locking cylinders 9, see FIG. 2, to be extended, thus locking the outer drum 5 to the inner drum 4. Simultaneously the arresting cylinder 11 for the outer drum 5 must be retracted thus allowing the outer drum 5 to rotate with the inner drum 4.

Upon recommencement of rotation, the cable will enter groove 23 of the outer drum 5 and will commence the second layer of winding.

The clearance 24, see FIG. 2, between the inside of the outside drum 5 and the apex between grooves of the inner drum 4 is quite small (for example, one-eighth of an inch on a 15-ft. diameter) and thus the outer drum which has some springiness due to the transverse slot between faces **14** and **15**, is permitted to contract under cable tension, thus allowing the load to be supported on the inner drum **4**. The clearance **24** is governed by the ability of the outer drum **5** to contract without exceeding the stress yield point of the drum material. Thus, upon subsequent unwinding, the drum **5** will regain its original dimensions once the cable has been fully unwound from said drum and thus reestablishes the clearance **24** for free rotation of the inner drum when the outer drum **5** is again locked as shown in FIG. **3**.

The description to this point has been limited to a two-layer system. FIGS. **7**, **8** and **9** show a four-layer system.

FIG. **7** shows the situation in which a cable is being unwound onto the second layer drum **5** and thus the innermost drum **4** and the second drum **5** are locked, one to the other, and rotating. Accordingly, the slot between faces **14** and **15** in drum **5** has moved around from the starting position shown in FIG. **3**. At this time the third drum **25** and the outermost drum **26** are locked stationary.

It will be noticed that the third drum **25** has a transverse slot between faces **27** and **28** which is wider than the slot in the second drum **5**. Also the outer drum **26** has a transverse slot between faces **29** and **30** which is again wider than the slot in drum **25**. The reason for this is that the cable entering the drum complex is elevated at each subsequent layer of winding.

The second, third and fourth drums **5**, **25** and **26** are concentrically and rotatably mounted as shown in FIG. **8**, each supported on bearings **7**, **31** and **32** respectively. The end plates of each drum are equipped with a plurality of locking cylinders **9**, **33** and **34** respectively. Thus it is possible to lock or unlock drum **5** to drum **4**, drum **25** to drum **5**, and drum **26** to drum **25** independently during the cable heaving or veering process.

The drums that are not required to rotate in unison with the inner drum must be held stationary. This may be accomplished by a single double-ended locking cylinder **35** mounted on support frame **1**. This cylinder may be indexed for position by limit switches **36** and **37** such that at full stroke IN, drums **5**, **25** and **26** are locked stationary during the winding of the first layer of cable; drums **25** and **26** only are locked during the winding of the second layer of cable, and drum **26** only is locked during the winding of the third layer of cable. At full stroke OUT, all drums rotate in unison. The two intermediate stroke positions of cylinder **35** are controlled by the positioning of limit switches **36** and **37** respectively.

When the apex between grooves is required to support the load of the overlying drum, the depth of the cable grooves is progressively greater in drums **5** and **25** than the groove depth in drum **4**. The reason for this is illustrated in FIG. **9**. In this FIG., it will be seen that the cable forms a chord across the transverse slot in the respective drums. Consequently, the underlying layer of cable must be below this chord line to prevent fouling between layers. Since the chord length is greatest on the fourth layer, the dimension **38** to the bottom of the groove in the third layer must be greater than the equivalent dimension between lower layers. It is also important that the leading edges of either side of the slots must be radiused as illustrated at **39** such that the said radius is not less than the minimum bend radius of the faired cable.

An alternative means of locking the drums together (i.e., other than by cylinders **9**, **33** and **34** in FIG. **8**) may be accomplished as shown in FIG. **10**.

In this FIG., drum **5** is held concentric with drum **4** by means of hub **40** rotatably mounted on shaft **2**, and two radial spokes **41** and **42** on opposite sides of the transverse slot **44**. Normally, this would permit a small clearance **24** between drums **4** and **5**. However, a hydraulic cylinder **43** mounted between spokes **41** and **42** and may be energized to contract drum **5** onto drum **4**, thus providing a clutchlike action and causing the two drums to drive in unison. It may be noted that the outer drums never provide the motive force.

Another embodiment of my invention is shown in FIGS. **11** and **12**, said FIGS. illustrating a relatively small winch. For such applications, the axial span of the winch drums **4** and **5** may be sufficiently small as to permit the boundaries of the transverse slot at **14** and **15** on drum **5** to have sufficient strength to support the tensioned cable without reliance upon transference of load to a deeply grooved inner drum.

In this embodiment the access means for the passage of cable from the inner drum **4** to the outer drum **5** combines with a locking means which automatically causes said outer drum to commence rotation in unison with said inner drum as soon as said inner drum is filled with cable. This is achieved by profiling the depth of the access chamber **19** so that the radial distance between the profile of ramp **16** and the roof of access chamber **19** remains constant. This constant depth is equal to the longitudinal axis of the faired cable when viewed in section. In consequence when cable is reeled onto the inner drum and the final half turn is reached, said cable will be elevated as the ramp **16** passes beneath it until at the instant that the ramp **16** underlies the access chamber **19** as depicted in FIG. **12**, the faired cable will be fetched up into hard contact with the roof of said access chamber **19**. Continued turning of inner drum **4** will force the access chamber **19**, and then the entire outer drum **5**, to turn also in a locked relationship with said inner drum.

When the outer drum is required to remain independently stationary it may be arrested by a detent mechanism **44**, see FIG. **11**. By using said detent means, the driving force imparted to the outer drum by the cable as described in the immediately preceding paragraph is sufficient to overcome the arresting action of said detent. Conversely, when cable is being unwound from the winch apparatus, the detent mechanism **44** will again automatically arrest the rotation of outer drum **5** at the instant that said outer drum becomes empty.

The embodiment shown in FIGS. **11** and **12** includes an alternative means for providing independent relative rotation of outer drum **5** about inner drum **4**. In this arrangement the outer drum rotates on a series of trapped balls **45** which are inserted at the interface of the inner and outer drum walls. The ball races so formed permit the innner drum **4** to rotate when the outer drum **5** is held stationary. It is important to note that relative rotation occurs only when the outer drum is unloaded and therefore the ball race never operates under load.

In FIG. **11** a drive means is shown attached to one side of inner drum **4**. This comprises a sprocket **46** firmly bolted to drum **4** and a chain **47** which may be driven by any conventional motor mechanism.

The primary object of my invention, as previously stated, is to reduce the bulk of a faired cable winch. FIG. **13** shows in graph form the percentage volume of a two, three and four drive system in comparison with a conventional single drum winch where it may be seen that a four-drum configuration is reduced in volume to only 15 percent of the equivalent conventional single-drive configuration.

The invention discussed herein has been described substantially in terms of components used. I do not, however, wish the said invention to be restricted to the precise arrangement of parts described since this disclosure is intended to explain a workable construction illustrating a concept, and is not for the purpose of limiting the invention to any subsequent embodiment or details thereof.

I claim:

1. Apparatus for storing a cable comprising first rotatable drum means, second rotatable drum means spaced apart from and substantially surrounding said first drum means, means for arresting rotation of said second drum means, and access means for passage of said cable from said first drum means after winding thereon, onto said second drum means; and means for locking said second drum means to said first drum means comprising a ramp means attached to said first drum means, an overlying chamber means attached to said second drum means, said ramp communicating with said chamber to cause a locking action between said first and second drum means when said cable overlies said ramp in passage from said first drum means to said second drum means.

2. Apparatus according to claim 1, including means for winding said cable on said second drum means in a reverse direction to the winding of said cable on said first drum means.

3. Apparatus according to claim 2, wherein said first and second drum means include a helical groove on their respective outer surfaces to receive said cable, the helical groove of said second drum means being opposite to said helical groove on said first drum means.

4. Apparatus according to claim 1, wherein said second drum means has a transverse slot to permit said cable to be wound upon and unwound from said first drum means when said second drum means is stationary.

5. Apparatus according to claim 1, wherein direct drive means are included for said first drum means, whereas said second drum means is bearingly mounted for independent rotation.

6. Apparatus according to claim 1, having a third spaced-apart, rotatable drum means surrounding said second drum means, individual means for arresting said third drum means, a transverse slot in said third drum means to permit said cable to be unwound from said second drum means when said third drum means is stationary through said individual arresting means, said slot in said third drum means being larger than said slot in said second drum means.

7. Apparatus according to claim 3, wherein said second drum means has guide means to guide said cable from said access means into said helical groove on said second drum means.

8. Apparatus for storing a cable comprising first rotatable drum means, second rotatable drum means spaced apart from and substantially surrounding said first drum means, means for arresting rotation of said second drum means, and access means for passage of said cable from said first drum means after winding thereon, onto said second drum means; means for winding said cable on said second drum means in a reverse direction to the winding of said cable on said first drum means; and helical groove means on the outer surfaces of said first and second drum means respectively to receive said cable, the helical groove of said second drum means being opposite to said helical groove of said first drum means, and wherein the depth of the helical groove of said first drum means is sufficient to substantially envelope said cable, said second drum means being flexible to an extent such as to permit it to contract under cable tension into load-bearing contact with said first drum means.