# United States Patent [19]

**McCloud**

[11] **3,770,244**

[45] **Nov. 6, 1973**


[54] **WINCH MECHANISM**


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[52] **U.S. Cl.** ..... **254/164,** 254/150, 114/218

[51] **Int. Cl.** ..... **A63b 61/04**

[58] **Field of Search** ..... 254/164, 150; 114/218



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*Assistant Examiner*—Merle F. Maffei
*Attorney*—H. D. Messner

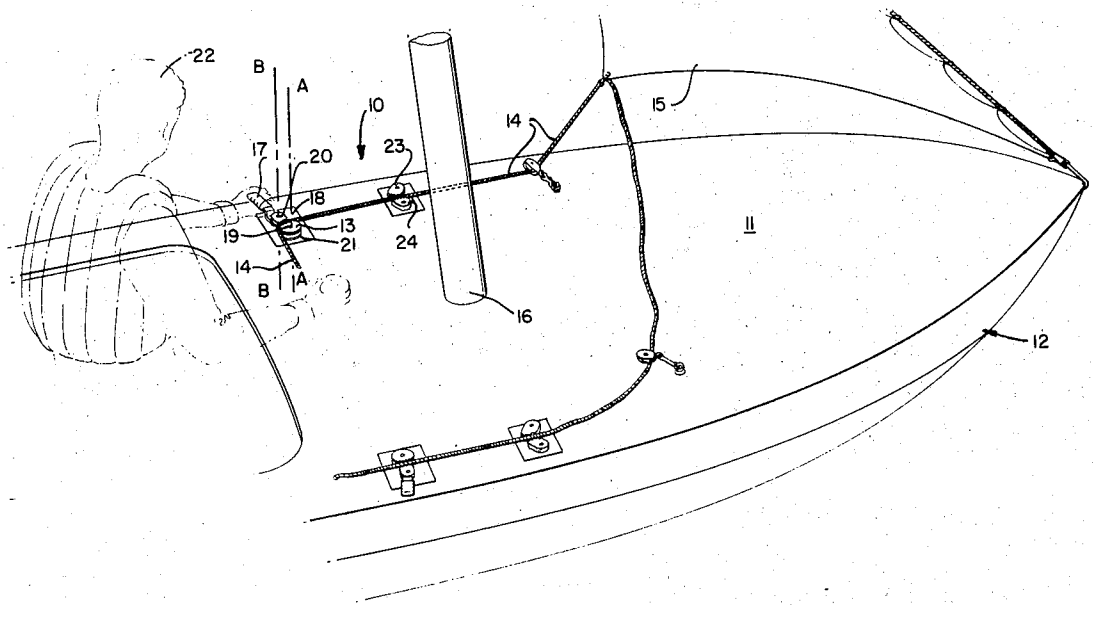


[57] **ABSTRACT**

A winch of the type for providing windup force to running rigging, such as sheets of a vessel, constitutes an elongated cylindrical winch drum pivotally attached to a stationary spindle mounted to a base or stable surface, such as a deck or the like, of the vessel, and a hand-powered leverage bar employed to rotate the winch drum about the spindle during stroking movement of the leverage bar in a first angular direction over an arcuate sector defined by a sector angle $\theta$ measured at the spindle for the purpose of tensioning the rigging connected in gripping contact with the working surface of the drum. The improvement of the present invention utilizes only a sector of the total available circumferentially extending working surface of the drum, the sector of the drum being in contact with only a small amount of the running rigging, yet providing the required amount of buildup force for performing useful work. In one aspect of the present invention, a linking assembly is utilized for permanently connecting the leverage bar relative to the spindle. The linking assembly includes a planar toggle bar. The toggle bar has an end permanently connected to the drum so that both are of rotation of substantially parallel to that of the stationary spindle. Such attachment effectively divides the leverage bar into a handle segment to which human-engendered rotational force can be applied, and a follower segment carrying a capture surface adapted to undergo swingable rotation about the knee pin means in response to operative conditions provided by the human-engendered rotational force applied at the handle segment. During operations, the capture surface travels along a double-crescent pathway, the first crescent segment has a center formation substantially coincident with the knee pin means. Its arcuate travel length terminates in intersection with the segment of the rigging disposed on the sector of the drum utilized to provide the required windup force to the rigging. The result: frictional capture of the segment of rigging between the leverage bar and the drum without the customary need to form several loops or turns of the rigging about the entire circumferential working surface drum. The second crescent pathway segment has a center formation coincident with the stationary spindle. Its travel length is defined by the common sector angle $\theta$. After the rigging is captured between the leverage bar and the drum, the rigging is rotated about the stationary spindle by corresponding rotation of the leverage bar over the sector angle $\theta$ to provide the required windup force for tensioning the rigging.

Spring-loaded cam cleats upstream from the linking assembly can be utilized to retain the running rigging in place when the leverage bar is not in capturing contact with the rigging. Such operative condition occurs when the capture segment of the bar is traveling along the aforementioned first crescent pathway segment as well as when the leverage bar is being returned to its original starting position after the running rigging has been rotated through the sector angle $\theta$.


**13 Claims, 12 Drawing Figures**



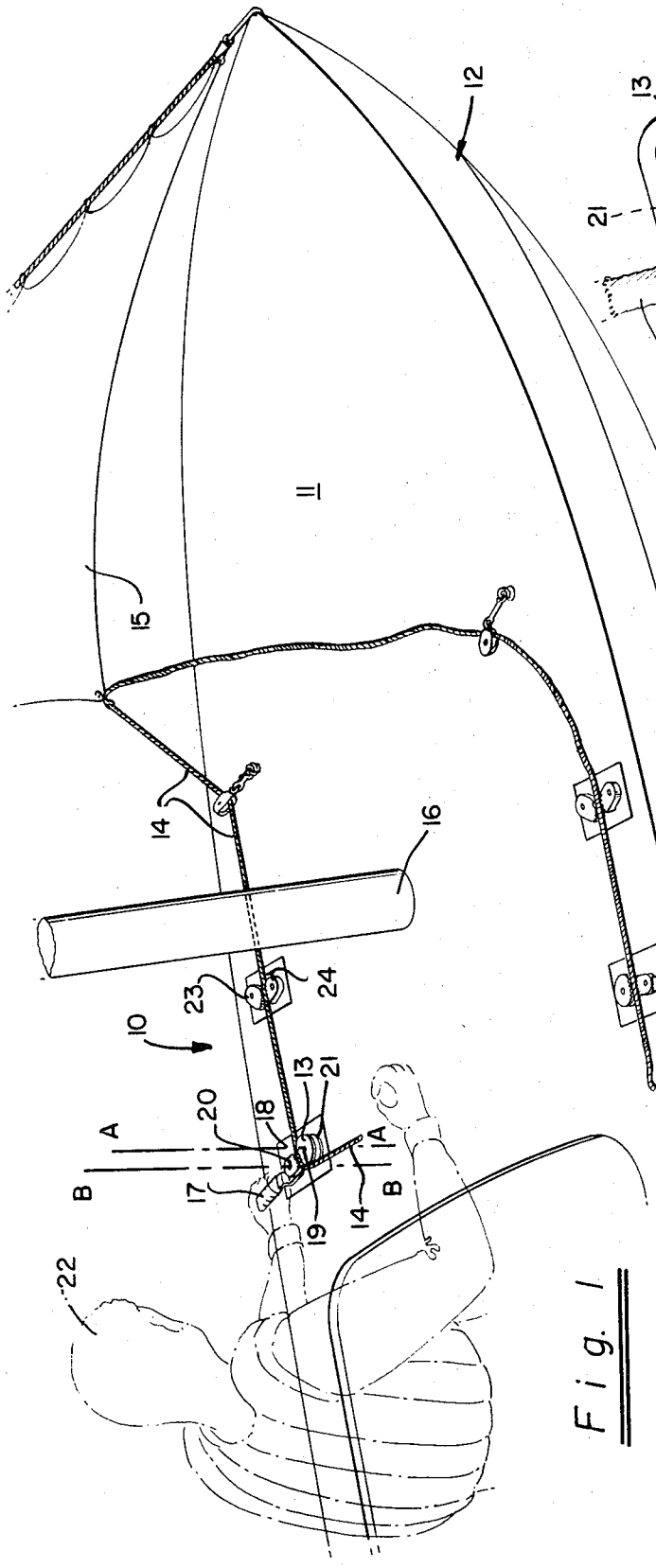

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Fig. 1

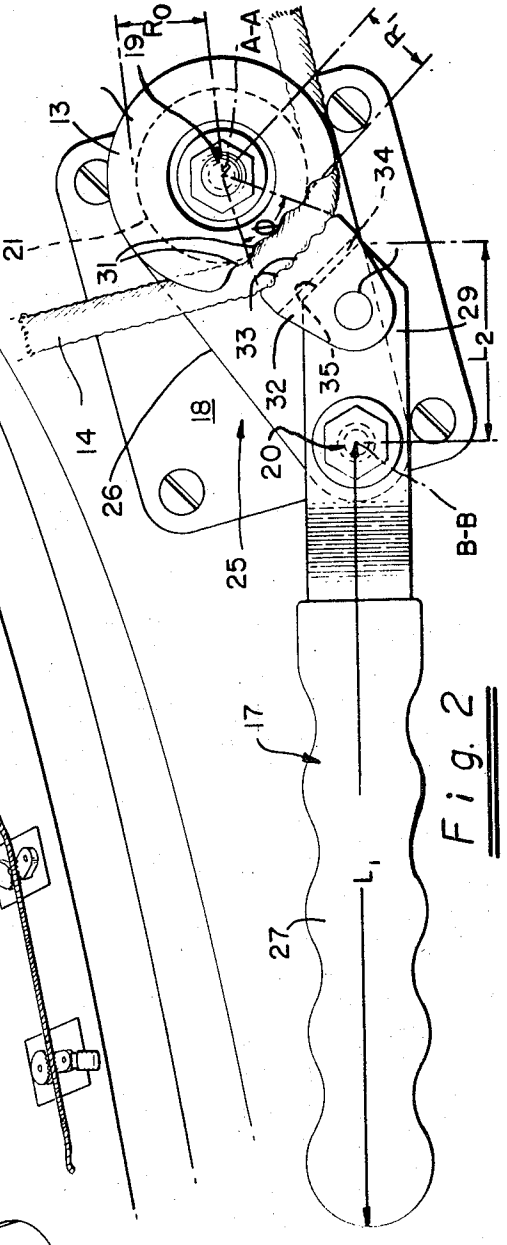

A-A
B-B
R'
R
T
θ
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32
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29
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14
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26
25
17
27
$L_1$

Fig. 2

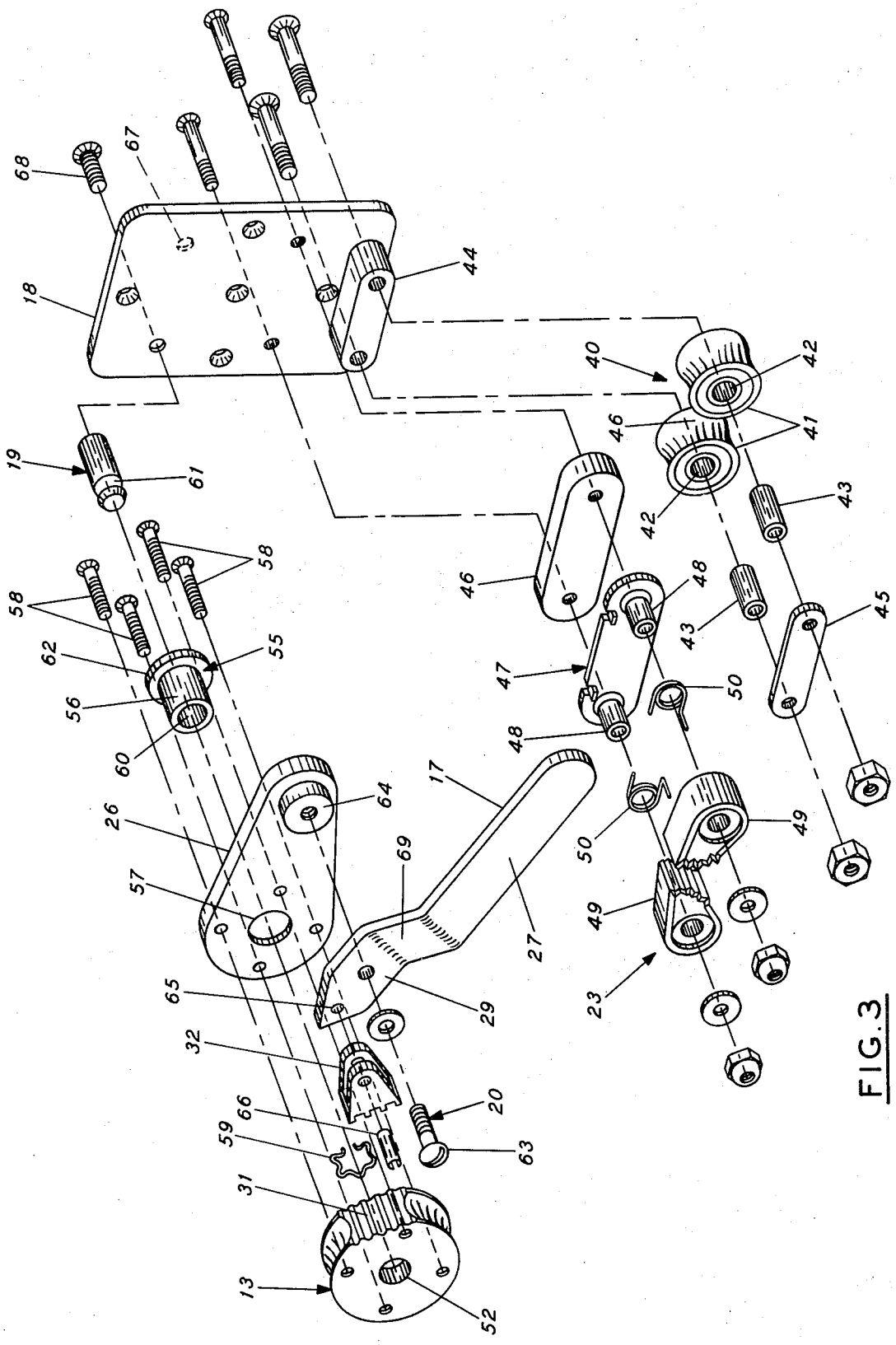

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FIG. 3

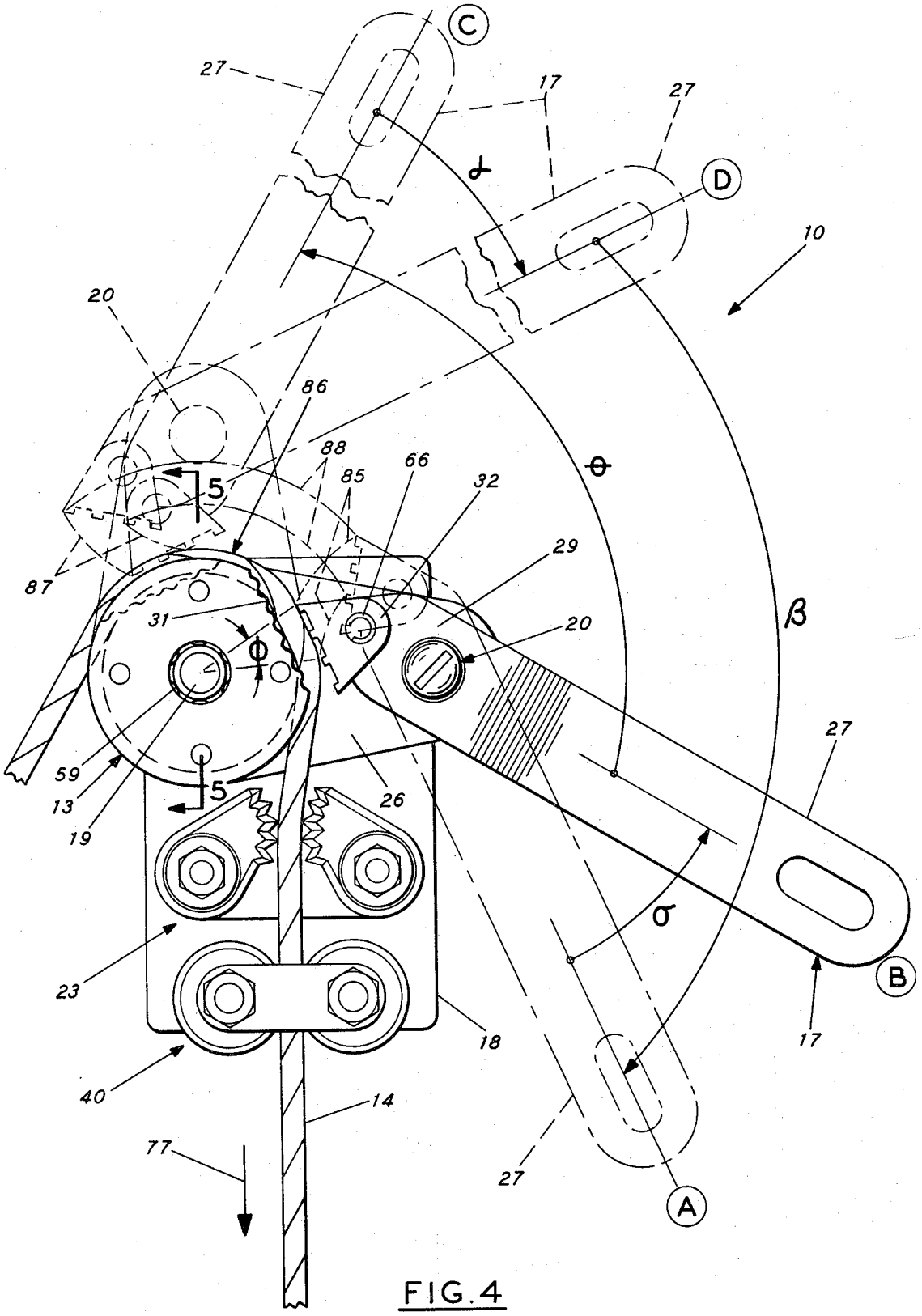

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FIG. 4

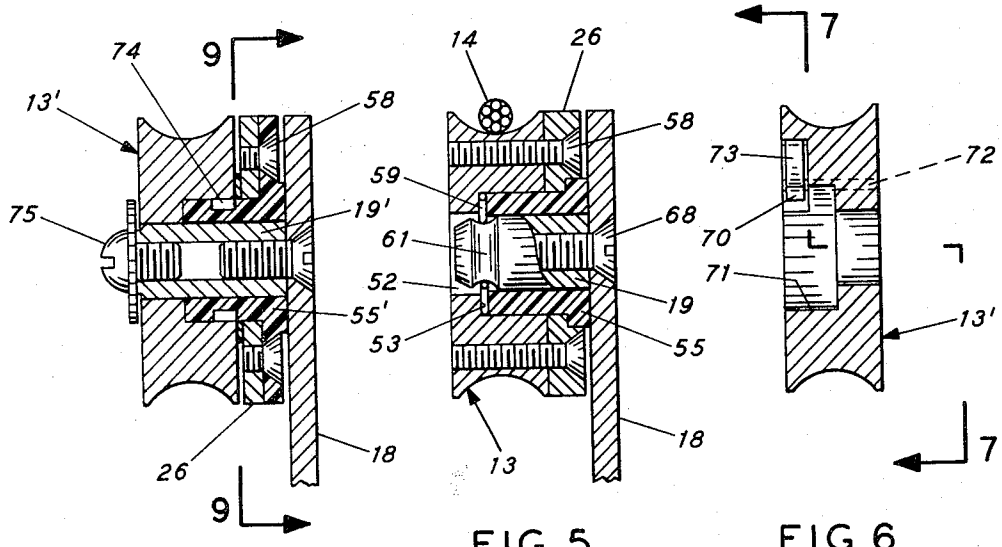



FIG.8

FIG.5

FIG.6

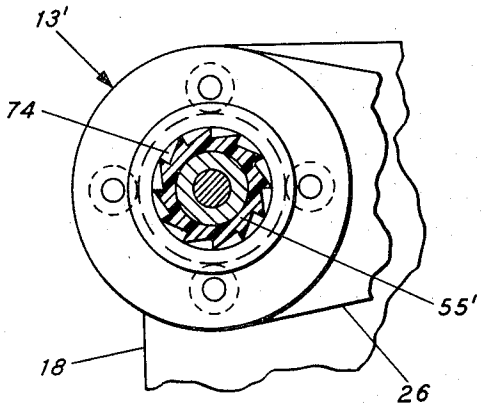



FIG.9

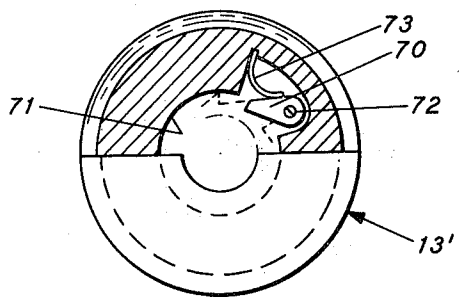



FIG.7

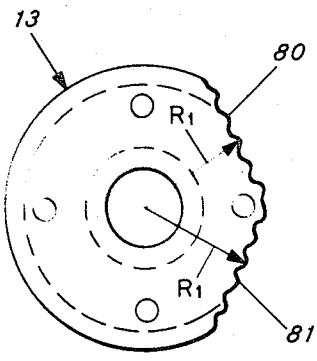



FIG.10

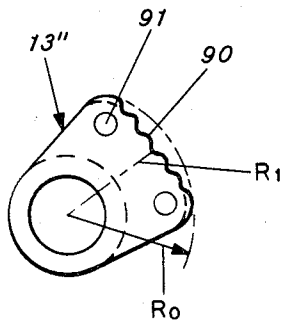



FIG.12

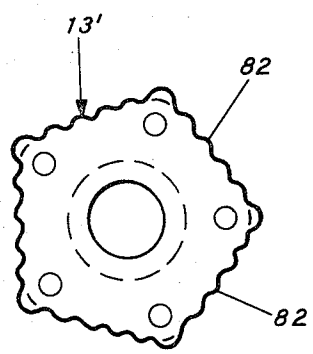



FIG.11

# WINCH MECHANISM

## FIELD OF THE INVENTION

The present invention relates to winches, windlasses, and capstans, and more particularly to a hand-powered winch for tensioning rigging of a vessel such as sheets and the like in smooth and uniform increments, utilizing only a sector of the total available circumferentially extending working surface of the winch drum in contact with only a small segment of the running rigging while retaining the winch bar or crank in a permanent mechanical relationship with respect to the winch drum or spindle.

## SUMMARY OF THE INVENTION

In accordance with the present invention, the turning bar of a drum winch is permanently affixed with respect to the winch drum or the mounting spindle, but is capable of being swingably oriented about two different axes of rotation substantially perpendicular to a stable surface, such as a deck or the like, of a vessel to perform useful work without severing mechanical connections between the bar and drum or spindle by means of a linkage assembly connected between the bar and the drum or spindle.

The linkage assembly of the present invention permits swingable rotation of the bar relative to the drum or spindle about a first axis offset from the axis of rotation of the drum but limits the degree of such rotation by the placement of the working surface of the drum in a fixed location to engage the bar along selected capture surfaces of each.

Further, the drum can be provided with a guide to place the running rigging in the plane of and between the capture surfaces of the drum and bar. Then, the linking assembly permits rotation of the drum, bar and rigging with respect to the stationary spindle or pin to provide windup tension in the rigging. During rotation of the drum and bar about the spindle, the rigging remains in gripping contact with the working surface of the drum without the need to form several loops or turns about the entire circumferential working surface of the drum as is customary. Since only a relatively small total working surface of each drum is utilized, drum design and construction as well as attendant equipment can be greatly simplified in the apparatus and method of the present invention.

In accordance with the further aspect of the present invention, the linking assembly includes a planar toggle bar permanently connected to the drum so that both are pivotal with respect to the stationary spindle. The toggle bar also includes an opposite cantilevered end pivotally connected to the leverage bar by a knee pin means forming an offset axis of rotation parallel to that of the stationary spindle. Such attachment effectively divides the bar into a handle segment to which human-engendered rotational force can be applied, and a follower segment carrying a capture segment thereon swingable about the knee pin means in a plane of rotation which intersects the working surface of the drum. The drum is of limited height above the base and is provided with a groove to place the running rigging in a working plane of rotation of the capture surfaces of the drum and the leverage bar. Angular rotation of the leverage bar about the offset axis is limited to a circumferential distance less than 360°. In the plane of rotation the capture surface of the leverage bar defines —



in essence — a double-crescent pathway of travel. The first pathway segment has a center formation substantially coincidental to knee pin means. Its arcuate travel length terminates at the intersection of the rigging and the capture surfaces of the drum and leverage bar. The second crescent pathway segment has a center formation coincidental with the stationary spindle; its travel length is, of course, defined by the common sector angle $\theta$ of the total travel of the winch drum.

In accordance with another aspect of the present invention, spring-loaded cam cleats can be positioned upstream from the linking assembly and utilized to retain the running rigging in place while the linking bar is not in capturing contact with the rigging with respect to the drum. Such conditions occur when the capturing surface of the bar is traveling along the first crescent pathway segment or when the leverage bar is being reoriented to its original starting position by retrogressive rotation of the bar with respect to the spindle.

## BACKGROUND OF THE INVENTION

Winches, capstans and windlasses have long been used on vessels to provide mechanical leverage. In its most familiar form, the winch comprises a drum rotatively mounted on a spindle and includes a winch bar installed diametrically through the drum serving as a lever arm to turn the drum.

Today's pleasure and racing vessels require the need for a capstan-like hand-powered winch for, inter alia, pulling in sheets, hoisting halyards and controlling position of the boom. Where it is desired to compete, the speed with which the various pulling functions can be performed, must be maximized.

One of the problems in applying a top-action winch (a winch having a turning bar attached to the drum at the upper end of the drum) is that the winch bar must be mechanically disconnected from the drum when release of the running rigging is desired. To couple the running rigging to the drum, it is customary to form several turns or loops in gripping contact with the working surface of the drum. As the drum is rotated, and the rigging is played over the drum, it is customary to draw off the first formed turns to prevent overwrapping by the latter formed turns so that a constant number of turns remain coupled to the drum. The removed turns constitute a standing part of the rigging as opposed to the hauling rigging attached to the drum and the object undergoing movement. When it is desired to release the loops from the drum, upward force is applied to the drum permitting them to slide from the working surface of the drum parallel to the axis of rotation in a direction away from the base of the winch. In my U.S. Pat. No. 3,536,299, there is described and claimed a drum winch which includes a linking assembly for permanently connecting a leverage bar relative to the drum but which does not interfere with release of the rigging from the drum. The assembly allows orthogonal reorientation of the leverage bar between a position of repose within the central cavity of the drum to a position atop the drum. In the latter position, the bar provides rotary motion without having its permanent mechanical connection severed relative to the drum or spindle. Release of the bar is in no way inhibited since the position of repose of the turning bar within a central cavity allows sufficient clearance of the loops with respect to the working surface of the drum. However, with the added convenience afforded by the

linkage assembly of the aforementioned patent, there has been corresponding increase in the costs attendant manufacture of such winches. Also, the need for several loops wrapped around the drum tends to require a rather large circumferential working surface depending from each drum. Aside from the additional cost, a further disadvantage of such drums relates to the face that a rather large mounting area must be available for connecting the winch relative to a stable surface such as a deck or the like. In today's modern vessels, such space may not always be available without interference with other operating equipment.

## OBJECT OF THE INVENTION

An object of the present invention is the provision of a less expensive, novel winch assembly including a linking assembly for permanently linking the turning bar relative to the winch drum or spindle during both release and leverage modes of the winch, as well as permitting modification of the drum so as to reduce the required surface area required to provide tensional force to the running rigging attached to the drum. By providing the turning bar with a first axis of rotation offset from the rotational axis of the drum and spindle, and positioning the running rigging and working surface of the drum in the plane of rotation of the bar, the running rigging can be placed in gripping contact with the bar and drum only over a small sector angle of each. While the capture surface of the drum and bar grip the rigging, the rotational axis of the turning bar is then relocated to become coincident with that of the drum and spindle. Rotation of the bar then causes corresponding rotation of the drum and rigging about the spindle.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective of the winch assembly of the present invention mounted to a deck on a vessel with a pair of cam cleats positioned upstream of the winch assembly, such cam cleats being complementary operative with respect to operations of the winch assembly;

FIG. 2 is a planned view of the winch assembly of FIG. 1, illustrating the turning bar and gripping relation with respect to the drum;

FIG. 3 is an exploded view of the winch assembly of FIG. 2 modified to provide a more compact accommodation of the winch assembly and cam cleats of FIG. 1;

FIG. 4 is a plan view of the winch assembly of FIG. 3, illustrating positional relationships of the turning bar, linking assembly and drum during various steps of operations.

FIG. 5 is a section taken along line 5—5 of FIG. 4, illustrating the mounting relationships of the drum and spindle.

FIGS. 6, 7, 8 and 9 are details of modifications useful in particular applications of the winch assembly of the present invention; FIG. 6 being a sectional view of a drum modified to provide a ratchet joint; FIG. 7 being a section taken along line 7—7 of FIG. 6; FIG. 8 being a sectional view of the assembled but modified drum of FIGS. 6 and 7 in mounting relationship with a modified sleeve member; and FIG. 9 being a section taken along line 9—9 of FIG. 8.

FIGS. 10, 11 and 12 are further details in plan view, of modifications useful in illustrating how the drum of FIGS. 2 and 3 can be modified to define different geometrical patterns in cross section.

## DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to FIG. 1. As shown, winch assembly 10 is seen to be attached to deck 11 of vessel 12. Winch assembly 10 includes drum 13 in capturing contact with sheet 14 connected to jib 15. During operation of the vessel, the broad surface of the jib 15 must be changed with respect to a plane through mast 16 to accommodate change in direction of vessel 12. During such operations, the condition of sheet 14 — in tension — can be varied by winch assembly 10 in which drum 13 is rotated about axis A—A in response to leverage force applied by turning bar 17 to provide the necessary windup force to sheet 14. In addition to drum 13 and turning bar 17, winch assembly 10 is also seen to include a base 18 and a spindle 19 about which the drum 13 rotates.

Turning bar 17 has not one but two axes of rotation: axis A—A coincident with that of drum 13 and axis B—B offset from but parallel to axis A—A. Axis B—B depends from offset pin means 20 which aids in permanently connecting the bar relative to the drum or spindle as explained in more detail below. Drum 13 is of limited height above base 18 and is provided with groove 21 to place sheet 14 in a horizontal plane coincident with the plane of rotation of the leverage bar 17 about axis B—B. The aforementioned plane of rotation also intersects a sector of the working surface of drum 13 in the plane of groove 21. Rotational force applied by operator 22 causes swingable rotation of the bar 17 about axis B—B to place the sheet 14 in a gripping relationship between the bar and drum as depicted in FIG. 1. As explained in more detail below, further application of rotational force translates the rotational axis of the bar 17 from axis A—A to axis B—B so that the drum 13, offset pin means 20 as well as turning bar 17 all rotate about spindle 19 to provide the necessary windup force to the sheet 14. While the bar 17 is undergoing rotation about axis B—B, the juxtapositioned capturing surfaces of the bar and drum are confined to concurrent planes of rotation parallel to base 18 but orthogonal to axes A—A and B—B. It should be apparent that rotation of the drum 13 about axis A—A is not unlimited. Instead drum 13 rotates in a series of incremental angular steps, each of which being less than 360° while the turning bar remains permanently affixed relative to the drum or spindle. In this way the bar cannot be mislaid or lost during the time the winch is in an inactive state.

Ahead of the drum 13, the sheet 14 is seen to pass through cleated cam means 23 mounted by a base 24 to the vessel 12 upstream from the movement of the sheet 14 as observed at the drum and spindle. Cam means 23 are of conventional design. Sheet 14 is free to proceed towards drum 13 as windup force is generated, but not in an opposite direction away from the drum and spindle. The total number of angular steps of the drum determines the total length of sheet drawn across the drum and hence the incremental distance an object attached to the sheet is moved with respect to a reference plane. It should be apparent that coupling the sheet to the drum only over a small segment eliminates the customary requirement of using several loops of the rigging about the drum. To remove segments of sheets constitute the standing part as opposed to the hauling part attached to the drum and the object undergoing movement, and to pervent premature release, groove 21 can be provided with a concave surface matching that of the sheet. Although the cleated cam means 23

prevent retrogressive movement of the sheet relative to the drum and spindle after the leverage bar is released from the drum, they in no way interfere with release of the sheet in an upward direction orthogonal to the rotating plane of the leverage bar **17**. Thus, applying upward force to the sheet **14** permits it to slide not only from the working surface of the drum **13** but also from contact with cleated cam means **23**.

FIG. **2** illustrates the operation of the winch assembly **10** of FIG. **1** in more detail. As indicated, the turning bar **17** always remains in permanent connection relative to the drum **13** or spindle **19**. In this way the bar **17** cannot be mislaid or lost during times in which the winch assembly is in an inactive state, and such permanent mechanical interconnection, in accordance with the present invention, is promoted by means of linkage assembly **25**.

Briefly, the linkage assembly **25** of the present invention includes a wedge-like toggle bar **26** pivotally mounted at one end and rotatable about the stationary spindle **19**. In the region adjacent to spindle **19**, the toggle bar **26** has a broad surface attached to the end wall of drum **13**. Such attachment may be by means of attaching screws (not shown) as well as other various attaching techniques such as welding.

At the opposite end of the toggle bar **26** is offset pin means **20** having a base (not shown) permanently attached to toggle bar **26** in a central region in pivotal contact with turning bar **17**. Not only does the offset pin means **20** pivotally mount turning bar **17** relative to toggle bar **26** but also offset pin means **20** effectively divides the turning bar **17** into a handle segment **27** of length $L_1$ and follower segment **29** of length $L_2$. Human-engendered rotational force applied to the handle segment **27** first causes angular rotation of the leverage bar about axis B—B in the direction of arrow **30**. Extent of such rotation is not unlimited, however. Drum **13** is mounted an offset distance with respect to axis B—B such that plane of rotation of the leverage bar **17** about axis B—B intersects a flattened wedge-like sector **31** cut from groove **21** of the drum **13**. This, in effect, shifts the rotational axis of the turning bar **17** from axis B—B to axis A—A. As indicated, sector **31** is positioned at minimum distance $R_1$ from axis A—A; if the drum groove **31** has a radius $R_0$, then $R_1$ is, of course, less than $R_0$. Sector **31** is spatially oriented so as to engage — in surface contact — a segment of sheet **14** on a side surface opposite to follower segment **29** of the leverage bar **17**. A sector angle $\phi$ measured at axis A—A of the drum **13** defines the intersection of contact between follower segment **29** and sheet **14**.

In order that sufficient force be developed between section **31** of the drum **13** and the follower segment **29** of the turning bar **17**, the follower segment **29** can also be provided with a U-shaped cleat **32**. The U-shaped cleat **32** is mounted with respect to the follower segment **29** such that its planar outer surface **33** is brought into surface contact with a segment of sheet **14** over sector angle $\phi$. In order to maximize frictional force generated between the follower segment **29** and the sheet **14**, the outer surface **33** can be gnarled, as by striations.

In order to provide flexibility in the assembly of the U-shaped cleat **32** relative to the follower segment **29**, limited pivotal rotation of the U-shaped cleat is provided by the limited clearance between throat **34** of the cleat **33** and sidewall **35** of the follower segment **29**. It should be apparent that capture of the sheet **14** between the U-shaped cleat **32** and drum sector **31** also serves to directly link — rotationally — the turning bar **17** with the drum **13**. By such arrangement, continued application of rotational force causes unitary rotation of the drum **13** and linkage assembly **25** about the spindle **19**.

It will be appreciated that the guiding of the sheet **14** so as to provide horizontally alignment within the plane of rotation of the follower segment **29**, can be accomplished in several ways. FIG. **3** illustrates the second embodiment of the assembly of the present invention in which guide roller assembly **40** in conjunction with cleated cam means **23** are positioned in close proximity to drum **13**. As shown, the guide roller assembly **40** as well as cleated cam means **23** can be mounted to the same base **18** as spindle **19**. As indicated, rollers **41** are provided with central bores **42** into which are mounted tubular shafts **43**, the remote end being positioned at the upper surface of offset block **44** while the near end is in contact with guide bar **45**. Moreover, the rollers **41** are positioned such that an opening is defined between the adjacent curve surfaces of the rollers **41** into which the running rigging can be disposed for passage to cleated cam means **23**. As shown, cleated cam means **23** include a support **46** to which is attached twin spindle support **47** to which. Twin spindle support **17** is provided with dual mounting shafts **48** to which cleats **49** can be rotatably mounted. Spring loading of the cleats **49** is provided by springs **50**, each having terminals in capturing contact with stops on each cleat **49** and support **47**.

Height of the drum **13** relative to base **18** must be correlated with the position of roller assembly **40** and cleated cam means **23** so as to properly guide the running rigging relative to the surface of base **18**. In this regard, drum **13** is provided with a central bore **52** enlarged over a central region to form a shoulder **53**, see FIG. **5**. Into the enlarged portion of the bore **52**, the drum receives flanged support sleeve **55**. Sleeve **55** is preferably formed of a material having a low coefficient of friction such as Teflon, a trademark of E. I. DuPont de Nemours, and is provided with exterior surface **56** in press fitting contact with bores **52** and **57** of the drum **52** and toggle bar **26**, respectively. Rigidly mounting toggle bar **26** closer to drum **13** is by means of a series of machine screws **58**. Prior to such attachment, however, a star spring **59** is inserted at the shoulder **53** (FIG. **5**) of the drum **13**. In that manner after sleeve **55** has been placed adjacent to shoulder **53**, the spring **59** is locked at a relative height with respect to the base **18**. Sleeve **55** also includes a central bore **60** of correct dimensions to fit about spindle **19** so that spring **59** is disposed within groove **61** of the spindle. However, due to the loose fit between spring **59** within groove **61** on spindle **19**, the axial bearing surface for the drum **13** is at enlarged head **62** of the sleeve **55**. Since the sleeve is formed of a material having a low coefficient of friction, the sleeve — and hence, drum — freely rotates about the spindle **19** even though in broad surface contact with base **18**.

It will be appreciated that positioning roller assembly **40** adjacent to cleated cam means **23** on the same base **18** as spindle **19** can inhibit complementary operation of the drum **13** relative to turning bar **17**. The term "complementary operation" refers to the fact that the turning bar **17** should have the capability of being able

to be turned in rotation by an operator using either his left or right hand. It should be apparent that operation in either a left-handed or right-handed mode is dependent upon the spatial location of the capture surfaces of the U-shaped cleat **32** on turning bar **17** as well as sector **31** of the drum **13.** In this regard, the leverage force provided by movement of the turning bar **17** is proportional to the magnitude of the force to be applied to the rigging by the operator's right or left hand.

It is also desirable that the frictional linkage between the cleat **32** in sector **31** have good mechanical characteristics. Accordingly, it is preferred that the orientation of the cleat relative to the sector **31** at one end provide full surface attachment to the rigging when the turning bar **17** is pivoted with respect to pin means **20.** As shown in FIG. **3,** pin means **20** includes a machine screw **63** threadable into enlarged lip **64** of the toggle bar **26.** When assembled, the pin means **20** effectively divides turning bar **17** into a handle segment **27** and a follower segment **29** as previously explained, with the follower segment being such that its terminous end is provided with an opening **65** into which U-shaped cleat **32** can be secured as by key pin **66.** It should be noted that U-shaped cleat **32** can be attached to either side of the terminous of the follower segment depending on whether right-handed or left-handed operations are contemplated. In this regard, it should be apparent that spindle **19** would have to be reoriented from its position relative to the base **18** as the winch is changed from a right-handed mode to a left-handed operating mode. For that purpose, phantom hole **67** is provided in the base **18** for the purpose of allowing the spindle **19** to be secured thereto by means of screw **68.** After spindle **19** has been relocated to change operating mode, the turning bar **17** can be easily reoriented without loosening offset pin means **20** relative to toggle bar **26.** Simply removing key pin **66** and to reorient U-shaped cleat **32** and then applying angular movement to the turning bar as viewed in FIG. **3** places the winch in condition for orientation in a complementary mode. In this regard, note that turning bar **17** of FIG. **3** is provided with a step **69** positioned along handle segment **27** of sufficient elevation to allow the turning bar handle to pass over drum **13** even while the turning bar remains pivotally fixed relative to toggle bar **26.** That is to say, the elevated handle segment of the turning bar is permitted to ride over the drum **13** during clockwise rotation of the handle, as the operating mode of the winch is changed.

In order to accommodate such changes in operation, drum **13** may be modified by forming justapositioned sectors **80, 81** in the manner illustrated in FIG. **10.** As shown, Sector **80, 81** define flattened surfaces of minimum radius $R_1$. Each sector **80, 81** is conjunctive with the turning bar, is used to capture and hold rigging depending on the operating mode of the winch. Yet the drum **13** always remains fixedly attached to toggle bar **26** of FIG. **3** during the orientation of the turning bar **17** required to effect change in operating mode.

To further aid in adding flexibility to the operation of the winch assembly of the present invention, the quick-release feature of the present invention provided by spring clip **59** of FIG. **3** relative to groove **61** of the spindle **19,** is of consequence. Release of the drum **13,** as well as turning bar **17** and toggle bar **26,** from the spindle **19** is provided by a lifting force applied upward parallel to the axis symmetry of the spindle away from base **18.** Where the vessel is positioned in an unsecured area, the quick release feature is often very useful in preventing loss of operations of the winch assembly since the drum **13,** turning bar **17** and toggle bar **26** — as a unit — can be easily removed from contact with the stationary spindle **19** and stored in a secure storage area adjacent to the vessel.

When the drum **13** is mounted relative to spindle **19,** it is apparent that both clockwise and counterclockwise rotation of the drum **13** about the spindle is permitted. However, where it is desirable that drum **13** rotate in only one direction, say counterclockwise as viewed in FIG. **3,** modification of sleeve **55** and the drum **13** in accordance with FIGS. **6, 7, 8** and **9** is desirable so as to provide a ratcheting joint. From FIGS. **6** and **7** drum **13'** is seen to be provided with a pawl **70** at a selected circumferential position at sidewall **71.** Pawl **70** is pivotally mounted relative to the sidewall **71** by pin **72** and has an inherent inclination for rotation by positioning a leaf spring **73** at one side in contact with sidewall **71.** In FIGS. **8** and **9,** sleeve **55'** is seen to have an exterior wall provided with a rack **74.** Dependent upon the direction of relative movement, the pawl **70** of FIGS. **6** and **7** thus can be "locked" into one of the pockets of rack **74** or can ride from one to the other. E.g, when the turning bar **17** is to be rotated in a counterclockwise direction as viewedin FIG. **2,** the pawl **70** of FIG. **7** can seat into one of the pockets of the rack **74** of FIG. **9.** Thus, the drum **13'** of FIG. **8** is "locked" relative to the sleeve **55'.** Retrogressive movement of the turning bar and sleeve **55'** relative to the drum **13'** is permitted, however, when an opposite force is applied to the turning bar, as when the turning bar, after providing windup force, is returned to its original position to start another stroke. Then, the pawl **70** rides from pocket to pocket within the rack **74.** Drum **13'** remains fixed in height relative to spindle **19,** however, as by a machine screw-washer joint **76.** It should be apparent that the force due to placing in surface contact the sheet relative to drum **13'** also contact the sheet relative to drum **13'** also aids in preventing relative corresponding movement of the drum **13'** about the spindle **19** as the sleeve **55'** undergoes retrogressive rotation. Since the turning bar and sleeve **55'** must be independent of rotation relative to the drum **13',** the machine screws **58** must be shortened in the manner depicted in FIG. **8.**

Other drum modifications are also possible. E.g, since to drum **13'** of FIG. **8** remains stationary with respect to the spindle **19** as the turning bar and sleeve **55'** undergo retrogressive movement about the spindle **19,** the exterior of the drum in contact with the rigging need not be cylindrical orientation. That is, the drum **13'** can have a pentagonal cross section as depicted in FIG. **11** in which a series of sectors **82** are formed. The extent of rotation of the drum **13'** per stroke of the turning bar must be synchronized with the position and extent of each sector **82** so as to allow maximum surface engagement relative to the U-shaped cleat **32** attached to the turning bar **17** (FIG. **3**). Since the length of each sector **82** is dependent upon several factors including, inter alia, (i) the size of the U-shaped cleat as well as (ii) the diameter of the drum, the exterior working surface, in cross section, can also define a number of other geometrical figures such as a triangle, a square, etc.

FIG. **4** illustrates the operational seequence in the use of the winch assembly **10** of the present invention.

As indicated, turning bar 17 is not allowed to rotate a full 360°. Instead, angular incremental steps over common arcuate angle designated angle $\theta$ measured with respect to spindle 19 in the working plane of rotation of the U-shaped cleat 32 attached to turning bar 17, are used. As indicated, the U-shaped cleat 32 grips sheet 14 over an incremental sector angle $\phi$ measured at the contacting surfaces of the sheet 14 and U-shaped cleat 32 and maintains such capture linkage throughout rotation of the drum 13 and turning bar 17 through common angle $\theta$. After each incremental step, the rigging 14 is released by clockwise rotation of the turning bar relative to the offset pin means 20 over an angle $\alpha$ whereby the turning bar 17 undergoes an incremental rotational movement equal to the angle $\alpha$; thereafter the turning bar 17 is rotated in a clockwise direction through yet another angle $\beta$ to return the turning bar 17 and toggle bar 26 to an original position where the operative steps may be repeated. In order to repeat operation, the turning bar 17 must first be placed in capturing contact with the sheet 14; this is done by the turning bar being angularly rotated through an angle $\sigma$ relative to the offset pin means 20.

In order to better understand the operative steps in accordance with the winch assembly of the present invention, a detailed description of the rotational movement of the turning bar 17 during each of the aforementioned operations may be instructive.

Rotation Over Angle $\sigma$

The initial position of turning bar 17 is depicted in phantom line at position A. In such position, rigging 14 is disposed in firm contact with cleated cam means 23 so as to resist a tensile force ($F_t$) acting in the direction of arrow 77. Toggle bar 26 is pivotally mounted at one end to spindle 19 and at the other end to the turning bar 17. It should be apparent that the turning bar 17 and the toggle bar 26 in their initial positions have intersecting vertical planes of reference which pass through their axis of symmetry, and that these reference planes are offset from each other. That is, vertical plane of reference of the toggle bar 26 would pass through the spindle 19 as well as offset pivot means 20; likewise, a plane of reference of turning bar 17 passes through offset pivot means 20 intersecting the first-mentioned plane of reference. As turning bar 17 swings around offset pivot means 20 to travel from position A to position B handle segment 27 undergoes movement over angle $\sigma$. That these planes of reference tend toward axial alignment reaching a maximum degree of alignment at position B, is readily apparent from FIG. 4. The operation of the turning bar 17 and toggle bar 26 over angle $\sigma$ thus is — in essence — representative of a toggle joint, the "knee" of which constitutes offset pin means 20.

During operation of the aforementioned toggle joint, a pathway of travel 85 of the capture surface of U-shaped cleat 32 is seen to terminate at sheet 14. The capture surface of the U-shaped cleat 32 which defines pathway 85 is defined by the section angle $\phi$ measured at spindle 19.

At the position B sufficient force is exerted by handle segment 27 of the turning bar 17 to create a friction force ($F_c$) on sheet 14 of a magnitude greater than and in an opposite direction to the tensioning force ($F_t$) acting on the sheet 14 in the direction of arrow 77. As previously mentioned, the follower segment 29 has a length $L_2$ substantially less than length $L_1$ of handle segment 27. Thus, the magnitude of the frictional force ($F_c$) can be many times the magnitude of any rotational force applied to the handle segment 27. In this regard, any magnification factor (C) must be greater than unity and, moreover, is equal to the distance (in the plane of rotation of the U-shaped cleat 32) between the offset pivot means 20 and the handle segment 27 where the rotational force is applied over the distance (in the same plane of rotation) between the pivot means 20 and the capture surface of the U-shaped cleat 32 where capture force is applied.

Arcuate pathway 85 has a center formation coincident with the axis of rotation of offset pivot means 20; however, a limited extent. Accordingly, in some application where, for example, the sheet 14 is of a relatively large diameter, the center of formation of the pathway 85 may be slightly shifted from coincidence with pin means 20.

Rotation Over Angle $\theta$

When the turning bar 17 ceases rotation about offset pivot means 20, sufficient leverage or bias force is generated through U-shape cleat 32, rigging 14 and sector 31 of drum 13 measured over angle $\phi$ so as to generate the required magnitude of frictional force ($F_c$). Such condition effectively "locks" the turning bar 17 relative to the drum 13 during further rotation of the turning bar over the angle $\theta$. But the magnitude of the rotational force applied by turning bar 17 to effect capture, is quite small compared to that remaining for rotation of the drum 13, rigging 14 and turning bar 17 about spindle 19. The force applied to the handle segment 27 of the turning bar 17 comprises two constituents, a primary force ($F_1$) equal to the magnitude of force required to rotate the drum 13, rigging 14, toggle bar 26 and turning bar 17 about spindle 19, and a secondary force ($F_2$) which establishes the frictional force at the capturing surfaces of the turning bar 17 and drum 13. Due to the geometry of the lengths of the follower segment 29 and the handle segment 27, the magnitude of the primary force ($F_1$) is of a sufficient magnitude to establish a rotational torque (T) to cause rotation of the assembly defined by angle $\theta$. In this regard, the rotational torque (T) is equal to

$$F_1 \times D_3$$

where $F_1$ is the primary force as defined hereinbefore and $D_3$ is the distance from the spindle 19 to projected central point of application of rotational force at handle segment 27 of the turning bar 17.

During rotation about spindle 19, it is apparent that the effective axis of rotation of the turning bar 17 has shifted from offset pin means 20 to become coincident with that of drum 13 about spindle 19. That a second toggle joint — in essence — has been formed is also apparent, the toggle joint constituting two linear elements having offset planes of reference, one such element constituting segments of the drum 13, rigging 14 and U-shaped cleat 32 defined by and depending from sector angle $\phi$, while the other element constituting the turning bar 17.

Rotation of the handle segment 27 of the turning bar from position B to position C, defines a further pathway of travel 86 of the capture segment of the U-shaped cleat 32 coincident with the exterior surface of sheet 14. The pathway 86 is seen to have a center of forma-

tion coincident with the axis rotation of spindle **19**. It is readily apparent that cleated cam means **23** do not grip or restrain the sheet **14** during rotation of the turning bar over angle $\theta$. Turning bar **17** terminates at position C of FIG. **4**.

### Rotation Over Angle $\alpha$

Retrogressive movement of the handle segment **27** of the turning bar **17** over the angle $\alpha$ is seen to cause the capture segment of U-shaped cleat **32** to travel along pathway **87** defining a center of formation at offset pin means **20**. In effect, rotation about the offset pivot axis **20** over angle $\alpha$ releases the sheet **14** from capturing contact between the drum **13** and the turning bar **17**. I.e., the toggle joint defined by and depending from sector angle $\phi$ when the turning bar **17** is at position C of FIG. **4** is dissolved as the turning bar rotates relative to offset pivot means **20** to position D. Simultaneously, the cleated cam means **23** reestablish restraining contact with the sheet **14** and prevents retrogressive movement in the direction of arrow **77**. dissolved as the turning bar rotates relative to offset pivot means **20** to position D. Simultaneously, the cleated cam means **23** reestablish contact with the sheet **14** and prevents retrogressive movement in the direction of arrow **77**.

### Rotation Over Angle $\beta$

After the second toggle joint has been dissolved by retrogressive movement of the turning bar **17** about the pivot means **20**, the turning bar undergoes further retrogressive movement to return the turning bar **17**, toggle bar **26**, as well as drum **13**, to their original positions at position A. In order to cause such retrogressive rotation, it is apparent that the force applied to handle segment **27** at position D must have a component of force acting parallel to the axis symmetry of the turning bar **17**. Such force acts through pivot means **20** and toggle bar **26**. Since drum **13** is affixed to the turning bar **17** through toggle bar **26**, the retrogressive movement of the turning handle is also translated to the drum **13**. In this regard, it is noteworthy to mention that the capture segment of the U-shaped cleat **32** defines yet another arcuate pathway **88** during travel over angle $\beta$, i.e., from position D to position A. As the capture surface of the U-shaped cleat **32** is reoriented, arcuate path **88** is seen to be centered coincident with the axis of rotation of spindle **19**. The cleated cam means **23** remain in firm contact with the sheet **14**. Thus, as the turning bar **17**, toggle bar **26** and drum **13** are reoriented from position D to position A, the drum **13** is caused to ride over sheet **14**. The drum **13** and turning bar **17** is then in position to initiate a new operational ("stroking") cycle.

It is apparent that all arcuate pathways **85, 86, 87** and **88** have a common plane coincident with plane of rotation of the U-shaped cleat **32**. By this it is meant that these pathways lie in a common plane substantially orthogonal to the axis of rotation of spindle **19** yet intersecting sheet **14** at its intersection with the sector **31** of drum **13**.

Modifications

In order to further reduce drum costs, drum **13** can be modified in accordance with the modification depicted in FIG. **12**. As shown, drum **13''** is a pie-shaped wedge cut from an imaginary cylinder of radius $R_0$. Such pie-shaped wedge has an outer surface **90** having a minimum distance $R_1$ where $R_1$ is obviously less then $R_0$. Outer surface **90** is used in conjunction with the turning bar to effect discontinuous capture of the sheet **14** of FIGS. **2** and **3**. Drum **13''**, of course, requires a mounting scheme which fixedly secures it relative to the sleeve **55** and the hub **13** of the assembly of FIG. **4**. For this purpose, mounting holes **91** are provided through which mounting screws (not shown) project.

Although certain embodiments of the present invention have been illustrated and described, the invention is not meant to be limited by these embodiments, but rather by the scope of the following claims.

What is claimed is:

**1.** In a winch of the type for providing windup force to running rigging such as sheets, halyards, and the like of a vessel, having an elongated cylindrical hub pivotally attached to a stationary pin mounted to a base or stable surface such as a deck or mast or the like of said vessel, and a hand-powered leverage bar employed to rotate said hub about said pin about a first axis rotation in incremental angular stroking steps each being in a first angular direction over an arcuate sector measured at said secondary pin for the purpose of tensioning said rigging disconnectably connected in gripping contact with a working surface of said cylindrical hub in a working plane of rotation substantially transverse to said first axis of rotation, the improvement which utilizes only a sector of total circumferential working surface of said hub in contact with only a small segment of said running rigging to provide required windup force, comprising:

a. a linking assembly permanently connecting said leverage bar relative to one of said hub and stationary pin and including a planar toggle bar and a knee pin means, said toggle bar having a broad top wall surface permanently connected at one end to said hub and including a first wall means at said one end in pivotal engagement with said stationary pin, said knee pin means having a base connected to said toggle bar at an opposite end cantilevered from said stationary pin and a central elongated wall means depending from said base pivotally connected to said leverage bar along a second axis of rotation substantially parallel to said first axis of rotation,

b. said leverage bar attaching to said knee pin means at a point intermediate to ends thereof to define a handle segment to which human-engendered rotational force can be applied, and at an opposite end, a follower segment carrying a capture surface thereon adapted to undergo swingoff rotation in response to operative conditions, provided by said human-engendered rotational force which defines a double-crescent pathway in said plane of rotation, said double-crescent pathway including a crescent pathway segment having a center of formation substantially coincident with said knee pin means and an arcuate travel length terminating in intersection with said segment of rigging disposed on said sector of said working surface of said hub thereby permitting frictional capture of said segment of rigging between said follower segment of said leverage bar and said sector of working surface of said hub, and a second crescent pathway segment having a center of formation coincident with said stationary pin and having a selected arcuate travel length whereby said captured segment of running rigging can be carried in rotation about

said stationary pin over said sector angle $\theta$ during each incremental arcuate step of said leverage bar and thus be provided with windup force for tensioning said running rigging.

2. Improvement of claim 1 in which said hub is a wedge of a cylinder of radius R, said wedge defining an outer surface forming said working sector of said hub and including near wall means having an axis of symmetry substantially coincident with an axis of formation of said outer surface, said near wall means being positioned in pivotal contact with said stationary pin.

3. Improvement of claim 1 further characterized by said toggle bar means between said hub and said leverage bar being adapted to be operative in response to human-engendered return force applied to said handle segment of said leverage bar in a second angular direction opposite to said first direction so as to cause retrogressive counterrotation of said hub thereby returning said hub to its original work position, said human-engendered return force having a component of force parallel to the axis of symmetry of said leverage bar to cause said retrogressive counterrotation of said hub.

4. Improvement of claim 1 in which said hub is a modified cylinder of radius $R_0$ having a central wall means in contact with said stationary pin and an outer circumferential surface remote from said central wall means modified to include a flattened sector at a minimum radial distance $R_1$ from said central wall means where $R_1$ is less than $R_0$, said flattened sector comprising said segment of working surface of said hub onto which said segment of running rigging is disconnectably connected in said plane of rotation.

5. Improvement of claim 4 in which said capture surface of said leverage bar is further characterized by a wedge-like cleat means pivotally attached to said follower segment of said leverage bar, said wedge-like cleat means having an axis of rotation substantially transverse to said working plane of rotation and includes a planar surface remote from said axis of rotation adapted to operatively contact said segment of running rigging at a side diametrically opposite to said flattened sector of said hub thereby effecting rigid engagement of said running rigging relative to hub during rotation about said stationary pin.

6. Improvement of claim 5 in which said outer circumference surface of said modified cylindrical hub absent said flattened sector is provided with a groove means over a central region thereof for maintaining said running rigging in alignment with said plane of rotation as said hub and leverage bar undergo rotation in said first direction.

7. Improvement of claim 5 in which said cleat means includes associated means for limiting arcuate rotation of said cleat means relative to said follower segment of said leverage bar during arcuate travel along said double-crescent pathway in said plane of rotation, whereby correct orientation can be maintained.

8. Improvement of claim 1 in which said knee pin means pivotally attaching said leverage bar relative to said hub is further characterized by its being positioned longitudinally nearer to said capture surface of said leverage bar than to said handle segment whereby said capture surface of said follower segment can be maintained at capturing contact with said running rigging using a minimum component of said human-engendered rotational force.

9. Improvement of claim 8 in which said capture surface of said leverage bar in contact with said segment of running rigging, generates a frictional force ($F_c$) having a magnitude greater than and in an opposite direction to tensioning force ($F_t$) acting at a remote end of said running rigging.

10. Improvement of claim 9 in which said frictional force ($F_c$) is a direct function of said human-engendered force (F) applied to said handle of said leverage bar and of a factor (C) greater than unity in the equation $C = L_1/L_2$ where $L_1$ is the distance in said plane of rotation from said knee pin means to a central projected location of said human-engendered rotational force at said handle segment and $L_2$ is the distance in said plane of rotation from said knee pin means to a central point of said capture surface of said leverage bar.

11. Improvement of claim 10 in which said human-engendered force (F) applied to said handle segment of said leverage includes a bias force ($F_1$) and a rotational force ($F_2$), operative during rotation of said hub and leverage bar about said stationary pin means wherein bias force $F_1$ is the force which establishes said frictional force ($F_c$) at said capture surface of said leverage bar, and rotational force $F_2$ is the force for rotating said hub, said running rigging, said leverage bar and said linking assembly in unitary rotation about said stationary pin.

12. Improvement of claim 11 in which said rotational force ($F_2$) must be sufficient in magnitude to establish a rotational torque (T) to cause unitary rotation of said hub, said running rigging, said linking assembly and said leverage bar about said stationary pin, said rotational torque (T) being equal to

$$F_2 \times D_3$$

where $F_2$ is as defined above and $D_3$ is the distance from said stationary pin to a projected central point of application of said rotational force $F_2$ in said plane of rotation.

13. Improvement of claim 8 in which the leverage bar is further characterized by step means formed in said handle segment so positioned with respect to said knee pin means so as to allow said handle segment of said leverage bar to ride over said hub during counterrotation of said leverage bar in a second direction opposite to said first direction to thereby reorient said leverage bar from a right-hand position of operation to a left-hand operating position with respect to said hub and said stationary pin.

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