United States Patent

Morgan

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[45] **Apr. 18, 1972**

[54] MULTISPEED WINCH

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[52] **U.S. Cl.** .....**192/17 R,** 74/116, 74/142, 192/114, 254/150 R

[51] **Int. Cl.**.....**F16d 67/02,** F16h 29/04, B66d 1/24

[58] **Field of Search**.....192/17 R; 74/116, 117, 142; 254/150 R

[56] **References Cited**

UNITED STATES PATENTS

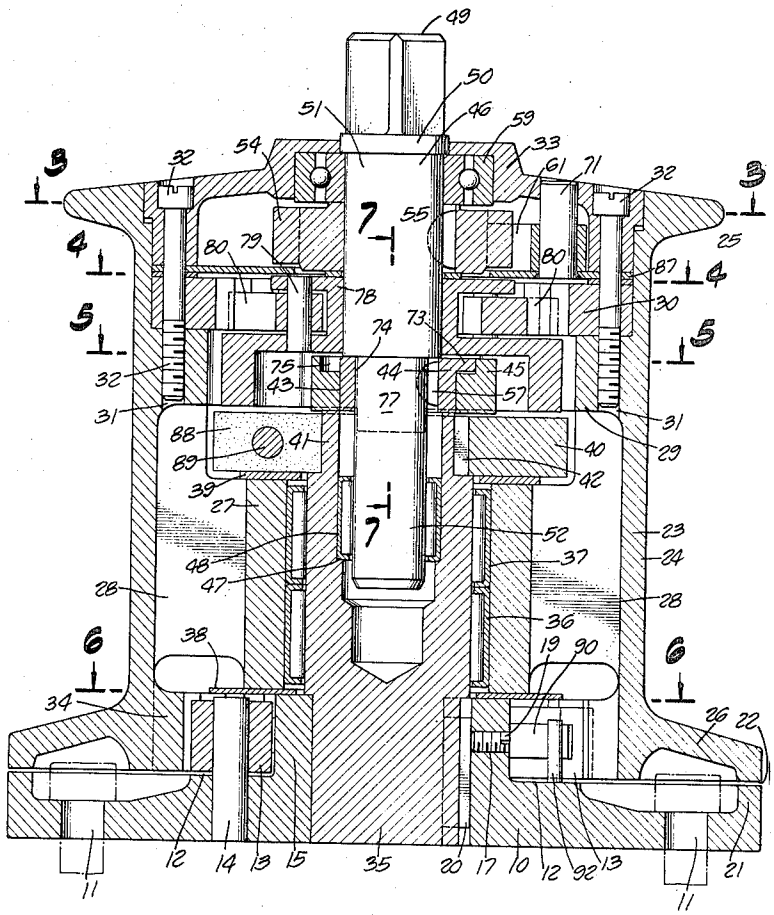
217,026	7/1879	Stuart	74/116 X
637,477	11/1899	Newman	74/117
659,079	10/1900	Lieb	74/116
1,735,923	11/1919	Helgeby	74/116
2,081,373	5/1937	Viscasillas	74/117
2,933,931	4/1960	Lisinski	74/116

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[57] **ABSTRACT**

There is disclosed herein a multispeed winch using a mechanical power transmission device which provides a unidirectional output and two transmission ratios selected by changing the direction of the input motion. The transmission device uses a cam capable of two eccentricities and a pawl and ratchet wheel mechanism to provide the two transmission ratios. A direct drive is also provided by locking the winch drum to the input shaft.

9 Claims, 10 Drawing Figures



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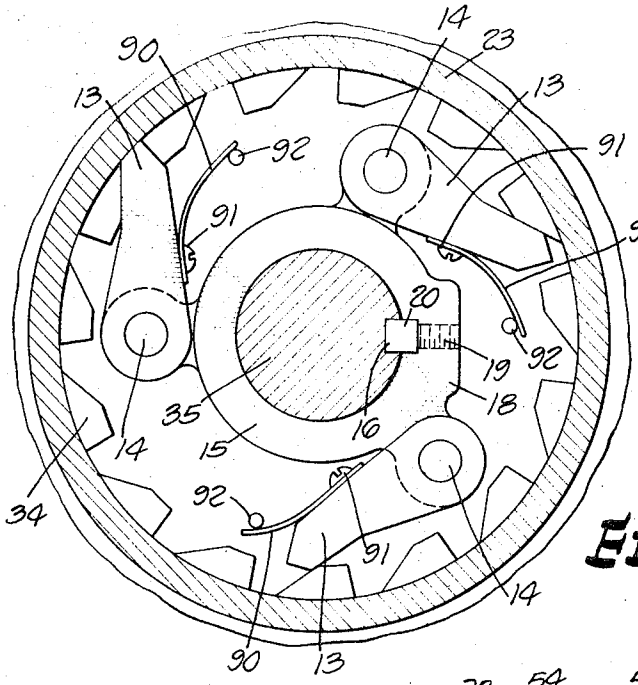
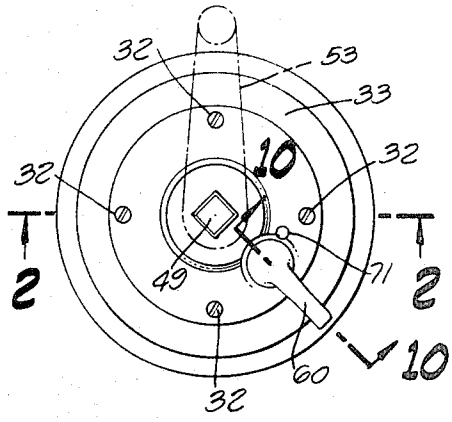


FIG. 6.

FIG. 1.



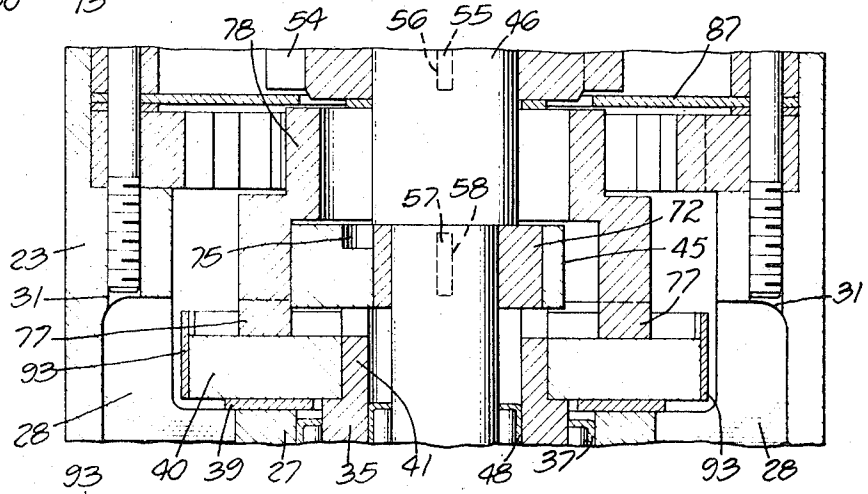


FIG. 7.

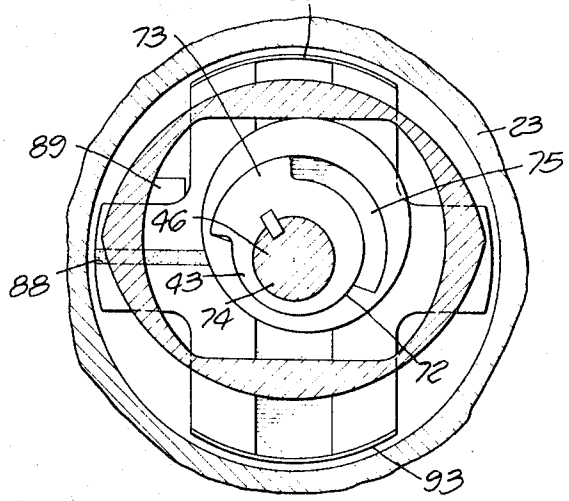


FIG. 8.

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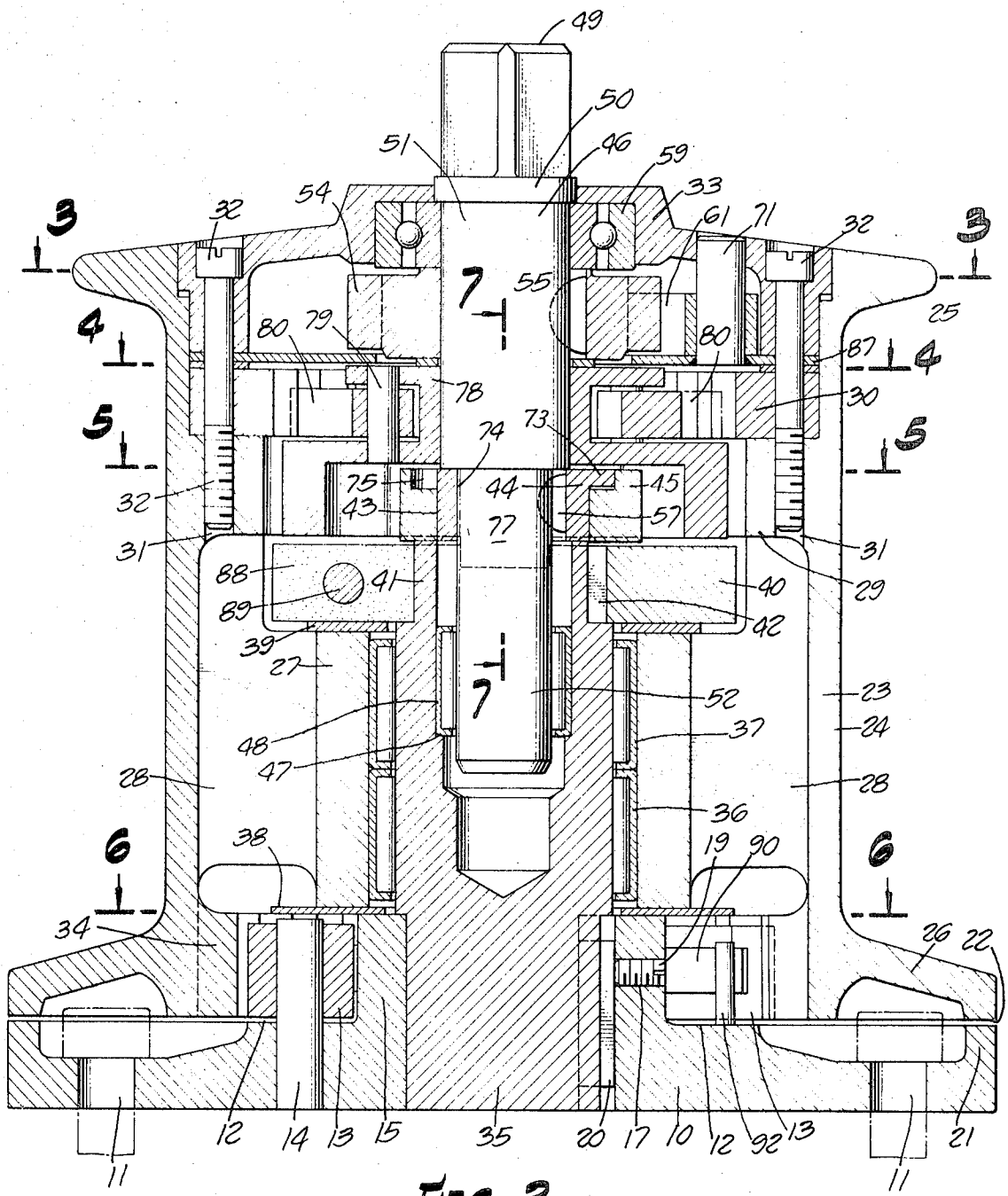


FIG. 2.

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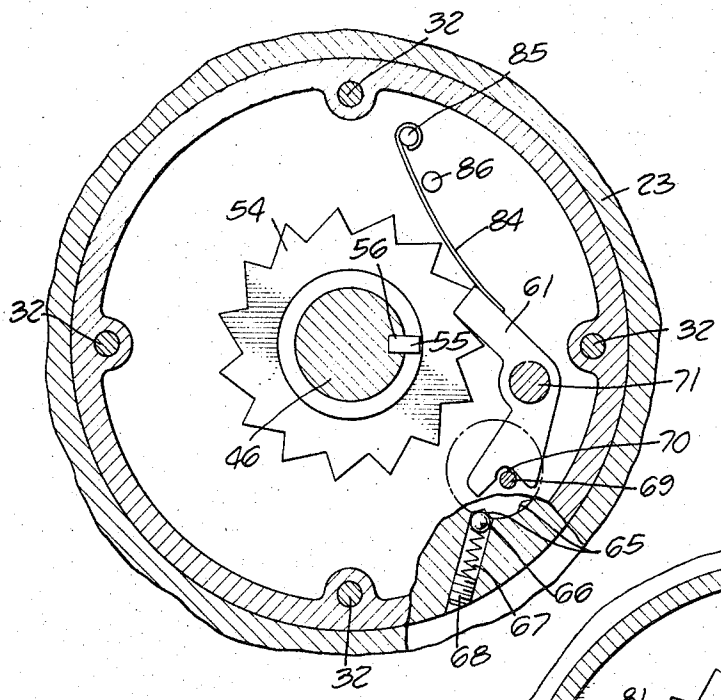


FIG. 3.

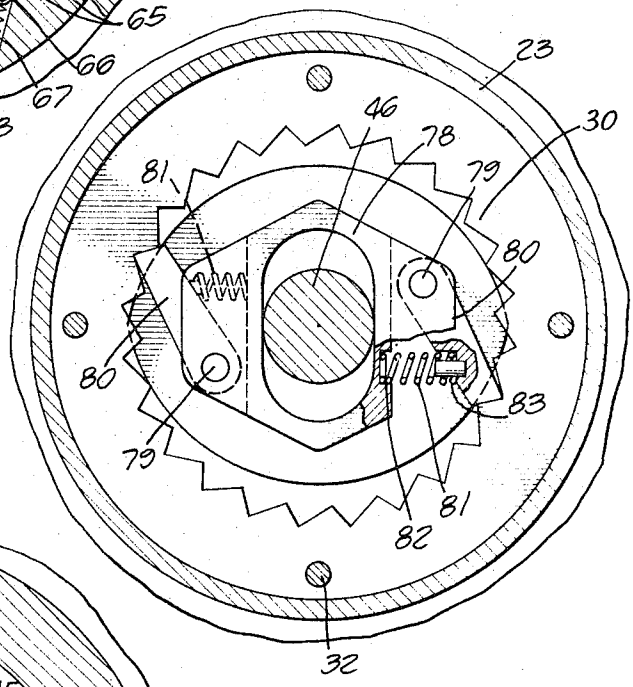


FIG. 4.

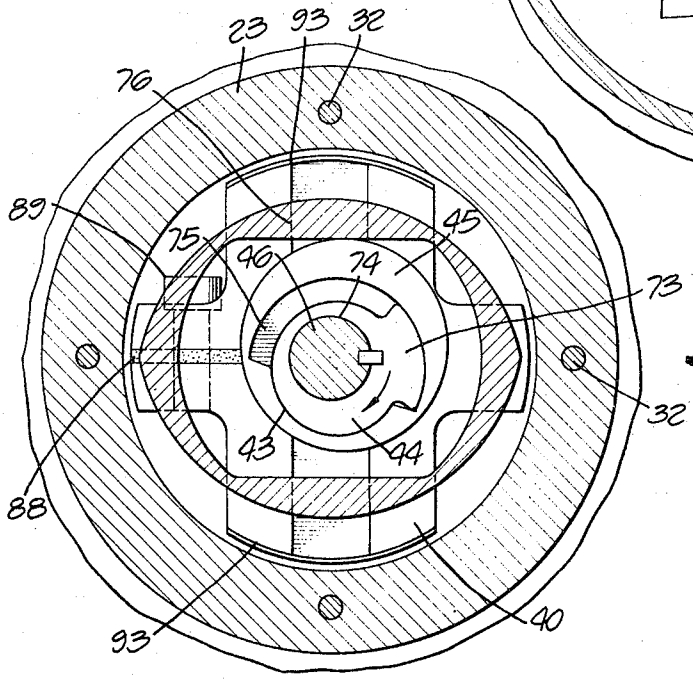
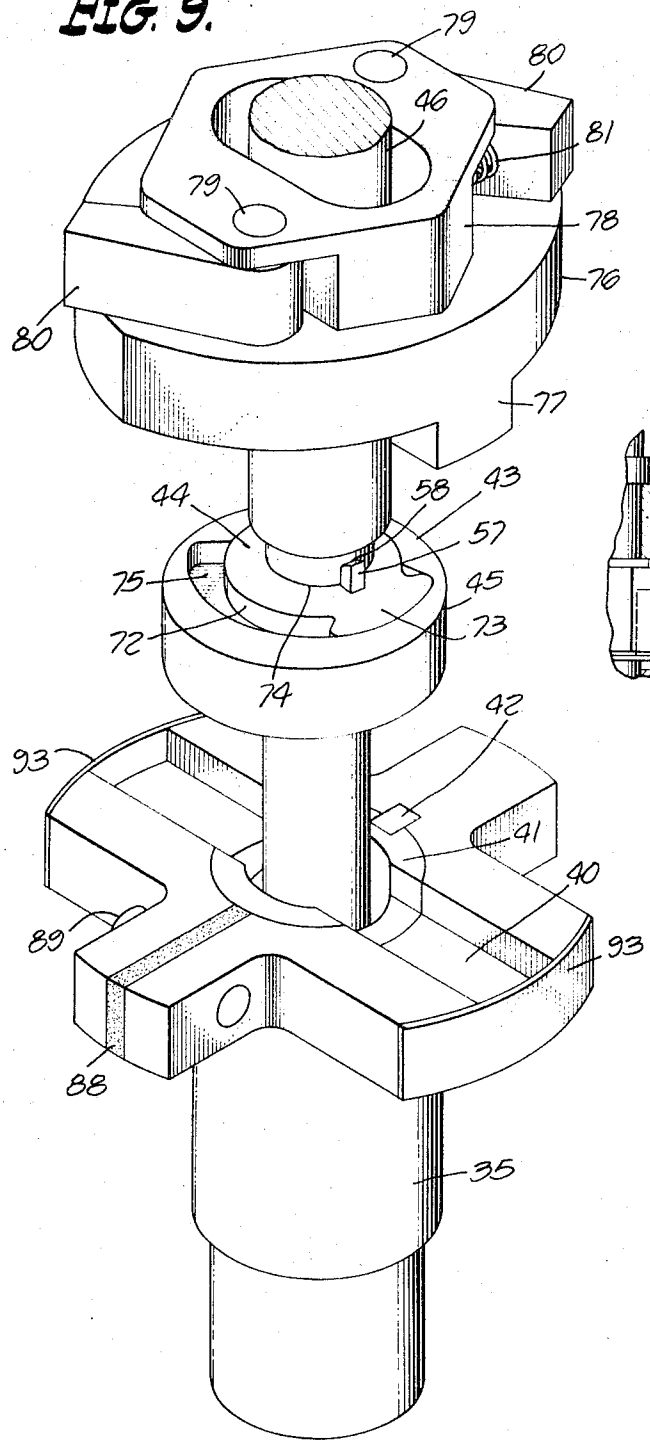


FIG. 5.

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FIG. 9.



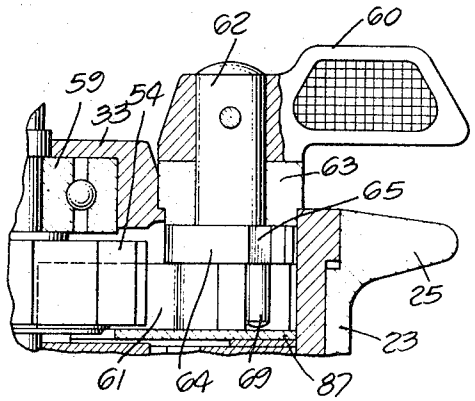


FIG. 10.

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MULTISPEED WINCH

BACKGROUND OF THE INVENTION

Mechanical winches have come to play an important and ever-expanding role in meeting high load requirements where limited ranges of input power and speed are available. However, when variable load conditions exist and the time required to complete the operation must be minimized, the standard winch must act through a power transmission device which can vary the input to output speed ratio and correspondingly the overall mechanical advantage. Sailing is a classic situation where these somewhat conflicting requirements exist. Also in sailing, stringent space and weight limitations are demanded of winch designs.

To meet the above requirements, a mechanism is required which can provide speed ratio variations and high torque capabilities without long moment arms and mechanical linkages, multiple gear trains and separate shifting mechanisms. The common multiple gear train power transmission device cannot satisfactorily meet these requirements. Excessive weight is accrued by the multiplicity of gears and shafts needed for a multispeed mechanism of this type. Separate shifting mechanisms are required for these configurations to drive the gears into the various engaged positions. Also, multiple gear trains are unable to provide large transmission ratios without further adding to the weight and space required. To effect a 20-to-1 ratio, the input gear must have 20 teeth for every one tooth on the output gear or a multiple number of reduction gears would be required.

To date, the use of ratchets and ratchet wheels in multispeed power transmission devices has not proven successful for use in compact winch designs. Ratchet and ratchet wheel devices are advantageous because of their comparatively light weight. Speed ratio changes may be accomplished by varying the working links of connecting shafts or rods, thus eliminating the weight disadvantage inherent in a variable ratio device using a redundancy of drive paths. Also, the ratchet and ratchet wheel devices allow high transmission ratios without requiring large diameter ratchet wheel, However, the current power transmission devices incorporating ratchets and ratchet wheels necessitate pinned members of sufficient length to transform rotational input motion into reciprocating linear motion. A winch incorporating such a ratchet mechanism would be prohibitively large. Because of this significant disadvantage, commercial winch designs have only used ratchet wheels as means for preventing motion in one direction and have not used such mechanisms as means for transmitting power.

Thus, a need exists for a mechanical transmission device which can provide a range of quickly selected input speed ratios, is light weight, compact and at the same time is capable of handling high loads. Multispeed transmission devices currently available have not been able to meet this variety of requirements. The multipath gear train transmission devices are heavy, require separate shifting mechanisms, and cannot effectively provide high transmission ratios. The ratchet and ratchet wheel designs take up far too much room.

SUMMARY OF THE INVENTION

The object of the present invention is to develop a power transmission device which can be used in conjunction with the winch drum to meet the stringent requirements of sailing and similar applications. The device disclosed herein provides a means by which rotational motion can be transmitted using a ratchet mechanism to give multiple transmission ratios. The rotational input motion is transformed into linear motion acceptable to the ratchet mechanism by a cam acting through a follower. The cam is capable of a plurality of selected maximum eccentricities which, in turn, give the multiple transmission ratios.

By using a cam and follower to transform rotational motion into linear motion, the device completely avoids the long mechanical linkage heretofore employed to provide the motion required to drive a ratchet mechanism. Replacement of the pinned mechanical linkage has set the way for a compact power transmission device. The use of the cam has enabled the power transmission device to be contained within a winch drum and has eliminated column failure problems characteristic of long pinned members. Excess weight has been eliminated. The incorporation of the ratchet device has made possible large input to output ratios not available in compact gear designs.

The use of a cam capable of a plurality of maximum eccentricities has eliminated the heretofore-required multiple transmission paths necessary in a variable speed device and has eliminated the need for a separate shifting mechanism for the selective employment of the various transmission paths. The problems associated with the engagement and disengagement of mechanical elements have been eliminated because the maximum cam eccentricity is selected by changing the relative positions of the cam components with the aid of preset stops. By eliminating the multiple transmission paths, the size and weight of the device have been significantly reduced. With the variable cam device, only one variable cam, one follower, and one ratchet device are required to provide a multiplicity of transmission ratios.

Thus, the power transmission device disclosed herein, because of its compact nature, its relative weight, its ability to shift ratios almost instantaneously, and its high ratio capabilities, makes it an ideal solution when combined with a winch drum to the problem of meeting the plurality of requirements placed upon winches used in sailing and other similar applications.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a multispeed winch.

FIG. 2 is a cross-sectional view of the multispeed winch taken along lines 2—2 of FIG. 1.

FIG. 3 is a cross-sectional plan view of the multispeed winch taken along lines 3—3 of FIG. 2.

FIG. 4 is a cross-sectional plan view of the multispeed winch taken along lines 4—4 of FIG. 2.

FIG. 5 is a cross-sectional plan view of the multispeed winch taken along lines 5—5 of FIG. 2.

FIG. 6 is a cross-sectional plan view of the multispeed winch taken along lines 6—6 of FIG. 2.

FIG. 7 is a cross-sectional elevation of the multispeed winch taken along lines 7—7 of FIG. 2.

FIG. 8 is a cross-sectional plan view of the multispeed winch as shown in FIG. 5 with the variable cam shown in an alternate mode.

FIG. 9 is an exploded view of the mechanical power transmission device.

FIG. 10 is a cross-sectional view of the throwout lever and mechanism taken along lines 10—10 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the winch base generally designated 10 is rigidly fixed to the supporting structure by bolts 11 and includes raised semicircular bearing surfaces 12 to support the pawls 13. Rigidly centered through the bearing surfaces 12 are shafts 14 which act as pivots for the pawls 13. A hub 15 provided with a keyway 16 forms the center of the winch base 10. A threaded hole 17 extends through a reinforced portion 18 of the hub 15 into the keyway 16. A set screw 19 is positioned within the threaded hole 17 to insure retention of the key 20. A flange 21 extends around the perimeter of the winch base 10 to effect a clearance 22 between the winch base 10 and the winch drum 23 small enough to prevent the entrance of particles of sufficient size to jam the mechanism.

The winch drum 23 provides a surface 24 for winding a line or "sheet" and has circular flanges 25 and 26 to keep the sheet from slipping off the top and bottom, respectively, of the winch drum 23. Circular flange 26 is also constructed so as to

provide the required clearance 22 with the winch base 10. The winch drum hub 27 is attached to the winch drum 23 by webs 28 radially disposed. An interior concentric ring 29 is provided on the winch drum 23 to provide a base for the annular ratchet wheel 30. Threaded holes 31 are provided in the rings 29 to accommodate the bolts 32 required to fix the drum cap 33. The annular ratchet wheel 34 is provided at the bottom of the winch drum 23 to work in conjunction with the pawls 13.

The base journal 35 is rigidly fixed in the base hub 15 by the key 20 and set screw 19. The base journal 35 provides the axis for the winch drum hub 27 which is accommodated by two antifriction bearings 36 and 37. A thrust washer 38 is provided between the base hub 15 and the winch drum hub 27. Above the winch drum hub 27, there is a second thrust washer 39 positioned beneath the cam follower guide slot 40. The upper end 41 of the base journal 35 is reduced in diameter to accommodate the cam follower guide slot 40 which is keyed to the base journal 35 by key 42. The upper end 41 of the base journal 35 also acts as a thrust surface to retain the positioning of the variable cam generally designated 43 and comprised of eccentric 44 and cam 45. The base journal 35 is hollowed to accommodate the input shaft 46. The hollowed base journal 35 has a reduced inside diameter at 47 to retain the antifriction bearing 48.

The input shaft generally designated 46 comprises a head 49, a collar 50, a main shaft 51 and a smaller shaft 52. The input shaft head 49 is square to accommodate the crank 53. The collar 50 acts to keep the input shaft 46 from sliding downward. The main shaft 51 drives the ratchet wheel 54 through the key 55 set in the keyway 56. The smaller shaft 52 drives the eccentric 44 through key 57 located in keyway 58. The input shaft is contrained at the top by the roller bearing 59 and at the bottom by the antifriction bearing 48.

To achieve the operating mode with the highest input to output speed ratio, the throwout lever 60 must be rotated to disengage the upper pawl 61, and the input shaft 46 must be rotated in a clockwise direction as viewed from the top of the winch. The throwout lever 60 is rigidly fixed to a shaft 62 constrained to rotate in the bearing 63. A collar 64 is provided on the face of the shaft 62. The collar 64 retains the throwout lever 60 and has two notches 65 on its perimeter to act with a ball bearing spring lock comprising a ball bearing 66, a spring 67 and a set screw 68 for locking the throwout lever in position. A throwout pin 69 is attached to the bottom of the collar 64 where it engages the bearing surface 70 of the pawl 61. By rotating the throwout lever 60 in a clockwise direction as viewed from the top of the winch, the throwout pin 69 is driven to rotate the pawl 61 about the pawl shaft 71 which disengages the pawl from the ratchet wheel 54. With the first pawl 61 disengaged, rotation of the input shaft 46 will only drive the eccentric 44. The eccentric 44 has a cylindrical working surface 72, a protruding stop 73 and a bore 74 not concentric with the cylindrical working surface 72. The smaller diameter portion 52 of the input shaft 46 is keyed to the eccentric 44 causing it to rotate with the shaft. A cam 45 is positioned around the eccentric 44 with sufficient tolerance to allow the eccentric 44 to rotate freely within the cam 45. A slot 75 is provided on the cam 45 to allow the stop 73 to rotate through an arc with respect to the cam 45. The exterior cam surface is shown here to be circular and not concentric with its bore which mates with the cylindrical eccentric surface 72.

When the input shaft 46 is rotated clockwise as viewed from the top of the winch, the eccentric 44 rotates relative to the cam 45 until the stop 73 reaches the end of the notch 75. The eccentric and cam then rotate together, providing a specific eccentricity which gives a corresponding displacement to the cam follower 76. The cam follower 76 is constrained to move back and forth in a linear manner by the cam follower tongues 77 which ride in the cam follower guide slots 40. On top and integral with the cam follower 76 is a pawl mounting base 78. The pawl mounting base 78 provides support for the pawl shaft 79 both above and below the drive pawls 80. Springs 81 are provided to keep the drive pawls 80 in contact with the annularly disposed ratchet wheel 30. A hole 82 and a pin 83 are provided to keep each spring 81 in place. The drive pawl mounting base 78 drives the drive pawls 80 through the pawl shafts 79 which in turn drive the annularly disposed ratchet wheel 30. The annularly disposed ratchet wheel 30 is rigidly fixed to the winch drum 23 which provides the output motion to drive the sheet. The annularly disposed ratchet wheel 30 is shown with 24 teeth. The eccentricity of the combined eccentric 44 and cam 45 and the length of the drive pawls 80 are shown here in a configuration which would cause the pawls 80 to advance four teeth for every one rotation of the input shaft 46. Therefore, the winch drum rotates once for every six rotations of the input shaft 46. With a proper selection of the maximum eccentricity and drive pawl lengths, the annularly disposed ratchet wheel 30 could be caused to move one-half of a tooth for every 180° of rotation of the input shaft 46. Still considering a 24-tooth annular ratchet wheel, the winch drum 23 would then make one rotation for every 24 rotations of the input shaft. A large number of input to output ratios can thus be obtained by varying the number of teeth on the annularly disposed ratchet wheel 30, the length of the drive pawls 80 and the maximum eccentricity of the combined eccentric 44 and cam 45.

To select the midrange transmission ratio, the input shaft 46 must be rotated in a counterclockwise direction as viewed from the top of the winch. This range is selected without regard to the position of the throwout lever 60. When the throwout lever 60 is in the low range position as described above, the pawl does not engage at any time the upper ratchet wheel 54. The input shaft 46 only acts to rotate the eccentric 44. When the throwout lever 60 is in the high range position, the pawl 61 does not engage the ratchet wheel 54. Because the ratchet wheel 54 is being rotated in a counterclockwise direction by the input shaft 46, the pawl 61 clicks backwards over the teeth and again only the variable cam 43 is driven by the input shaft 46.

By rotating the input shaft 46 in a counterclockwise direction, the eccentric 44 will rotate relative to the cam 45 until the eccentric stop 73 is prevented from further relative motion by the end of the notch 75 in the cam 45. As the input shaft 46 continues to rotate, the eccentric 44 and cam 45 will act as one unit rotating with a new eccentricity. The new eccentricity will cause the cam follower to travel through a new displacement. Because counterclockwise rotation was selected as the midrange mode, the combined eccentricity of the eccentric 44 and cam 45 will be larger than the combined eccentricity effected by clockwise rotation. Therefore, the linear motion of the cam follower 76 will be through a greater displacement. This will cause the drive pawls 80 to drive the annularly disposed ratchet wheel 30 further with each stroke. The example herein disclosed would require that the variable cam 43 acting through the drive pawls 80 would cause the annularly disposed ratchet wheel 30 to advance four teeth with each stroke. Thus, for each revolution of the input shaft, the annularly disposed ratchet wheel would rotate through eight teeth; or the winch drum 23 attached to the annularly disposed ratchet wheel 30 would rotate once for every three rotations of the input shaft 46. Again, as disclosed for the high ratio mode above, by varying the maximum eccentricity of the variable cam 43, the length of the drive pawls 80 and the number of teeth on the annularly disposed ratchet wheel 30, various transmission ratios can be obtained.

The third transmission ratio is a direct drive. This mode requires that the throwout lever 60 be moved to its extreme counterclockwise position and the input shaft 46 rotated in a clockwise direction. The pawl 61 is driven into the ratchet wheel 54 by the retaining spring 84, when the throwout lever 60 is moved into its extreme counterclockwise position. The end of the spring 84 is held in position by virtue of its being wrapped about peg 85. Peg 86 is so positioned as to keep the spring 84 in a flexed position at all times which in turn causes the pawl 61 to follow the surface of the ratchet wheel 54. With the pawl 61 engaged with the ratchet wheel 52, clockwise

input torque is transferred through the pawl **61** to the pawl shaft **71**. The pawl shaft **71** is fixed within the winch drum top **33** and brazed to the retainer disc **87**. The force of the pawl shaft **71** is thereby transferred through the top **33** and the retainer disc **87** to the winch drum **23**. Thus, one revolution of the input shaft **46** causes one revolution of the winch drum **23**. The spring positioning pegs **85** and **86** are also brazed to the retainer disc **87**.

To aid in lubricant retention, end plates **93** are fixed to the end of the slots in the cam follower guide **40**. A neoprene filler **88** is clamped in the adjustment gap on the cam follower guide **40**. Bolt **89** is used to tighten the cam follower guide **40** to the base journal **35**.

To keep the winch drum **23** from rotating counterclockwise under the tension of the sheet wound about the winch drum **23**, pawls **13** fixed in the base **10** through pawl shafts **14** are forced by the springs **90** into the annularly disposed ratchet wheel **34**. The springs **90** are affixed to the pawls **13** by screws **91** and are kept under flexure by pins **92** which are braced to the base **10**. The three pawls **13** shown in this configuration are placed so that the engaging surface of each succeeding pawl is offset one-third of a ratchet tooth space from the preceding pawl. When one pawl is engaged with a ratchet tooth, the next pawl is one-third of the pitch distance from engaging a ratchet tooth. The third pawl is two-thirds of the ratchet pitch from engaging the next tooth. By so staggering the pawls, the number of ratchet points becomes three times the number of ratchet teeth. If two pawls were used with the pitch offset of one-half, the number of ratchet points would be twice the number of ratchet teeth. Therefore, a sufficient number of ratchet points can be obtained by varying the number of pawls and the number of ratchet teeth.

Having fully described my invention, it is to be understood that I am not to be limited to the details herein set forth but that my invention is of the full scope of the appended claims.

I claim:

1. A mechanical power transmission device for converting rotational input into unidirectional output with two transmission ratios determined by the direction of ROTATION of said input; said device comprising: an input shaft, a variable cam rotated by said input shaft having two eccentricities, the employment of each being determined by the direction of rotation of said input shaft, a cam follower driven by said variable cam, guide means by which said cam follower is constrained to follow said variable cam in a linear manner, a plurality of opposed pawls pivotally hinged to said cam follower, a ratchet wheel rotated in one direction by said cam follower acting through said pawls, and output means driven by said ratchet wheel.

2. The same device as defined in claim **1**, wherein said variable cam comprises two elements, an eccentric having a center of rotation coincident with the center of rotation of said input shaft and rigidly fixed thereto, and a cam having a center of relative rotation with respect to said eccentric coincident with the center of figure of said eccentric, and means for constraining said elements from rotating relative to each other through more than a predetermined angle.

3. The same device as defined in claim **2**, wherein said means for limiting the relative rotation between said variable cam elements comprises a slot located on one of said variable cam elements, and a stop located on the other of said variable cam elements and positioned within said slot.

4. A three-speed winch comprising: a winch drum, a ratchet wheel rigidly fixed to said winch drum, an input shaft, a variable cam rotated by said input shaft having two eccentricities, the employment of each being determined by the direction of rotation of said input shaft, a cam follower driven by said variable cam, guide means by which said cam follower is constrained to follow said variable cam in a linear manner, a plurality of opposed pawls pivotally pinned to said cam follower which act to rotate said ratchet wheel in one direction, means for preventing rotation of said winch drum in a direction opposite to that direction in which said winch drum is driven by said plurality of opposed pawls acting through said ratchet wheel, locking means whereby said winch drum is constrained to rotate with said input shaft, means for disabling said locking means, and positioning means preventing relative linear motion between said guide means and said input shaft and said winch drum.

5. The same device as defined in claim **4**, wherein said variable cam comprises two elements, an eccentric having a center of rotation coincident with the center of rotation of said input shaft and rigidly fixed thereto, and a cam having a center of relative rotation with respect to said eccentric coincident with the center of figure of said eccentric, and means for constraining said elements from rotating relative to each other through more than a predetermined angle.

6. The same device as defined in claim **5**, wherein said means for limiting the relative rotation between said variable cam elements comprises a slot located on one of said variable cam elements, and a stop located on the other of said variable cam elements and positioned within said slot.

7. The same device as defined in claim **6**, wherein said means for preventing rotation of said winch drum in one direction comprises: a ratchet wheel rigidly fixed to said winch drum and a plurality of pawls pivotally pinned to said positioning means so as to engage said ratchet wheel.

8. The same device as defined in claim **7**, wherein said locking means comprises: a ratchet wheel rigidly fixed to said input shaft, an element rigidly fixed in said winch drum, a pawl pivotally pinned to said element and positioned to prevent relative rotation of said ratchet wheel with respect to said pawl; and wherein said means for disabling said locking means comprises a means for pivoting said locking pawl so that said locking pawl does not engage said locking ratchet wheel.

9. The same device as defined in claim **8**, wherein said input shaft, said variable cam, said cam follower, said guide means, said plurality of opposed pawls, said means for preventing rotation in a direction opposite to the driving direction of said opposed pawls, said locking means and said means for disabling said locking means are all positioned within said winch arm.

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