

Aug. 29, 1961

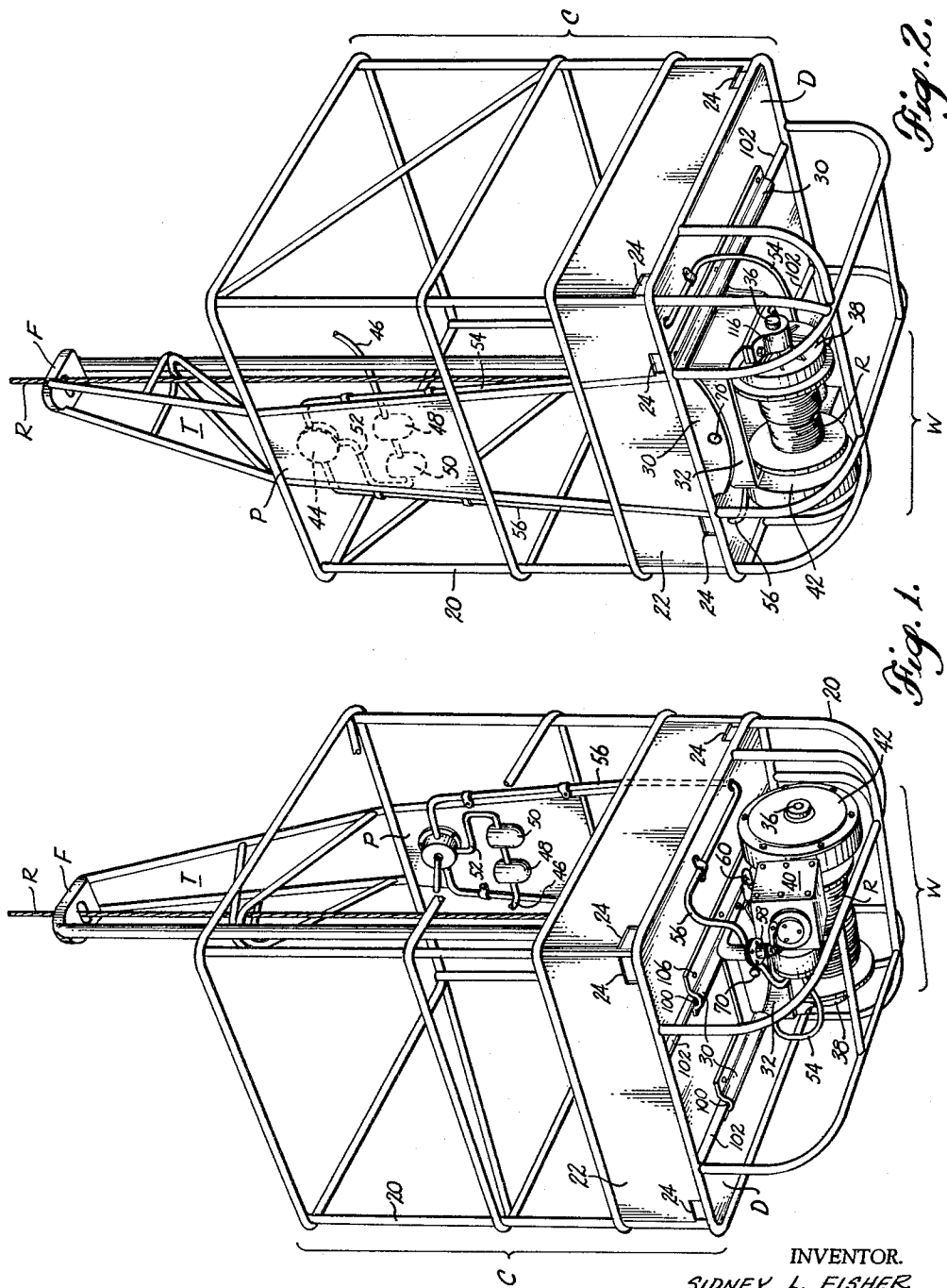
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LEVEL WINDING WINCH MECHANISM

Filed Sept. 18, 1958

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LEVEL WINDING WINCH MECHANISM

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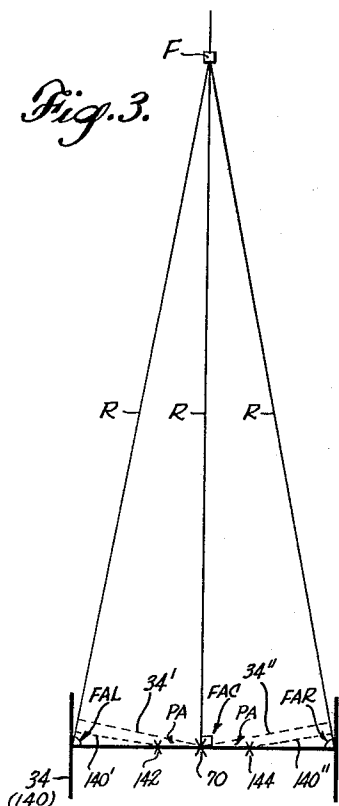


Fig. 4.

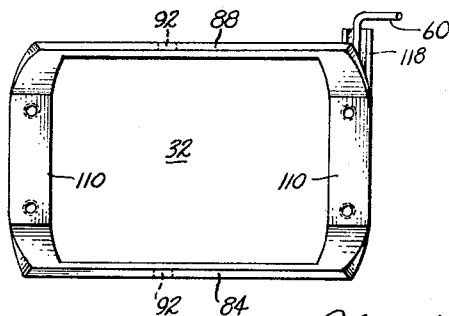
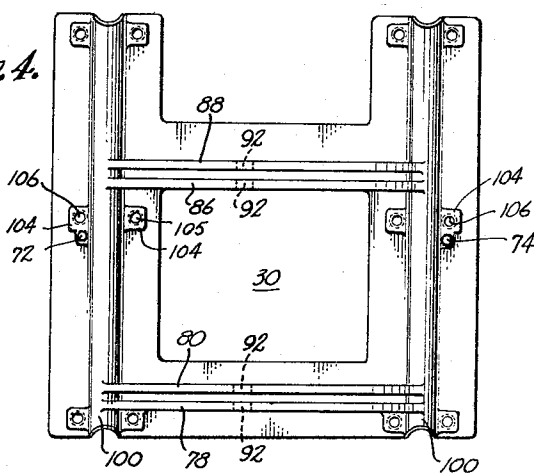


Fig. 5.

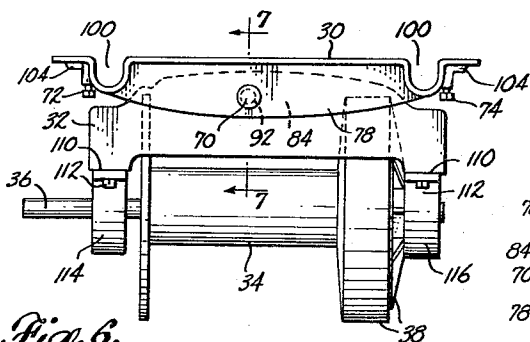


Fig. 6.

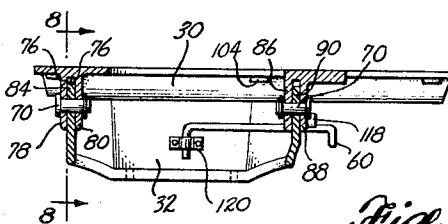


Fig. 7.

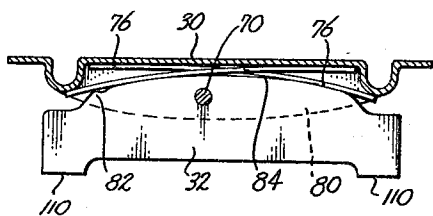


Fig. 8.

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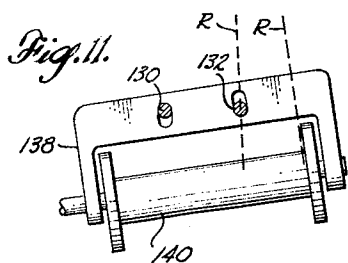
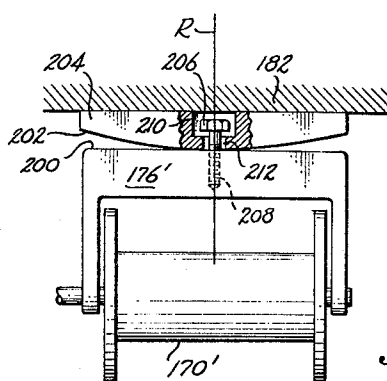
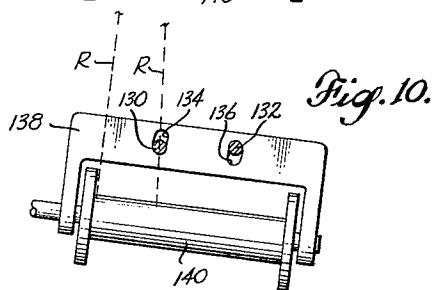
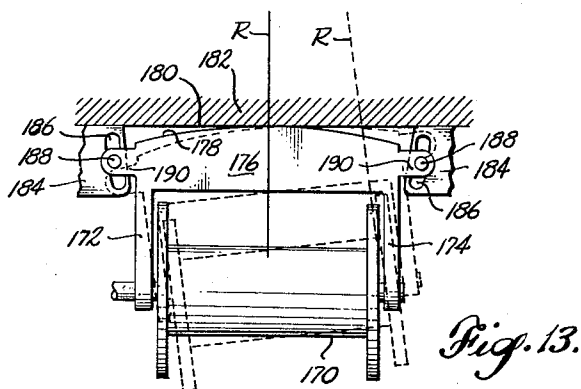
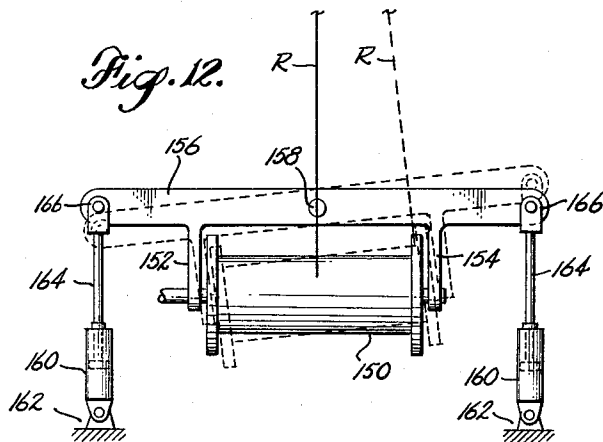
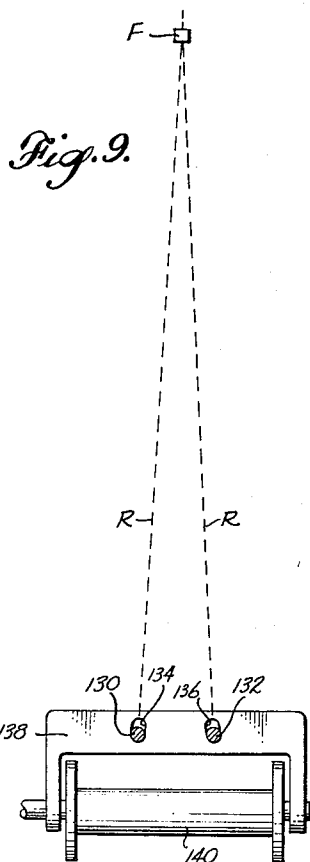
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LEVEL WINDING WINCH MECHANISM

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3 Sheets-Sheet 3



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LEVEL WINDING WINCH MECHANISM

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34 Claims. (Cl. 182—142)

This invention relates to winch mechanisms and more particularly relates to improved level winding winch mechanisms operated in conjunction with a comparatively close fixed fairlead or guide from which the wire rope or cable is led and spooled in successive layers onto a power driven winch drum of substantial length.

Heretofore, in winch units involving a fixed fairlead and a power driven winch drum, it has been conventional practice to fixedly mount the drum base with respect to the fixed fairlead, so that when the length of the winch drum is substantial, there is a substantial variation in the angle of approach of the wire rope or cable. This variation in the approach angle, which angle is also commonly called the "fleet angle," often results in the wire rope or cable bunching or gapping between successive turns or between successive layers, with consequent wastage of drum capacity and excessive wear on the wire rope, as well as a certain degree of unevenness in the lineal speed of letout or takeup of the wire rope on the drum. While certain attempts have been made to solve this problem by guide devices which mechanically reciprocate across the drum, such have proven cumbersome and mechanically complex, as well as introducing an additional friction point to the wire rope, with consequent undue wear.

Objects and advantages of the present invention include the provision of a level winding winch mechanism which simply, effectively, and reliably maintains the fleet angle of a wire rope leading from a fixed fairlead to a winch drum within tolerable limits insuring that the wire rope will spool onto the drum in a level manner, i.e. compactly without gaps and without bunching of the turns. More specifically, it is an object and advantage of the present invention to provide, in a level winding winch mechanism having a fixed fairlead and a winch drum unit wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the effective half length of the winch drum by a ratio of less than about 35 to 1, the winch drum mounting automatically maintaining the fleet angle variation at less than about 1½° as the wire rope spools onto the drum. Similarly, in preferred application of the present invention, it is an object and advantage thereof to thus maintain fleet angle variation at less than about 3°, even when the ratio of fairlead distance and winch drum half length is less than about 19 to 1.

Other objects and advantages of the present invention include the provision of a level winding winch drum mechanism wherein the arrangement and components thereof are strong, compact and durable, wherein the winch drum is mounted to permit a limited degree of angular movement responsive to the tension on and point of approach of the wire rope on the drum, i.e. the position of wrap of the wire rope onto the drum, in a manner minimizing variation in fleet angle and reducing the amount of wear on and consequently lengthening the life of the wire rope, wherein such movement of the winch drum is in a manner effectively reducing any tendency of the fleet angle to vary substantially and wherein the degree of limited angular movement of the winch drum and thus the degree of fleet angle variation is selectively adjustable.

It is yet another object of the present invention to provide various typical forms and embodiments of level winding winch mounting mechanisms, adaptable to vari-

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ous conditions of fleet angle variation, by means of which the apparent fleet angle variation can be reduced to any desired value, even to the point of substantially complete elimination of fleet angle variation.

5 Other related and more specific objects and advantages of the present invention include the presentation of various winch drum mounting means constructed and arranged to reduce or in some cases substantially eliminate fleet angle variation, wherein one or more pivot or like means are provided to permit limited angular movement of the drum axis substantially in the plane of said axis and a fixed fairlead associated therewith, wherein gravity, spring, hydraulic or like loading is utilized to render an arcuately movable winch drum normally self-centering and/or to at least in part relate the extent of such angular movement to the tension and point of approach of the wire rope or cable to the drum, wherein such angular movement either is more or less segmental in nature, by employment if one or more pairs of pivot pins between a fixed baseform and the angularly movable drum mounting base or is rendered substantially continuous in nature by suitable loading or by employment of an arcuately shaped rocker surface between the fixed baseform and the movable drum base, and/or wherein means are provided for simply adjusting the range or extent of arcuate movement of the movable drum base.

An additional object and advantage of the present invention is to provide an increase in the effective capacity of the winch drum by insuring level winding of the wire rope thereon throughout the length of the wire rope, and to obviate any transient variation in the rate of payout or takeup of wire rope from the winch drum.

A further object and advantage of the present invention is to present a winch drum mounting mechanism readily adaptable for replacement of conventional fixed winch drum bases and/or mounting means, without substantial change in the overall size, weight or strength thereof.

These and other various and more specific objects and advantages of the present invention will be apparent from the following disclosure of certain typical and therefore nonlimitative embodiments thereof.

In order to illustrate the basic constructional arrangement and mode of operation of the present invention, such is illustrated with reference to certain applications thereof to the field of power driven staging or scaffolding of the general type disclosed in Fisher U.S. Patent 2,112,837. As will be readily understood, this type of equipment is typical of winch mechanisms having a fairlead in fixed location above a movable platform, the entire staging being suspended and movable vertically on a single wire rope or cable.

The equipment in connection with which the power driven winch unit is employed need not be movable with respect to the supporting structure, nor need not be portable. Thus, it will be readily apparent that similar types of winch mechanisms are used in fields other than scaffolding and staging; for example, winch units used in combination with a comparatively close fixed fairlead are found in truck or wrecker winches, bulldozer winches, cranes, cargo winches, davit winches, and in many other marine or land heavy hoisting, hauling or suspending equipments.

Accordingly, and with reference to the indicated type of scaffolding and staging equipment, various embodiments and modifications of the present invention are presented by the following disclosure, and in the accompanying drawings, wherein like elements refer to like parts and wherein:

FIG. 1 is a perspective view from a lower aspect of a single-suspension power driven staging, incorporating a winch unit characterizing the present invention;

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FIG. 2 is another perspective view of the equipment illustrated in FIG. 1 taken from an opposite lower aspect from that shown in FIG. 1;

FIG. 3 is a diagrammatic sketch illustrating various considerations involved in fleet angle relationships and fleet angle variation, as applied to conventional winch mechanisms and as applied to the winch mechanism characterizing the present invention;

FIG. 4 is a detached, bottom view of the fixed baseform element of the winch mounting unit shown in the equipment illustrated in FIG. 1;

FIG. 5 is a detached, bottom view of the pivoted mounting base forming a part of the winch from mounting mechanism illustrated in FIGS. 1 and 2;

FIG. 6 is a side view of the assembled baseform, drum mounting base and winch drum as used in the equipment illustrated in FIGS. 1 and 2;

FIG. 7 is a cross-sectional view of the baseform and pivoted drum base illustrated in FIG. 6, taken substantially along line 7—7 thereof;

FIG. 8 is a cross-sectional view of the baseform and pivoted drum mounting base illustrated in FIG. 7, taken substantially along line 8—8 thereof;

FIG. 9 is a fragmentary side view, somewhat diagrammatic in character, showing a modified form of winch drum mounting involving plural pivot pins and a succession of movements of the drum mounting placed with respect to the pivot pins to compensate for and minimize fleet angle variation, the view of FIG. 9 being with the drum of the base in a central position occurring when the wire rope is at a point of approach near the center of the drum;

FIG. 10 is a view of the arrangement shown in FIG. 9 with the drum mounting base pivoted to one extremity of movement, as occurs when the wire rope point of approach to the drum is near the left extremity of the drum, as viewed;

FIG. 11 is a view similar to that presented in FIG. 10, but showing the position of the winch drum mounting base when pivoted to the other extreme of movement as occurs when the wire rope point of approach to the drum is near the right extremity of the drum, as viewed;

FIG. 12 is a fragmentary side view, somewhat diagrammatic in character, corresponding to the view of FIG. 9 and showing another modified form of the present invention, wherein the manner of movement of the winch drum mounting base is controlled by hydraulic means;

FIG. 13 is a fragmentary side view, somewhat diagrammatic in character, showing another modification of the arrangement characterizing the present invention, wherein the winch drum mounting base includes an arcuately shaped rocker surface engaging a fixed, generally flat surface on the baseform, the relative movement of the wire rope across the winch drum serving to change the point of contact between said arcuate surface and said flat surface in a manner compensating for and minimizing variation in fleet angle;

FIG. 14 is a further modified form of the present invention, shown in fragmentary side view and somewhat diagrammatically, similar to the form shown in FIG. 13 in that an arcuate surface is employed, but presenting a reversal of the elements so that the arcuate surface is on the fixed baseform and the flat surface is on the winch drum mounting base.

Turning now to a specific consideration of a staging equipment typically incorporating an embodiment of the invention, as such is illustrated in FIGS. 1 and 2, the staging shown comprises an operator's cage C having a deck D and mounting a fixed mast or tripod T having at the top thereof a guide or fairlead F, through which is led the wire rope R on which the staging is suspended. Winch unit W is mounted at the bottom of cage C and wire rope R is wound upon the power driven winch drum thereof.

As will be readily understood, this type of equipment

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is operator controlled, and is designed to be suspended along the side of a building, antenna structure, stack or the like, the operator selectively controlling up and down movement of the equipment while riding in cage C, by means available to him on control panel P.

This type of equipment is exemplary of equipment where safety and reliability of operation render it important and even vital that the wire rope R spool onto the winch drum of winch unit W compactly and levelly, that the takeup and letout of the wire rope R progress evenly, and that no undue wear of the wire rope R occur.

While the novel features characterizing the present invention are typified in certain of the details of the winch unit W, and in the combination thereof with fixed fairlead F, it is considered appropriate to briefly detail certain of the operatively related elements of the equipment assembly illustrated in FIGS. 1 and 2, in order that a clear undertaking of the overall assembly and its manner of operation will be readily understood.

The open cage C and tripod T of the staging comprise a framework 20 of integrally welded, heat-treated aluminum alloy tubing, integrally welded for high strength. Skirt 22 extends around cage C immediately above deck D thereof and serves as a toeboard to keep paint and tools from falling from the stage. Openings 24 in skirt 22 permit access for attachment of flydecks to a staging or for spanning sections or platforms between a pair of stagings used in concert, to increase the reach or swath of the equipment.

In the equipment shown in FIGS. 1 and 2, and having particular reference to the details of the winch unit W and particularly the novel winch drum mounting elements used therein, as also presented in FIGS. 4-8, said winch unit W comprises a fixed baseform 30, an arcuately movable drum mounting base 32, a flanged winch drum 34 having a drive shaft 36, an automatic, inertially operated emergency brake 38, and a reversible air motor 40 driving self-locking reduction gearing 42 splined to winch drum shaft 36.

Air motor 40, in a typical equipment, develops 1 1/4 H.P. at 90 pounds p.s.i. line pressure, delivered at 20 cubic feet per minute. A four-way air valve 44 on control panel P can be manipulated by the operator to cause the wire rope R to be either taken up or let out from winch drum 34, with the rate of movement of the staging being selectively variable from 0-30 f.p.m. Air supply line 46, from a suitable source (not shown), delivers the air through a filter 48 and an oiler 50, thence through line 52 to control valve 44. The left hand or "down" side of control valve 44 as viewed in FIG. 1, communicates with air motor 40 through line 54, and the right hand or "up" side of control valve 44 communicates with air motor 40 through line 56, lines 46, 54 and 56 being broken away in the views of FIGS. 1 and 2 for clarity of illustration. The compressed air source feeding supply line 46 is on the structure from which the staging is suspended or on the ground below the staging.

Also of note in the air line 56 between the right hand or "up" movement side of control valve 44 and the air motor 40 is a plunger type shut off valve 58 which functions to cut off the air in the line automatically whenever the wire rope R should become overloaded during upward travel of the staging. The matter of operation of this automatic shutoff valve is as follows: Air motor 40 and reduction gearing 42 are mounted so as to rotate or "rock" slightly about drive shaft 36 of winch drum 34, the rocking movement being against the pressure exerted by torsion bar 60 mounted on the movable drum mounting base 32 (see FIG. 5). Should the loading be excessive during the upward travel of the equipment (i.e. during takeup of wire rope R on drum 34), then torsion bar 60 yields to a point where shutoff valve 58 functions to interrupt the air being delivered to air motor 40, thus completely stopping air motor 40 and giving a further safety factor to the equipment. Again considering a typi-

cal installation, wire rope R is $\frac{5}{16}$ " in diameter and has a test breaking strength of 8,000 lbs., and shutoff valve 58 is designed to operate at overloads in excess of 1,000 lbs., providing a safety factor of about 8 to 1.

Heretofore it has been conventional practice in this type of equipment to fixedly mount winch drum 34 so that the axis of rotation thereof was fixed with respect to the fairlead F and the deck D of the staging, such as by use of a single or unitary base member.

In order to adequately consider some of the geometrical and theoretical considerations involved with respect to fleet angle and fleet angle variation in the type of winch system to which applicant's invention is directed, FIG. 3 presents a diagrammatic sketch of such a system, with angles of variation exaggerated for clarity of illustration. As shown in FIG. 3, fairlead F is at a fixed distance from winch drum 34 and is conventionally situated, as shown in solid line, so that the angle of approach of wire rope R when at the center of the winch drum is substantially 90°, as indicated at angle FAC (Fleet Angle, Center). As the wire rope R progressively winds across the drum and reaches an extremity of travel against one of the flanges of winch drum 34, the fleet angle gradually decreases until reaching an angle FAL (Fleet Angle, Left), at the left, or FAR (Fleet Angle, Right), at the right.

The extent of fleet angle variation, i.e. the difference between angle FAC and angle FAL or angle FAR, is a function of the distance of fairlead F from winch drum 34 and the effective half length of winch drum 34. In a typical installation having reference to the type of equipment presented in FIGS. 1 and 2 for example, the distance from fairlead F to winch drum 34 is 60", and the length of winch drum 34 is 9" (effective half length 4.5"). In such an arrangement, angle FAC is 90° and, by computation, angle FAL and angle FAR are 85.7°, giving a fleet angle variation of 4.3° when the axis of rotation of winch drum 34 is held in fixed position with respect to fairlead F in the conventional manner.

In contrast to such order of fleet angle variation, it has been determined that the fleet angle variation should not exceed about 3°, and most advantageously should not exceed about 1.5°, to ensure level winding.

While it is of course true that some winch drum installations involve a fairlead remotely enough situated so as not to generate a fleet angle variation of more than about 1½°, when the fleet angle variation is excessive, prior to the present invention there was no known, simple, reliable and effective means by which to maintain the fleet angle at an optimum ensuring level winding. Accordingly, the present invention is applicable to situations where the fleet angle would otherwise vary more than about 1½° as the wire rope or the like spools onto the winch drum, i.e. where the ratio of the distance from the fairlead to the winch drum axis of rotation and the effective half-length of the drum axis is less than about 35 to 1. In a particularly advantageous area of application, the present invention provides such reduction of fleet angle variation to less than about 3° even when the ratio of fairlead distance and drum axis half-length is less than about 19 to 1, or for practical purposes even eliminate fleet angle variation. In the specific arrangement selected for purposes of illustration, i.e. where the fairlead distance is 60" and where the winch drum effective half-length is 4.5", the indicated ratio is about 13.3 to 1.

As a basic feature of the present invention, the winch drum 34 is mounted so as to be movable angularly a limited degree with respect to the fairlead, the plane of movement of the axis of rotation being substantially in the plane of said axis and the fairlead. In one form of such angular movement, as available from the type of winch drum mounting illustrated in FIGS. 1, 2 and 4-8, such angular movement is provided by a pivotal mounting, an opposed pair of pivot pins 70 being disposed between fixed baseform 30 and winch drum mounting base 32 (see FIGS. 6 and 7). The extent of angular movement of the winch drum is limited, such as by suitable

stop means, a typical form thereof being adjustable bolts 72 and 74 mounted on fixed baseform 30 in register with the upper outer edges of winch mounting base 32, as shown in FIG. 6.

By virtue of such pivotal mounting and the limited degree of angular movement thus provided, the effective half-length of the winch drum 34 is substantially halved. To illustrate, and again referring to FIG. 3 for the example wherein the fairlead distance is 60" and the effective half-length of the winch drum 34 when fixedly mounted is 4.5", when the winch drum 34 is pivoted centrally, as indicated at 70, and when the extent of arcuate movement is limited to about 3°, as indicated at pivot angles PA, the fleet angle variation is then reduced to about 3° at most (occurring just before and just after the wire rope W passes across the pivot axis), and the fleet angle variation at the extremities to travel of wire rope W on winch drum 34 is only about 1.3°. Obviously, the ideal extent of movement of winch drum 34 in the case of a single pivotal mounting 70 and in the example selected is when the pivot angle is about 2.15°, in which case the fleet angle variation is about 2.15° at most, occurring when the wire rope is immediately at either side of the center of the drum in the area of the pivot axis and occurring at both right and left extremities of travel of the wire rope R on winch drum 34.

Many variations are available as to further refinements and further reduction of the fleet angle variation from the simple case where only a single pivot axis (such as pivot pins 70) is provided. One manner in which further reduction can be accomplished is by means of suitable "loading" of the arcuate movement of the winch drum. One manner of such "loading" is to provide spring means by which the natural gravitational tendency of the winch drum to level or self-center is augmented, and to this end the embodiment of the invention illustrated in FIGS. 1, 2 and 4-8 incorporates two spring rods 76 (FIG. 8), each arranged between the fixed baseform 30 and winch drum base 32 in a manner to oppose each other under bending stress or torque. In connection with spring rods 76, and noting also their disposition between depending flanges or ears 78 and 80 on fixed baseform 30 (also see FIG. 7) it will be observed that a small nub 82 is provided at one end of arcuately shaped upstanding flange 84 on winch drum mounting base 32 (see FIG. 8), the purpose of such nub 82 being to equalize the stress of the spring rod 76 contacting same so that the axis of rotation of winch drum 34 is maintained when in a normal or no-load condition substantially parallel to the upper surface of baseform 30. As will also be observed in FIGS. 4 and 7 an opposed pair of depending flanges 86 and 88 on fixed baseform 30 correspond with the aforementioned flanges 78 and 80, and an opposed second upstanding flange 90, corresponding with the first mentioned upstanding flange 84 of winch drum mounting base 32 complete the pivotal mounting, all such flanges being provided with aligned pivot pin receiving bores 92.

Completing the detail of fixed baseform 30, as shown in FIG. 4, the upper surface thereof is provided with a parallel pair of channels 100. Channels 100 in baseform 30 are received by deck rails 102 (FIGS. 1 and 2) of staging framework 20. Baseform 30 is attached to said deck rails 102 by straps (not shown) received in recesses 104 and bolts (also not shown) threaded into the various pairs of holes 106 arranged at the sides of the channels 100.

Completing the detail of the winch drum mounting base, as shown particularly in the assembled view of FIG. 6 and as also shown in part in FIGS. 5, 7 and 8, said baseform 32 presents an opposed pair of flat bearing received surface 110 (FIG. 5), to which are mounted by bolts 112 (FIG. 6) a pair of pillow block type ball bearings 114 and 116, respectively journalling the shaft end and emergency brake end of winch drum 34.

As a constructional detail, winch drum mounting base 32 also includes a channel shaped extension 118 (FIGS. 5 and 7) mounting overload cutoff valve 58 (cf. FIG. 1). Interiorly of base 32, the bitter end of torsion bar 60 is clamped by means of strap 120 (FIG. 7).

In the typical embodiment presented, the winch drum 34 is of a size to have a capacity of about 350 lineal ft. of $\frac{5}{16}$ " diameter wire rope, and it will be evident that the capacity of the winch drum can be increased by suitable spacer blocks (not shown) situated between bearing receiving surfaces 110 of base 32 and bearings 114 and 116, coupled with corresponding radial extension of the flanges of winch drum 34. In one existing installation, using stagings such as illustrated in FIGS. 1 and 2, the capacity of the winch drum unit and consequently the range of vertical travel of the stagings has been increased to an effective length of over 700 feet by such procedure.

Returning to a consideration of the fleet angle variation and some of the considerations involving same, as earlier discussed in connection with FIG. 3, it will be likewise readily understood that wide choice is available, as desired, with respect to the comparative abruptness or gradualness with which the winch drum 34 changes from one pivotal position (e.g. position 34') to the other position (e.g. position 34'') about pivot pins 70. When the rate of change of fleet angle variation is not critical, such angular movement as is involved can occur rather abruptly, in which event no spring or like loading is necessary and springs 76 can be omitted. It is considered preferable, however, to utilize some form of loading to augment self-centering of the winch drum in order that the transfer thereof from one pivoted position to the other can invariably proceed uniformly and more slowly and in order that the no-load condition of the drum is substantially self-centered and without "flop." This is particularly preferable for situations where the equipment must be transported from location to location fairly frequently. Also, when the loading tension on the wire rope is fairly constant and predetermined, the loading can be designed to yield generally linearly and as a function of the point of approach of the wire rope to the drum and the drum tension, so that the variation in fleet angle is substantially eliminated altogether even though the mounting has a single pivot axis.

Another element readily subject to wide variation in specific form and design is the means by which the extent of arcuate movement of the winch drum is stopped or limited when an appropriate pivot angle is reached. Thus, rather than adjustable, threaded bolt type stops 72 and 74, as shown in FIG. 6, such movement limiting means can be non-adjustable if the requisite pivot angle is substantially constant, and can be integral protuberances or like portions structurally a part of baseform 30. Similarly, a yielding type stop means, such as rubber bumpers, can be provided, conjunctively or alternatively, to supplement or replace the limiting and yielding functions of stop means 72 and 74 as well as the spring loading means provided by rods 76. Also, other types of shock resistant stop means, such as wood blocks, serve satisfactorily in certain installations.

Having considered in detail certain forms of the invention wherein a single pivot axis is provided to permit arcuate movement of the winch drum and winch drum mounting base, consideration will now be given to further modifications of the invention by which the fleet angle variation is similarly effectively reduced.

In FIGS. 9, 10, and 11, there are presented respective somewhat diagrammatic views of a modified form of pivotal mounting, utilizing a plurality, two being shown, of fixed pairs of pivot pins 130 and 132, channeled in a fixed baseform (not shown), in the same manner as the pair of pivot pins 70 is channeled in depending flanges 78, 80 and 86, 88 of fixed baseform 30. Such fixed pair of pivot pins 130 and pair of pivot pins 132 cooperate

with corresponding pairs of short slot-like recesses 134 and 136 to effect a pair of spaced axes for the winch drum mounting base 138 on which winch drum 140 is mounted. Such pivot axes are placed to substantially trisect the length of winch drum 140 and function to place the pivot axes at spaced points 142 and 144 along the length of the winch drum 140, as respects the angles of approach of wire rope R and in effect reduce the effective half length of the winch drum by a factor of 3, i.e. to one-third.

As will be evident, when the point and angle of approach of wire rope R to winch drum 140, in the form of the invention illustrated in FIGS. 9-11, lies substantially between the pivot axes provided by the pairs of pivot pins 130 and 132, the winch drum mounting base 138 will be disposed on the pins substantially in the position illustrated in FIG. 9. As the point and angle of approach of wire rope R to the winch drum 140 progress to near either the right or left extremity of the winch drum 140, there is a pivotal movement about one or the other of the pairs of pivot pins 130 and 132, as the case may be, to establish the winch drum axis of rotation at a pivot angle. The pivot angle occurring near the left extremity of the drum is illustrated in FIG. 10 and diagrammatically illustrated in FIG. 3 at 140'. The pivot angle and disposition of the axis of rotation of winch drum 140 when wire rope R is near the right extremity of the winch drum is illustrated in FIG. 11 and indicated diagrammatically in FIG. 3 at 140''. In said FIGS. 9, 10 and 11, the point and angle of approach of wire rope R for the respective winch drum positions shown are presented in diagrammatic dotted line leading in each case from the fixed fairlead F.

FIG. 12 presents yet another modification of means for mounting a winch drum for limited angular movement with respect to a fixed fairlead, in accordance with the principles of the present invention. In FIG. 12, winch drum 150 is journaled in arms 152 and 154 of a winch drum mounting frame 156, in turn mounted to pivot about an opposed pair of aligned pivot pins, one such pivot pin being indicated at 158. Loading and limitation of the extent of angular movement of winch drum 150 is provided by means of a pair of hydraulic cylinders 160, each anchored at one end thereof to the fixed base frame of the assembly, as indicated at 162, with the connecting rods 164 thereof pivotally connected to the ends of frame 156, as indicated at 166. It will be understood that hydraulic cylinders 160 are of a type conventional per se, such as are employed as vehicle shock absorbers, for example, wherein the rate of movement of the rod 164 thereof is restricted under load by constricted flow of contained hydraulic fluid, thus contributing a gradual change in the position of the axis of rotation of winch drum 150. In operation, for example, when the wire rope R proceeds from the central position thereof shown in solid line to a position at one extreme of travel on winch drum 150 as at the right as shown in dotted line, a gradual change in angular position of the mounting frame 156 results, and the winch drum moves to the dotted line position shown, the loading being accomplished by the hydraulic drag generated in both cylinders 160. Also evident will be the fact that the extent of movement of rods 164 in cylinders 160 is limited by the longitudinal dimension of said cylinders, which provides a limitation as to the extent of angular movement of winch drum mounting frame 156 about pivot pins 158, in a manner characteristic of the present invention. Likewise evident will be the feasibility of use of only one hydraulic cylinder in certain installations.

FIG. 13 presents yet another form of winch drum mounting according to the present invention, wherein winch drum 170 is journaled in arms 172 and 174, depending from a winch drum mounting base 176, which in turn has an upper surface 178 of arcuate shape, in the configuration substantially of a segment of a cylinder.

Arcuate surface 178 contacts and rests against a flat surface 180 presented by the fixed basework 182 of the assembly. Attached to fixed basework 182 are a laterally disposed pair of guide blocks 184 presenting slot-like guide surfaces 186 in which ride guide pins 188 in turn mounted on extensions or ears 190 of mounting base 176. Guide surfaces 186 and pins 188 serve to limit the degree of angular movement of winch drum mounting base 176 and also serve to retain the mounting base 176 and winch drum 170 attached to the basework 182 in the event there is no tension on wire rope R, as when the assembly is transported.

Considering the manner of operation of the form of the invention shown in FIG. 13, it will be apparent that when wire rope R is under tension arcuate surface 178 of winch drum mounting base 176 functions to maintain the line of contact thereof with flat surface 180 substantially in intersecting relationship with the line of approach presented by wire rope R. Thus, proceeding from a position shown in solid line where wire rope R is at a central point of approach on winch drum 170, as wire rope R progressively spools onto winch drum 170 and proceeds to one extremity of travel thereof on said winch drum 170, such as shown at the right in dotted line, the line of contact of arcuate surface 178 progressively moves to the right on flat surface 180 and progressively changes the angle of the axis of rotation of winch drum 170 until the winch drum base 176 and winch drum 170 are in the position shown in dotted line, thus effecting a gradual and substantially linear change of the angle of the axis of rotation of winch drum 170 respecting the fixed fairlead, and thus maintaining a substantially constant fleet angle. With respect to a form of the invention involving an arcuate surface generating a moving line of contact between the winch drum mounting base and the fixed basework of the assembly, such as illustrated in FIG. 13, it is to be observed that such functionally represents a refinement of earlier discussed forms of the invention involving a single pivot axis (e.g. in FIGS. 1, 2 and 4-8 and in FIG. 12) and plural pivot axes (e.g. FIGS. 9-11), wherein the number of pivot axes become infinite, resulting in the theoretical fleet angle variation being reduced substantially to zero.

FIG. 14 presents a still further form of the present invention similar to that shown in FIG. 13, but being somewhat simplified in construction and utilizing a reversal of parts as between the arcuate surface and the flat surface generating a progressively moving line of contact (i.e. pivot axis), between the fixed baseform and the angularly movable winch drum mounting base. Specifically, in FIG. 14, the winch drum mounting base 176' on which winch drum 170' is journaled presents a flat surface 200 in contacting engagement with an arcuate surface 202, which arcuate surface 202 is of a configuration substantially the segment of a cylinder with the hypothetical centerline thereof substantially intersecting with fixed fairlead F. Arcuate surface 202 forms a part of base block 204 which is in turn fixedly attached to basework 182 and is thus stationary thereon. Loose attachment and retention of winch drum mounting base 176' on base block 204 is accomplished by centrally disposed bolt 206 threaded into base 176', as indicated at 208, sufficient spacing being provided between the head and shank of said bolt 206 and the facing recesses 210 and 212 in base block 204 to permit and accommodate the arcuate movement of winch drum mounting base 176' as wire rope R progresses from one extreme of travel to the other while spooling onto or off winch drum 170'. As is the case in the form of the invention presented in FIG. 13, the functional relation of flat surface 200 and arcuate or rocker surface 202 in FIG. 14 is such that the line of contact therebetween will be maintained in substantially intersecting relationship with wire rope R and will progressively move from side to side as the spooling progresses in a manner maintaining the fleet angle variation

of wire rope R with respect to the axis of rotation of winch drum 170' substantially zero.

The application of the present invention to any winch mechanism, regardless of use or purpose, wherein a comparatively close fixed fairlead or guide is presented, will be evident whether the line of approach of the wire rope is vertical, horizontal, or otherwise, or whether the axis of rotation of the winch drum is disposed generally horizontally, vertically, or otherwise. In like manner, it will be readily apparent that the winch drum motive power can be by other than the air motor type specifically disclosed, such as by electric or internal combustion prime movers in common use in the winch art. Likewise, while application of the present invention has been disclosed and discussed in connection with use of wire rope or cable, it will be understood that similar problems occur in use of hemp rope or the like and the features of the present invention can be used as well to minimize fleet angle variation when troublesome in such other winched lines. In this latter connection, it is of course to be kept in mind that the tolerable fleet angle variation in a specific installation depends to some extent on the nature of the cable or rope at hand, and the lay or warp of the cable or rope, it being well known that a given cable or rope has a characteristic greater or lesser tendency to bunch or gap, as the case may be, than other similar cables or ropes, and demands correspondingly greater or lesser control of fleet angle variation. Further, it is also well known that a given tendency to bunch or gap of a cable or rope often exerts itself to a greater extent at one end of the winch drum more than at the other end, and it will be readily understood that the degree of compensation for fleet angle variation contemplated by the present invention can be accordingly predetermined or adjusted to maximize compensation where most needed.

Having considered in greater or lesser detail the specific construction and manner of operation of various forms of the invention, various other modifications thereof will readily occur to those skilled in the art, within the spirit and scope of the following claims.

What is claimed is:

1. A winch mechanism comprising a fixed fairlead through which a tensioned wire rope or the like is led to a winch drum, winch drum mounting means comprising a baseform in fixed position with respect to said fairlead, a winch drum mounting base mounted for angular movement with respect to said baseform, and stop means to limit the extent of such angular movement to a small arc, the said winch drum being mounted on said mounting base with the axis of rotation thereof normally disposed substantially perpendicularly to the line of approach of said wire rope, the limited angular movement of the winch drum occurring in response to the tension on said wire rope and the progressive change of the position of wrap thereof onto said drum and reducing variation in fleet angle of the wire rope as it spools across said drum.

2. A level winding winch mechanism having a fixed fairlead from which a tensioned wire rope or the like is led to a winch drum unit, wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the half length of the winch drum by a ratio of less than about 35 to 1, said winch drum unit comprising a power driven winch drum, means mounting said winch drum for angular movement of the drum axis substantially in the plane of said drum axis and said fairlead, and stop means limiting the extent of winch drum angular movement to a small arc, such angular movement being responsive to the tension of the wire rope and progressive change of the position of wrap thereof onto the drum and reducing the variation in fleet angle of the wire rope with respect to the drum axis of rotation as the wire rope spools onto the drum.

3. A level winding winch mechanism according to claim 2, wherein the ratio of fairlead distance and winch

drum half length is less than about 19 to 1, and the variation in fleet angle is less than about 3°.

4. A level winding winch mechanism according to claim 2, wherein said limited arcuate movement maintains a fleet angle variation at less than about 1.5°.

5. A level winding winch mechanism according to claim 2, wherein the ratio of fairlead distance and winch drum half length is less than about 19 to 1 and the fleet angle variation is maintained at less than about 1.5°.

6. A level winding winch mechanism according to claim 2, wherein the ratio of fairlead distance and winch drum half length is about 13.3 to 1.

7. In a winch mechanism comprising a fixed fairlead through which a tensioned wire rope or the like is led to a winch drum comparatively close to said fairlead, winch drum mounting means comprising a baseform in fixed position with respect to said fairlead, a winch drum mounting base mounted on said baseform for angular movement with respect to thereto, a winch drum mounted on said mounting base with its axis of rotation normally disposed substantially perpendicularly to the approach angle of said wire rope, and stop means on said baseform to limit the extent of such angular movement to a small arc, the angular movement of said winch drum mounting base being responsive to the position of wrap of the tensioned wire rope onto the drum and reducing the variation in the wire rope approach angle as said wire rope is spooled across said winch drum.

8. In a winch mechanism according to claim 7, means loading said winch drum mounting base so as to be substantially self-centering with respect to the arc of movement thereof on said baseform.

9. A winch mechanism according to claim 8, wherein said means loading said winch drum mounting base to establish the same substantially self-centering is correlated with the amount of tension on the wire rope so as to render the rate of arcuate movement of the winch drum and winch drum mounting base substantially linearly related to the tension and progressive change of the position of wrap of said wire rope onto said drum as the same spools from the center of the drum outwardly toward either end thereof.

10. A winch mechanism according to claim 8, means for self-centering said winch drum mounting base with respect to the arc of movement thereof on said baseform, said self-centering means comprising spring means interposed between said baseform and said mounting base.

11. A winch mechanism according to claim 10, wherein said spring means comprises an opposed pair of spring rods maintained under stress with one end of each of said spring rods disposed against said baseform at respectively opposite sides thereof and the other end of each of said spring rods disposed against said mounting base at respectively opposite sides thereof.

12. A winch mechanism according to claim 7, wherein said stop means comprises hydraulic means loading said winch drum mounting base to limit the arc of movement and rate of angular movement thereof.

13. A winch mechanism according to claim 12, wherein said hydraulic means comprises double acting hydraulic cylinders situated at opposite sides of said winch drum mounting base.

14. A level winding winch mechanism having a fixed fairlead from which a tensioned wire rope or the like is led to a winch drum unit, wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the effective half length of the winch drum by a ratio of less than about 35 to 1, said winch unit comprising a reversible power driven winch drum, means mounting said winch drum for angular movement of the drum axis substantially in the plane of said axis and said fairlead, and stop means to limit such angular movement to a small arc, the said winch drum mounting means comprising a fixed baseform and a winch drum mounting

base with pivot means therebetween affording movement of said base on said baseform in an arc lying substantially in the plane of movement of said wire rope as the rope spools across said winch drum, such pivotal movement of said mounting base being responsive to such movement of the tensioned rope across the drum and effectively reducing fleet angle variation in the angle of approach of said wire rope to the drum.

15. A level winding winch mechanism according to claim 14, wherein said winch drum mounting base is mounted with respect to said baseform by pivot means providing at least one pivot axis.

16. A level winding winch mechanism according to claim 15, wherein said winch drum mounting base is mounted with respect to said baseform by pivot means providing a single pivot axis disposed substantially in a plane intersecting said fairlead and substantially bisecting said winch drum.

17. A level winding winch drum mechanism according to claim 14, wherein the pivot means between said winch drum mounting base and said baseform comprises two spaced and substantially parallel pairs of pivot pins disposed in respective planes intersecting said fairlead and substantially trisecting the length of said winch drum, which pins cooperate with slot-like recesses dimensioned to provide the said stop means.

18. A level winding winch mechanism having a fixed fairlead from which a tensioned wire rope or the like is led to a winch drum unit, wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the effective half length of the winch drum by a ratio of less than about 35 to 1, said winch drum unit comprising a reversible power driven winch drum, means mounting said winch drum for angular movement of the drum axis substantially in the plane of said axis and said fairlead, and stop means limiting the extent of winch drum angular movement to a small arc, such arcuate movement being responsive to the tension of the wire rope and progressive change of the position of wrap thereof onto the drum and reducing the variation in fleet angle of the wire rope with respect to the drum axis of rotation as the wire rope spools onto the drum, the said winch drum mounting means comprising a fixed baseform and a winch drum mounting base, one of such winch drum mounting means components having an arcuate surface constituting substantially a segment of a cylinder, with the said arcuate surface in contact with an essentially flat surface on the other of such components.

19. A level winding winch mechanism according to claim 18, wherein said arcuate surface is on said winch drum mounting base and said essentially flat surface is on said fixed baseform.

20. A level winding winch mechanism according to claim 18, wherein said arcuate surface is on said fixed baseform and said essentially flat surface is on said winch drum mounting base.

21. A level winding mechanism according to claim 18, wherein the said arcuate surface on said fixed baseform has a hypothetical centerline substantially intersecting said fixed fairlead.

22. A level winding winch mechanism having a fixed fairlead from which a tensioned wire rope or the like is led to a winch drum unit, wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the effective half length of the winch drum by a ratio of less than about 35 to 1, said winch drum unit comprising a reversible power driven winch drum and means mounting said winch drum for limited angular movement of the drum axis substantially in the plane of said axis and said fairlead responsively to the tension and position of wrap of the wire rope onto the drum, the said winch drum mounting means comprising a fixed baseform, a winch drum mounting base, and stop means limiting the extent of angular movement therebetween, the extent of angular movement thus provided by said

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stop means establishing the angle of approach of the wire rope to the axis of the drum at the extremes of travel thereof on the drum as an acute included angle which is substantially but not quite 90° .

23. A level winding winch mechanism having a fixed fairlead from which a wire rope or the like is led to a winch drum unit, wherein the distance of the fairlead to the axis of rotation of the winch drum is related to the effective half length of the winch drum by a ratio of less than about 19 to 1, said winch drum unit comprising a reversible power driven winch drum and means mounting said winch drum for limited arcuate movement of the drum axis substantially in the plane of said axis and said fairlead, the said winch drum mounting means comprising a fixed baseform, a winch drum mounting base, and stop means limiting angular movement therebetween, determining the extent of fleet angle variation when the wire rope is at positions of wrap onto the extremities of the winch drum, and establishing such fleet angle variation at less than about 3° .

24. A level winding winch mechanism according to claim 23, wherein said stop means are adjustable as to the extent of winch drum angular movement thereby provided.

25. In combination with a power driven winch assembly adapted for applications involving a fixed fairlead and a winch mechanism comparatively close thereto, the improvement which comprises winch drum mounting means including a fixed baseform, a winch drum mounting base mounted for angular movement with respect to said baseform, and stop means to limit such angular movement to a small arc, the said winch drum being mounted on said mounting base with the axis of rotation thereof normally disposed substantially perpendicularly to the line of approach of a tensioned wire rope led thereto through said fixed fairlead, such combination further comprising means arranged and acting between said baseform and said winch drum mounting base to maintain the limited arcuate movement of the winch drum substantially in the plane of said axis and said fairlead and cause occurrence thereof in response to progressive change of the position of wrap of said wire rope onto said drum, thus reducing variation in fleet angle of the wire rope and render such level winding as it spools across said drum.

26. In combination with a suspended, power driven staging of the type described, having a fixed fairlead at the top thereof through which a wire rope or the like suspending said staging is led to a winch drum in the lower portion of said staging and comparatively close to said fairlead, the improvement which comprises winch drum mounting means including a baseform in fixed position below said fairlead, a winch drum mounting base mounted on said baseform for limited arcuate movement with respect thereto, a winch drum mounted on said mounting base with its axis of rotation normally disposed substantially perpendicularly to the approach angle of said wire rope, and stop means to limit such angular movement to a small arc, such combination further comprising means arranged and acting between said baseform and said winch drum mounting base to maintain the angular movement of said winch drum mounting base substantially in the plane of said axis and said fairlead and responsive to the tension and position of wrap of the wire rope onto the drum, thus reducing the variation in wire rope approach angle and render said wire rope level winding as it spools across said winch drum under the weight of said staging.

27. The combination set forth in claim 26, further comprising loading said winch drum mounting base so as to be substantially self-centering with respect to the arc of movement thereof on said baseform.

28. The combination set forth in claim 27, wherein said

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means for self-centering said winch drum mounting base with respect to the arc of movement thereof on said baseform comprises spring means interposed between said baseform and said mounting base.

29. The combination set forth in 28, wherein said spring means comprises a pair of crossed spring rods maintained under stress with one end of each of said spring rods disposed against said baseform at respectively opposite sides thereof and the other end of each of said spring rods disposed against said mounting base at respectively opposite sides thereof.

30. The combination set forth in claim 27 wherein said means loading said winch drum mounting base to establish the same substantially self-centering is correlated with the amount of tension on the wire rope so as to render the rate of arcuate movement of the winch drum and winch drum mounting base substantially linearly related to the progressive change of the point of approach of said wire rope to said drum as the same spools from the center of the drum outwardly toward either end thereof.

31. The combination set forth in claim 26, wherein the fairlead distance above the drum axis is about $60''$, the effective half length of the winch drum is about $4.5''$, said ratio is about 13.3 to 1, and the extent of angular movement of said winch drum is about 3° each side of the center position thereof.

32. In a power driven, suspended staging having a deck supporting the operator thereof and having a fixed fairlead above said deck from which a wire rope or the like is led to a winch drum unit below said deck, said winch drum unit including a reversible power driven winch drum pivotal mounting means permitting angular movement of the axis of rotation of said winch drum substantially in the plane of said axis and said fairlead, and stop means to limit such angular movement to a small arc, such angular movement occurring responsive to the tension and position of wrap of said wire rope onto said winch drum, the said winch drum mounting means comprising a fixed baseform on said deck, a winch drum mounting base depending from said baseform, and stop means limiting the extent of arcuate movement therebetween so as to maintain any variation in fleet angle of said wire rope with respect to said drum at less than about 3° .

33. In a hoisting mechanism including a winch assembly and a fixed fairlead having a cable leading to a winch drum comparatively close to said fairlead, winch drum mounting means comprising a baseform in fixed position with respect to said fairlead, a winch drum mounting base mounted on said baseform in a manner enabling slight angular movement of the axis of rotation of the winch drum with respect to said baseform, stop means to limit such movement to a small arc, and means acting between said winch drum and said baseform to normally substantially center said winch drum in its arc of movement on said baseform yet permit the torque generated by the tension and position of wrap of the cable onto the winch drum to angularly move the axis of rotation of the winch drum in a manner reducing variation in fleet angle of the cable with respect to the drum axis as the cable spools across the drum.

34. In a mechanism including a winch assembly and a fixed fairlead having a cable leading to a winch drum comparatively close to said fairlead, winch drum mounting means comprising a baseform in fixed position with respect to said fairlead, a winch drum mounting base pivotally mounted on said baseform, and limiting pivotal movement of said winch drum mounting base to a slight rocking movement of the ends of said winch drum toward and away from said fairlead to reduce variation in the fleet angle of the cable with respect to the drum axis as the cable spools back and forth onto the drum.

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