

Dec. 9, 1958

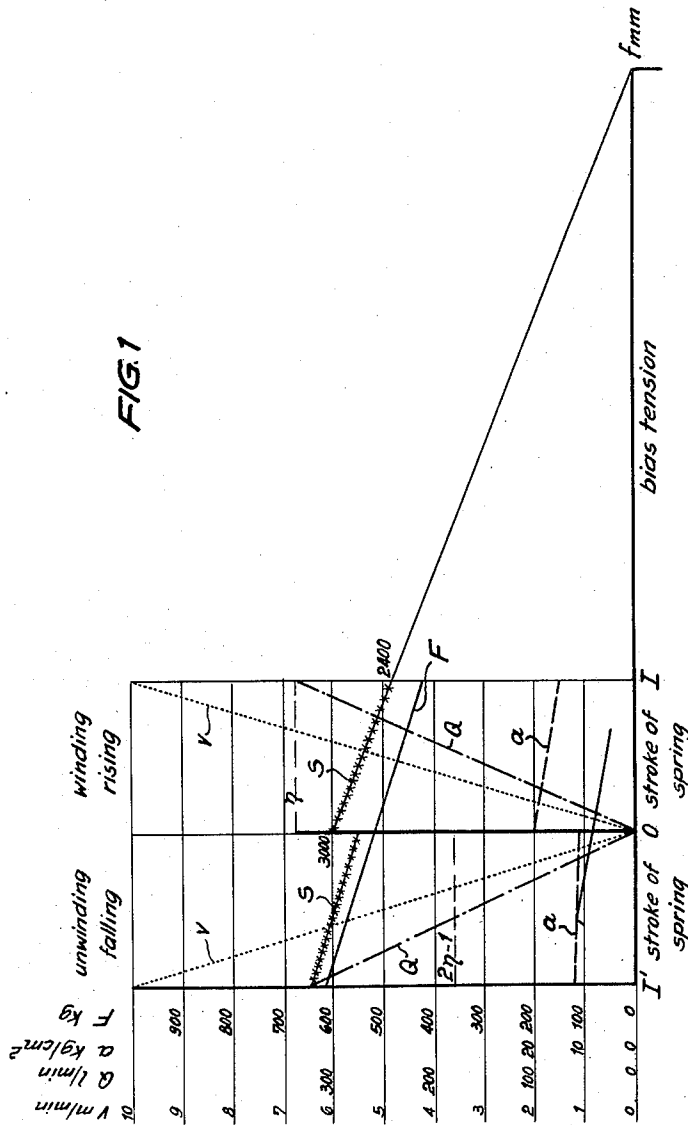
M. H. E. PAPE

2,863,636

WINCH WITH CABLE TENSION DEVICE

Filed Feb. 23, 1955

4 Sheets-Sheet 1



INVENTOR

MARTIN HERRMANN EMIL PAPE

Townsend F. Roaman
Attorney

Dec. 9, 1958

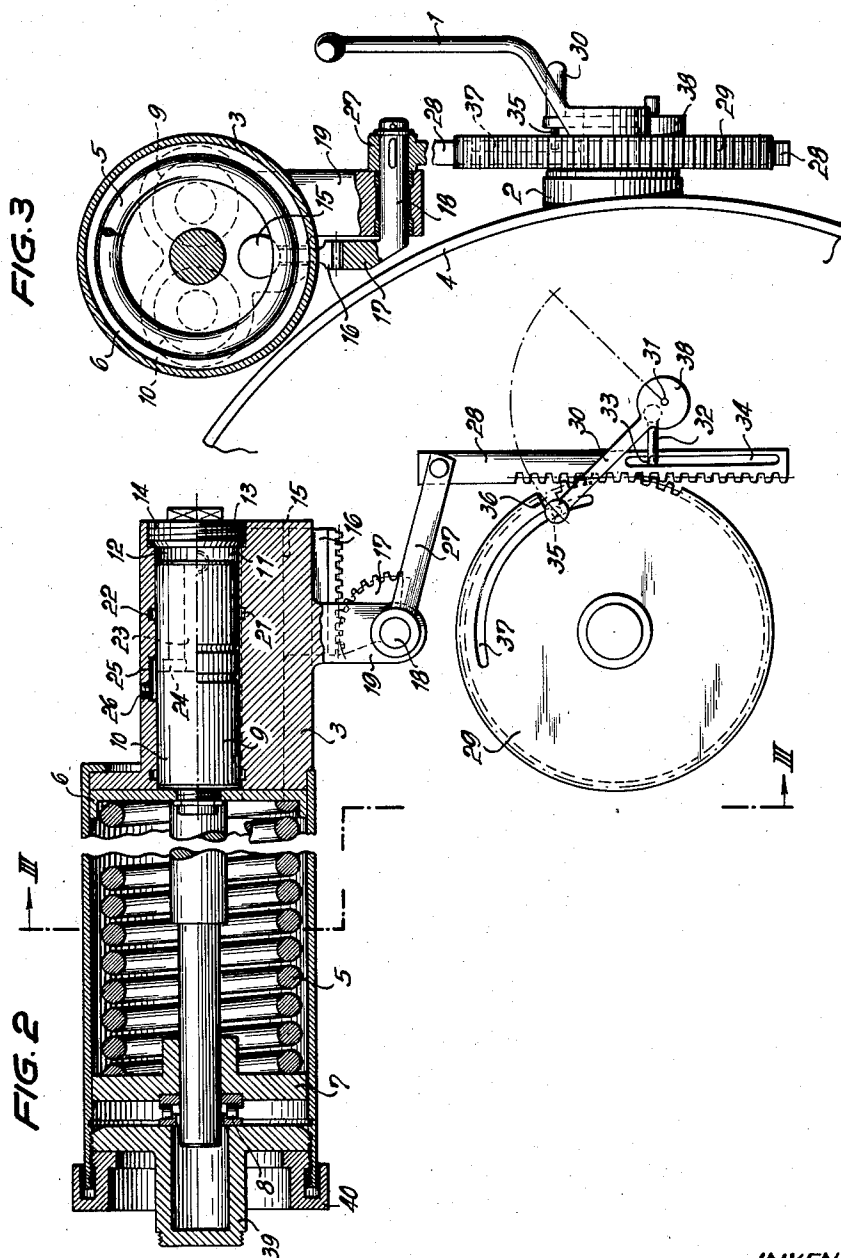
M. H. E. PAPE

2,863,636

WINCH WITH CABLE TENSION DEVICE

Filed Feb. 23, 1955

4 Sheets-Sheet 2



INVENTOR

MARTIN HERRMANN EMIL PAPE

Lansend F. Beaman
Attorney

Dec. 9, 1958

M. H. E. PAPE

2,863,636

WINCH WITH CABLE TENSION DEVICE

Filed Feb. 23, 1955

4 Sheets-Sheet 3

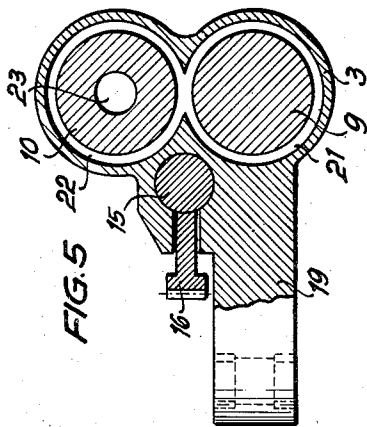


FIG. 7

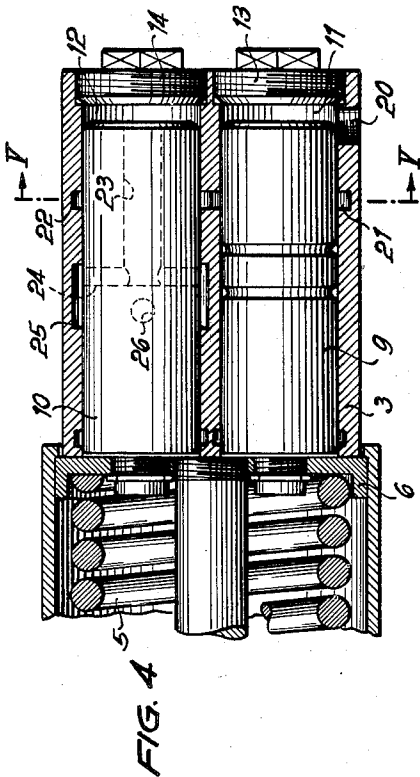
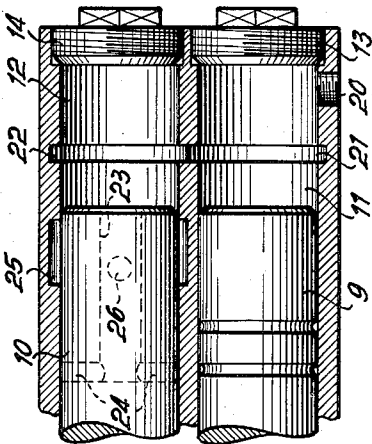
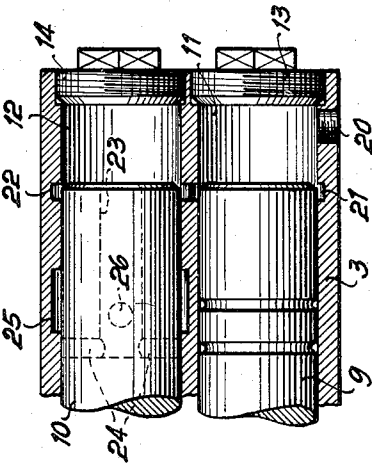


FIG. 6



INVENTOR

MARTIN HERRMANN EMIL PAPE
Lawrence F. Bohman
Attorney.

Dec. 9, 1958

M. H. E. PAPE

2,863,636

WINCH WITH CABLE TENSION DEVICE

Filed Feb. 23, 1955

4 Sheets-Sheet 4

Fig. 9

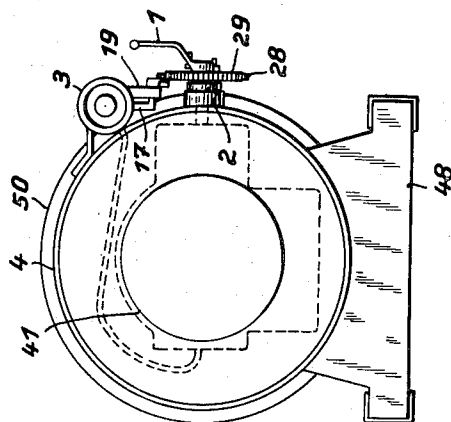
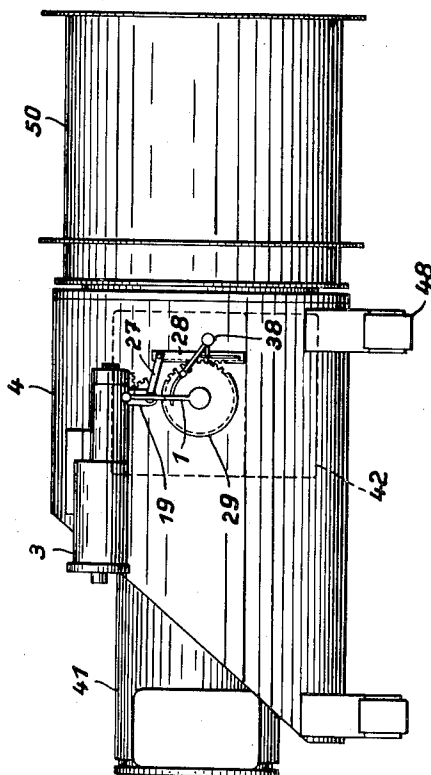


Fig. 8



1

2,863,636

WINCH WITH CABLE TENSION DEVICE

Martin Herrmann Emil Pape, deceased, late of Hamburg, Germany; Margarete M. J. Stolleis, heir of two-thirds and Edda M. E. Stolleis, heir of one-third of the estate of said Pape, assignors to Willi Baensch, Hamburg-Altona, Germany, a firm

Application February 23, 1955, Serial No. 490,105

Claims priority, application Germany February 23, 1954

3 Claims. (Cl. 254—172)

The invention relates to hydraulically controlled winches which, without appreciable alteration of their normal construction, can by an additional device solve the problem of automatically unwinding or winding up a cable while maintaining a given cable tension. Such a problem is posed when a vessel is moored to the lock walls in a lock, as are present for example between the North American lakes, and a desired cable force must be maintained, if the water level and vessel rapidly fall or rise, without necessitating attention. The same need arises in the rapid loading of a vessel from bunkers, in the rise and fall of a vessel on the tide, and in dumping the cargo of a vessel, which should lie or be held at a certain distance from the roadstead in front of the anchor.

Such warping winches (known as mooring winches abroad) were previously made as separate winches and constructed essentially as steam winches.

The invention provides a dual function for hydraulically regulated winches in that the winches can be used as loading winches in their normal construction and also as mooring winches, whereby in the later case a desired and even adjustable cable tension is automatically maintained in both directions (rising and falling).

The type of hydraulic winch with which the invention may be used is of the known construction which comprises a pump or primary part, driven from a power source, supplying pressurized fluid to an hydraulic motor or secondary part which in turn rotates the winch drum. Control means are used to regulate the output of the pump whereby the hydraulic motor and drum may be selectively rotated in either direction at infinitely variable speeds and torques.

Basically, an object of the invention is to automatically maintain a given tension in the rope or cable being wound or unwound on the winch drum by comparing the pressure of the fluid being supplied to the hydraulic motor by the pump to a preselected force produced by a spring to maintain a given tension on the rope. This may be achieved by the use of a piston, acted upon by the output fluid of the pump, compressing a spring of known characteristics whereby a rise in fluid pressure will further compress the spring and a decrease in pressure will cause the piston to move under the influence of the spring. The movement of the piston may be coupled by a mechanical connection to the control means regulating the pump output whereby an increase or decrease of the fluid pressure from the predetermined spring value will automatically result in a compensating movement of the pump control to regulate the pump output to produce the desired pressure and hence the desired speed and torque of drum rotation and cable or rope tension.

Considering firstly, for better understanding, only the lifting side, i. e. for example with a vessel in a lock, the rising of the vessel corresponding to the winding up of the

2

cable moored to the bank, it will be understood that, if the cable is wound up more rapidly than the vessel rises, the hydraulic pressure at the pump outlet rises, hence at the same time the spring is additionally stressed so that the amount of liquid and the winding velocity of the cable are automatically decreased until equilibrium is achieved between the hydraulic pressure and the spring force, whereby the cable velocity and the velocity of rise of the vessel are in the proper relation. An inequality of these two quantities involves either loosening of the cable, hence reduction of the driving liquid pressure, whereby the pump supplies a greater amount of liquid, i. e., greater cable winding velocity or additional tension of the cable with the opposite effect (increase of the liquid pressure, enhanced spring compression, decrease of liquid amount, i. e. smaller cable velocity).

In the reverse lock operation, i. e. on lowering of the vessel, the spring must have the tendency to alter the output of the pump to a minimum, hence also the liquid quantity to a minimum, which is opposite to raising of the vessel for in lowering of the vessel, the cable must be unwound. Excessive unwinding would make the cable slack, decreasing the hydraulic pressure, so that the excessive spring force must decrease the liquid quantity and hence the lowering velocity. That is also done, and the pump forced into its lowering position beyond the neutral position does directly what is required of it. Unfortunately the mechanical efficiency, and also the hydraulic efficiency, is reversed and assumes very different size values as in winding of the cable. Rising of the vessel is comparable with the winding up of a load, while unwinding compares to the lowering of the load. If now in the first case the efficiency is η , it is, as is well known, in the second case $2\eta-1$. In the case of the hydraulically adjusted loading winch, the amount

$$\frac{\eta}{2\eta-1} \text{ approximately equals } \frac{2}{1}$$

i. e. in unwinding the cable (lowering) with a given cable force, theoretically only half the liquid pressure within the hydraulic motor is necessary as in cable winding (rising) with the same cable force. As it is desired to use the same spring, piston and connecting means between the piston and pump controls for both winding and unwinding operations, it will be apparent that the reduced pressure required to maintain a given cable tension during unwinding of the drum, in respect to the winding or raising operation, necessitates means to compensate for this phenomenon and such compensating structure is provided by the invention. This effect is obtained according to the invention as follows: Two pistons are provided which move in common axial movement by a disc to which they are both secured. During the winding operation only one piston is subject to liquid pressure as described below. At the moment where the two pistons are in a position where the pump output is zero so that the two pistons communicate with the pressure liquid so that the double piston surface is available from this instant, so that a considerably decreased pressure, as arises only by the backward efficiency of $2\eta-1$ brings the regulating device into operation despite decreased hydraulic pressure and multiplied spring forces. According to the size of η and the ratio

$$\frac{\eta}{2\eta-1}$$

the diameter of the second piston may deviate from the diameter of first piston to operate to the satisfaction of

said ratios. As given in the later description of the example, supply and withdrawal of the pressure liquid for the second piston is controlled by the piston itself.

The automatic longitudinal movement of the pistons is transmitted by a rack coupled to it from the hand control wheel regulating the pump output. The biasing tension of the spring can be altered by a setting screw whereby it is possible to set the spring forces and hence the cable forces to a higher or lower level.

If the loading winch is to be used as a mooring winch, all that is necessary for such a change is turning a small hand crank through 90°. By this (1) a linked rack is engaged, (2) the hydraulic supply valve between the drive and pistons is opened and (3) the hand control wheel is brought into the greatest setting, "rising," since only thus can the small hand crank be turned into the "in" position.

A preferred example of the construction is described below:

Fig. 1 represents a graph illustrating various characteristics of the invention,

Fig. 2 shows a longitudinal section through the parts essential for the invention,

Fig. 3 shows a transverse section substantially along the line III—III of Fig. 2,

Fig. 4 shows a horizontal section through the two control cylinders,

Fig. 5 shows a section along the line V—V of Fig. 4,

Fig. 6 shows a section through the control cylinders similar to those of Fig. 4, wherein the two control cylinders are in the neutral position (O position of Fig. 1), and

Fig. 7 shows a section like Fig. 6, but with the pistons in the left hand end position corresponding to position I' of Fig. 1.

Figs. 8 and 9 illustrate general schematic elevational and end views of a possible arrangement of the components of the winch, the pump, motor and base forming no part of the invention.

The winch is provided with a liquid drive operating upon the displacement principle which includes a pump or primary part driving a motor or secondary part which rotates the winch drum. For reversing its operation the pump output is adjustable in either direction from a neutral position, whereas the motor part can be influenced automatically in either direction of rotation as above mentioned. An example of a liquid drive employing the above principles is shown in Patent No. 2,186,409 disclosing a typical general construction wherein a variable output pump is employed to drive a hydraulic motor at varying speeds and torques.

According to Figs. 2 to 6, in the vicinity of the hand lever 1 from which a pump output control drum 2 is operated, a housing 3 is provided consisting of several parts. The control drum 2 is operatively connected to the pump to adjust the pump output, both directional and quantity-wise, and consequently the motor characteristics of the hydraulic drive. In one direction of rotation of the hand lever 1, winding of the winch drum and cable is caused and in the other direction unwinding of the drum results. 4 indicates a part of the outer housing of the liquid drive. A possible arrangement of the components of a winch employing such structure is generally shown in Figs. 8 and 9, wherein the winch structure is supported upon a base 48 and includes a power source 41, drivingly connected to the liquid drive 42 which in turn rotates the winch drum 50, as desired.

A spring 5 is arranged in the housing 3 and contacts at one end a spring plate 6 and at the other end spring disc 7 which is backed by a roller bearing 8 on a nut 39 which is screwed into one part of the housing 3. A cover 40 encloses the hole and serves simultaneously as a lock nut for the nut 39. By screwing the nut 39 in or out, the tension of the spring 5 can be altered.

Two pistons 9, 10 arranged side by side are secured in

any way to the spring plate 6 and are movably arranged in the housing 3. Two operating spaces 11, 12 are created in this way which are enclosed by covers 13, 14.

A bolt or plunger 15 is also secured to the plate 6 in a manner not shown in detail which takes part in the inward and outward movements of the pistons 9, 10 as further described below. The bolt or plunger 15 is likewise guided in the housing 3 and rigidly connected with a rack 16, which engages with a toothed segment 17 rigidly connected with a shaft 18 which is rotatably mounted in a projection 19 upon the housing 3.

The cylinder space 11 of the piston 9 is connected at the connection 20 for fluid communication with the pressure or output side (of the pump or primary part) of the hydraulic drive. Both pistons 9, 10 are shown in Fig. 4 in the end position in which the pump operates with the maximum desired driving amount and the most rapid rising or winding up takes place. Thus, only the piston 9 is subjected to the fluid pressure supplied from the pump to the hydraulic motor when the pistons 9 and 10 are in the position shown in Fig. 4. As the fluid pressure rises, as in the case when the resistance to rotation of the winch drum increases resulting from increased tension in the rope or cable, the piston 9 will be forced toward the left compressing spring 5 and should the pressure decrease the spring 5 will move the piston 9 to the right, as viewed in Fig. 4.

When the pistons are moved to the position shown in Fig. 6, which is the neutral position, the fluid within cylinder 11 may now communicate with cylinder 12 by means of the intersecting annular grooves 21 and 22 formed in cylinders 11 and 12, respectively. Thus, once pistons 9 and 10 are in the position of Fig. 6 both pistons are subjected to the pump output pressure in all positions to the left and greater forces are exerted on spring 5 due to the greater piston area subjected to the fluid pressure. The function and operation of this construction will be later described.

The piston 10 is provided with a central drilling 23 from the base of which extend preferably a number of radial drillings 24. During the first part of the movement of the piston 10, the operating space 12 of this piston communicates by way of the central drilling 23 and the drilling 24 with an annular space 25 which is connected to the discharge by a connection 26. As soon as the piston 9 frees the annular space 21 and the operating space 12 has become connected with the pressure medium supply, the connection of the drillings 24 with the annular space 25 is interrupted, whereby the operating space 12 is shut off from the discharge.

The discharge of the pressure medium from the operating space 12 with the piston returning to its initial position can then occur again through the drilling 23, the radial drillings 24 and the annular space 25. In Fig. 6, the position of the two pistons 9, 10 is shown in the instant where the operating space 12 has been connected with the pressure medium supply and shut off from the pressure medium discharge. In Fig. 7 the position of the two pistons 9, 10 shown is the left-hand end position, which thus corresponds with the maximum unwinding position.

A lever 27 is keyed to the shaft 18 and a rack 28 is connected to it, the teeth of which mesh with the teeth of a gear wheel 29, which is rigidly connected with hand lever 1. Therefore, a mechanical connection is made between the piston movements and the means controlling the pump output which permits the device to operate as follows:

As stated above, the object of the invention is to provide automatic means for maintaining a given cable or rope tension on a hydraulic winch and such control is achieved by maintaining a balance between the force exerted by spring 5 and the force produced by the fluid pressure acting on pistons 9 and 10. Thus, initially the nut

39 is rotated to produce a predetermined compression of

5

spring 5, the lever 1 is then rotated to rotate drum 2 and regulate the pump output to either wind or unwind the drum as desired. For instance, where it is desired to maintain a given tension in a cable affixed to a vessel which is rising, as in a lock or incoming tide, the lever 1 is rotated to cause the winch drum to wind up and due to the connection between gear wheel 29 and spring plate 6 via rack 28, lever 27, rack and pinion 16 and 17, and plunger 15 the pistons 9 and 10 will be moved to the position shown in Fig. 4 where only piston 9 is subject to the fluid pressure of the pump output. Once lever 1 is in the wind position the winch drum will rapidly rotate to take up the cable slack, the pressure within cylinder space 11 will be small at this time. When the cable becomes taut the pressure within cylinder 11 will rise and upon the fluid pressure reaching a value sufficient to overcome the preset tension in spring 5 the piston 9 will begin to move to the left, Fig. 4. Such movement will cause plunger 15, rack 16, rack 28 to move, rotating gear wheel 29 in a direction to reduce the pump output, thus decreasing the cable tension and fluid pressure within cylinder 11, as the pump output is decreased a point is reached where the spring force is greater than the fluid force and spring 5 will then move the piston 9 and plate 6 to the right within a resulting rotation of gear wheel 29 which increases the output of the pump to a point where a balance is maintained between the force exerted by spring 5 and that produced by the fluid pressure. This pressure is that necessary to produce the desired tension in the cable or rope affixed to the vessel. Therefore, it will be understood that the pump output pressure will be automatically regulated to produce a given tension in the cable at all times irrespective of how fast or slow the vessel rises. To increase the cable tension the nut 39 must be rotated to further compress spring 5 necessitating a higher fluid pressure to initiate movement of piston 9 or conversely a lower tension may be maintained by decreasing the compression of spring 5 resulting in a lower pressure being supplied by the pump.

To maintain the proper tension in a vessel lowering on a tide or in a lock, the lever 1 is rotated in the opposite direction to that to produce winding of the cable. Such rotation of lever 1 will position pistons 9 and 10 as shown in Fig. 7 wherein the pressurized pump fluid has access to both cylinders 11 and 12 increasing the effective area of the fluid acting on spring 5. The increase in area is necessary for two reasons, the first being that less fluid pressure is required to maintain a given cable tension during unwinding as compared with winding, as explained above, secondly, as the spring 5 is compressed to a greater extent during the unwinding operation more force must be exerted by the fluid than in the winding phase.

During unwinding the operation is similar to winding except the pressure relationship is reversed. Initially, the lever 1 is rotated to maximum unwind, however, if the cable becomes slack the pump output pressure will decrease and pistons 9 and 10 will be moved to the right by spring 5 decreasing the pump output quantity slowing the unwinding of the drum to a point where a balance is achieved between spring and fluid pressure. If the cable unwinds too slowly the fluid pressure within cylinders 11 and 12 will move plate 6 to the left compressing the spring 5 with a resultant rotation of wheel 29 to increase pump output and cause faster unwinding.

By proper relationship of the spring properties to the pistons 9 and 10, which are preferably of substantially equal size, the same initial setting of the spring 5 to produce a particular cable tension during winding or unwinding may be obtained.

The theory of operation is graphically illustrated in Fig. 1 wherein the vertical coordinates I', O and I represent maximum unwinding pump output, neutral or zero pump output and maximum winding pump output, respectively. The lines "S" represent cable or rope tension, "F" is the spring force, "Q" is fluid quantity, "V" cable

6

velocity and "a" is the fluid pressure at the pump output or discharge. As will be noted, the fluid pressure at the pump outlet "a" is less during unwinding than winding for a given cable tension yet the spring forces are greater. Thus, the necessity for increased piston area during the unwinding operation.

To insure that the rack 28 is properly oriented to the gear wheel 29 each time the rack and gear are engaged, a hand lever 30 is provided which is rotatably mounted at 31 in a rigid part. This hand lever is connected by a rod 32 with a pin 33 which engages in a longitudinal groove 34 in the rack 28. The hand lever 30 also includes a pin 35 which can enter an arcuate groove 37 by way of a radial groove 36 in the gear wheel 29. The radial groove 36 is so arranged that the pin 35 can only enter it when the hand lever 1 has set the pump by way of the control drum 2 to its greatest output capacity during rising or winding up. The rod 32 is arranged at the same time so that, when the pin 35 enters the arcuate groove 37, the rack 28 is in engagement with the gear wheel 29 and hence the pump output can be adjusted in dependency upon the position of the pistons 9, 10 and hence upon the supply pressure of the pump part.

The hand lever 30 also acts upon a shut-off device 38 which is inserted in the duct which leads to the pressure medium connection 20. In the position of the lever 30 shown (Fig. 2) this shut-off device 38 is opened, the pistons 9, 10 thus being under the influence of the supply pressure of the pump part for automatic winch control.

When the lever 30 is turned through 90° into the "out" position shown by dot-dash lines (this is only possible if the gear wheel 29 is in the position of Fig. 2), the shut-off device 38 is simultaneously closed. The device described is thus disconnected which serves for the use of the winch as a loading winch. The winch can be used as a mooring winch again by operating lever 30 to open device 38 and engage rack 28.

What is claimed is:

1. In a hydraulic winch employing a cable drum and having a primary or pump part drivingly communicating with a secondary or motor part for rotating the cable drum and a control member for regulating the output of the primary part over a controlling range from maximum winding-up over a neutral setting to maximum unwinding, the improvement comprising automatic control means for maintaining a constant tension in a winch cable wound on the cable drum when winding-up or unwinding under load, said means comprising a housing structure defining first and second adjacent parallel cylinder spaces, said first of said cylinder spaces being in fluid communication with the outlet fluid pressure of the primary part, first and second interconnected pistons reciprocable in said first and second cylinder spaces, respectively, and operatively connected to the control member for correlated movement, spring means acting on said pistons urging the control member toward the maximum wind-up position, adjustable means adapted to pre-determine the force produced by said spring, a passage disposed in said housing communicating said first cylinder space with said second cylinder space at the position of said first piston corresponding to the neutral setting of the control member and said second cylinder space having means of communication for discharge of the fluid pressure within said second cylinder space only during movement of said pistons corresponding to the winding-up range of the control member.

2. Control means for a hydraulic winch as in claim 1 wherein said first and second pistons have substantially equal effective fluid pressure surface areas and disengaging means are interposed in the operative connection between said pistons and the control member selectively rendering the operative connection between said pistons and the control member ineffective to facilitate manual operation of the control member.

3. Control means for a hydraulic winch as in claim 1 wherein the operative connection between said pistons and the control member comprises an axially movable gear rack operated by axial movement of said pistons selective engageable with a gear affixed to the control member at a pre-determined relationship of said rack and gear.

References Cited in the file of this patent

UNITED STATES PATENTS

2,403,924	Herman et al. -----	July 16, 1946
2,554,381	Patterson -----	May 22, 1951
2,732,180	Gratzmuller -----	Jan. 24, 1956