Nov. 15, 1955 H. F. BURFEIND 2,723,833

NO-POWER HOLDING, LOW-INERTIA, WINCH SYSTEM

Filed May 8, 1953

2 Sheets-Sheet 1

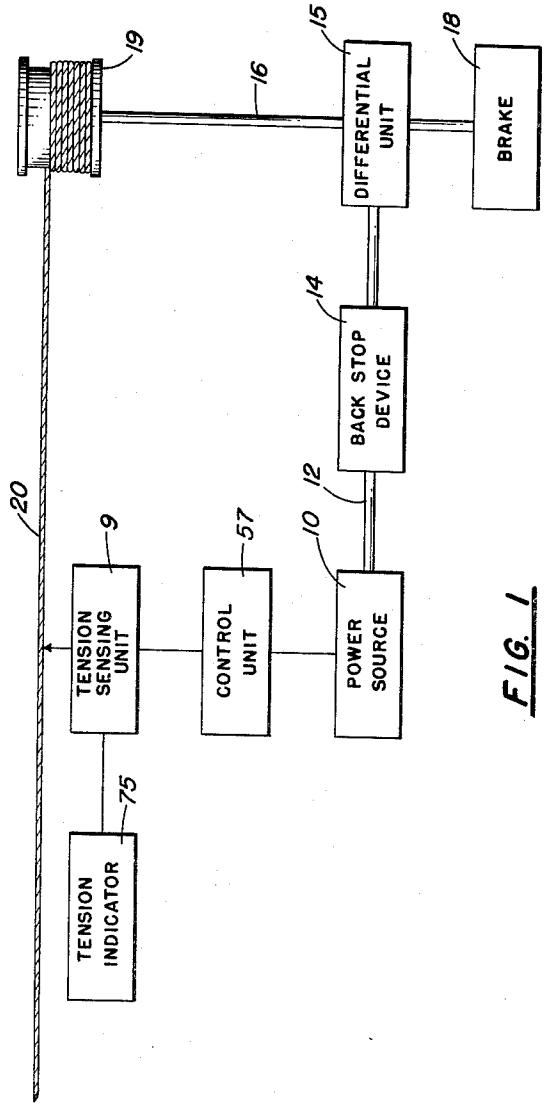

FIG. 1

INVENTOR
HENRY F. BURFEIND

BY J. Schmutt
R. I. Tompkins
ATTORNEYS

Nov. 15, 1955 H. F. BURFEIND 2,723,833

NO-POWER HOLDING, LOW-INERTIA, WINCH SYSTEM

Filed May 8, 1953 2 Sheets-Sheet 2

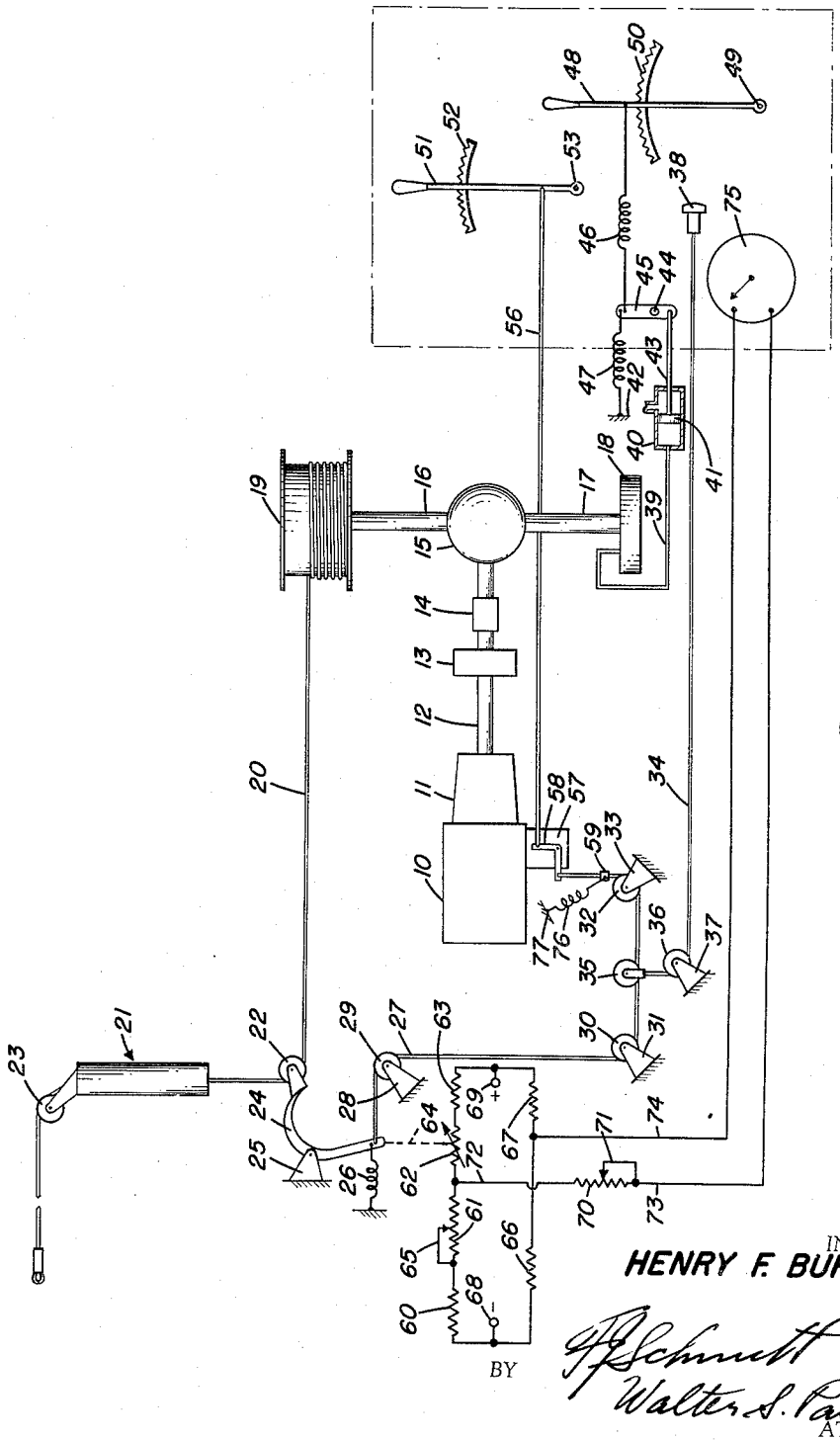

FIG. 2

INVENTOR
HENRY F. BURFEIND

BY

Walter S. Pawl.
ATTORNEYS

United States Patent Office 2,723,833 Patented Nov. 15, 1955

2,723,833

NO-POWER HOLDING, LOW-INERTIA, WINCH SYSTEM

Henry Frank Burfeind, United States Navy, assignor to the United States of America as represented by the Secretary of the Navy

Application May 8, 1953, Serial No. 353,925

13 Claims. (Cl. 254—172)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a no-power holding, low-inertia, winch system and more particularly to a no-power holding, low-inertia, winch system having automatic and manual control features.

The present invention is a winch control system wherein power is applied to a differential unit having two differential outputs, of which one is connected to a constant force brake and the other to a winch. Whenever the tension on the cable being hauled in by the winch exceeds the brake force, the brake slips allowing the cable to be payed out until the tension lowers again to the force of the brake. A tensiometer is provided to detect changes in cable tension and to adjust the power drive for the differential input to maintain a predetermined cable tension. A back stop device prevents the winch from acting as an input and reversing the direction of the power shaft when the cable tension exceeds the power input force. This system has many advantages over prior winch control systems including: low cost, automatic operation, more accurate tension control and quicker and safer action. It has applications including line handling in refueling and replenishment at sea by surface vessels, ground handling of airships, and generally for line handling where substantial lengths of cable must be controlled under rapidly changing tensions and speeds.

Accordingly an object of the present invention is the provision of a winch system wherein cable loads can be reversed approximately instantaneously upon the cable tension exceeding a predetermined value.

Another object is to provide a system for automatically maintaining a constant tension on a cable which is being hauled in by a winch.

A further object of the invention is the provision of a winch system which will hold a load automatically without the application of power.

Still another object is to provide a system which will maintain positive winch control and prevent the development of high inertia forces to be set up in the winch cable.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 shows a partially schematic and partially diagrammatic view of a preferred embodiment of the invention.

Fig. 2 illustrates a specific embodiment of the invention.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 (which illustrates a preferred embodiment) a power source **10** which drives a shaft **12** through a back stop device **14** to the input of differential unit **15**. One of the differential outputs is restrained by brake **18** while the other rotates shaft **16** and winch **19**. The tension of cable **20**, which is being hauled in or payed out by winch **19**, is detected by tension sensing unit **9**. One output of this unit operates a tension indicator which produces an indication of the tension of cable **20**, and another output operates a control unit **57** which controls the power developed by source **10** to produce constant tension on cable **20**. Typical examples of such power source control would be in the excitation of the field windings of an electric motor and the throttle movement in an internal combustion engine.

In the specific embodiment of the invention shown in Fig. 2, **10** denotes a conventional internal combustion engine which drives a shaft **12** through a conventional automatic clutch **11**. For coupling the shaft **12** to a differential unit **15** reduction gears **13** and a conventional back stop device **14**, which permits rotation in only one direction, are provided. A winch **19** is coupled to the shaft **16** of the differential, while a brake **18** is mounted on the other output shaft **17** of the differential. The brake **18** is shown as a conventional hydraulic brake, but any suitable brake means may be employed. Attached to the winch **19** is a winch cable which is adapted for connection to an air ship or other load (not shown) through the right angle arrangement of pulleys **22** and **23**, and the pintle **21**.

A carburetor **57**, associated with the engine **10**, is employed for controlling the power output of the engine. The throttle (not shown) of the carburetor **57** is opened and closed manually by means of the carburetor control handle **51** which is pivoted at **53**. The carburetor control handle **51** is employed during non-automatic control only. When the system is arranged for automatic control, the handle **51** is unlatched. The throttle is of the conventional type and includes a zero return spring, which, for the sake of clarity, has not been shown on the drawing. The handle **51** is connected, as shown, to the throttle crank **58** by means of a rod **56**. The latch mechanism **52** may be provided for use with the manual carburetor control lever **51** during non-automatic control of the carburetor.

A lever arm **24**, which is pivoted at **25**, as shown, has been provided. On the lever arm **24** is mounted a pulley **22**, which is engaged by the winch cable **20** to receive tension information from the cable. A tension information transmitting cable **27** is attached at one of its ends to the lower portion of the lever **24**. The cable **27** is entrained around the pulleys **29**, **30**, **32**, which are pivoted, respectively, at **28**, **31**, and **33**, and it is attached at its other end to the throttle crank **58**. An adjustable spring **26** is employed to tension the cable **27** so as to adjustably bias the throttle in an open direction, while the spring **76**, which is fixed at a point **77** and attached to the cable at **59**, is arranged to tension the cable **27** so as to bias the throttle in a closed direction.

For positively limiting cable tension, control is exercised by setting the pressure on the brake **18**. Pressure is exerted on the brake **18** by means of a conventional hydraulic brake cylinder **40**, having a piston **41** and a piston rod **43**, through a fluid conduit **39**. Movement of piston **41** is effected by means of the brake control lever **48**, which is pivoted at **49**, through spring **46** and arm **45**, which is pivoted at **44**, and the piston rod **43**. The spring **47**, fixed at **42**, is connected, as shown, to the arm **45**. The brake latch mechanism **50** is provided with a scale (not shown) calibrated in pounds tension.

A slack removal toggle **38** has been provided for re-

moving slack from cable 27 at the beginning of an operation. Slack removal cable 34 is supported by pulley 36, which is fixed at 37, and is connected to pulley 35 which rides on cable 27.

A meter 75 may be installed for providing a visual indication of the actual tension on the cable 20. The signal for the meter is obtained by the use of a conventional Wheatstone bridge which comprises the resistors 60, 61, 62, 63, 66 and 67. A tap 65 is provided to initially balance the bridge. A direct input voltage is applied between the terminals 68, 69. A tap 64 connected, as shown, to the lever 24 is provided for varying the resistor 62 to thereby provide an output across the lines 72 and 74. A sensitivity resistor 70 with its associated tap 71 has been connected in circuit with the lines 72 and 73 and the meter 75. It is clear that upon movement of the lever 24, a corresponding movement of the tap 64 will result. Movement of the tap 64 causes a change of resistance in resistor 62 causing an unbalance of the bridge which produces a signal across the terminals of the meter.

In operation, power source 10 of the generic system of Fig. 1 provides the rotational force, on winch 19, to haul in the cable load 20. The haul in tension of cable 20 is established by control unit 57. Sensing unit 9 detects any deviations from this tension and transmits the information to control unit 57 which adjusts the energization of source 10 in a direction to reestablish the desired tension in cable 20. However, it may happen that even with source 10 totally deenergized the tension on cable 20 exceeds the desired haul in tension. Back stop device 14 prevents the large force on shaft 16 from reversing shaft 12 and if the tension does not exceed the brake force, brake 18 will not slip, thus winch 19 does not haul in or pay out and the cable load 20 is held without an expenditure of energy. When the cable load exceeds the brake force, brake 18 slips allowing cable to be payed out; hence, the cable tension can never exceed the restraining force of brake 18.

The first act in operating the system of Fig. 2 is the setting of adjustable spring 26 to a value such that the sensing and control units produce the desired tension in cable 20 when the system is in operation. At this time there is no tension on cable 20 and thus the sensing system has throttle crank 58 in a wide open condition. If engine 10 were then started, it would operate at top speed, and since there is no tension on the cable, it would be hauled in quite rapidly, whipping back and forth, endangering workers and equipment. To avoid this, toggle 38 is first pulled out removing the slack in cable 27 thereby partially closing throttle crank 58 and then the toggle is pushed in slowly thus allowing motor 10 and cable 20 to gradually come up to normal operating condition. The differential unit is driven by way of an automatic clutch 11, through reduction gears 13, back stop device 14 and the shaft 12. As the engine 10 is accelerated, the automatic clutch engages and turns the shaft 12. Provided the setting of the load on the brake 18 is greater than the tension on the winch cable 20, the winch is turned by the differential unit 15 and the shaft 16 so as to haul in the craft or other load connected to the winch cable.

When the winch cable 20 increases in tension, the lower end of the lever 24 moves toward the right against the tension of the biasing spring 26. The spring 76 thereby produces a slack in the cable 27 between the point 59 and the crank 58. The throttle spring, not shown, thereby tends to move the throttle toward a closed position. As a result the power output on engine 10 is decreased thereby decreasing the tension on the cable 20.

With a decrease in tension, or a slackening of the cable 20, the spring 26 will pull the lower end of the lever 24 to the left thereby causing a counter-clockwise motion of the crank 58, whereupon the throttle is moved toward the open direction. As a result, the power output of the engine 10 is increased thereby increasing the tension on the cable 20.

The brake 18 is used in conjunction with the carburetor 57 to limit the maximum tension on the cable 20. The force on the brake 18 is dependent on the position of the brake control handle 48 on the calibrated latching mechanism 50. If during an operation of winch, the cable load is excessive and causes a tension on the cable greater than that set up and determined by the position of the brake control handle, the brake 18 slips and the winch 19 begins to pay out cable. This paying out continues until the cable load no longer exceeds the setting of the tension regulator or until the tension regulator setting is increased. A stop is usually provided on the latching mechanism 50 to eliminate the possibility of exceeding dangerous cable tensions before slippage occurs. This constant tensioning feature has been made possible in the system because of the inclusion of the differential unit 15 which has been placed between the winch and brake axle. Through the conventional epicyclic gear train in the differential unit, with a predetermined braking force on the brake 18 the winch is caused to turn until the winch load forces torque feed back through the differential units to slip the brake. In this condition the winch drum stops turning or begins to pay out. It may be necessary to provide an interlock between the slack removal toggle 38 and the brake control lever 48. The interlock must be designed so that it will prevent engagement of the slack removal toggle except at predetermined minimum brake settings, and so that the brake setting cannot be lowered below a predetermined minimum value after the slack removal toggle has been disengaged. The automatic transmission 11, shown in the preferred embodiment effectively produces these results since the transmission permits acceleration of the engine 10 to the required speed with no load. The brake, however, will slip at a predetermined minimum load.

A winch system has been disclosed which permits very accurate control of cable tensions. Normally the cable is drawn in at a constant tension in response to power source control application. However, when the cable tension exceeds the maximum force output of the source, hauling in stops and the cable load is held by the back stop unit which also prevents the cable load from reversing the source. In the event that the cable tension exceeds the brake setting, the differential-brake arrangement allows the cable to be payed out. Due to the light weight of component parts, the reversal of power has to overcome only very low inertia. In actual tests when cable loads and speeds were varying and even reversing (that is drawing in or paying out) the power source was decelerating or accelerating simultaneously with brake application or release in order to adjust to load requirements.

It will be understood that the above description and the accompanying drawing comprehend only the general and a preferred embodiment of this invention and that various changes in details of construction and arrangement of parts may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A winch control system comprising a winch drum, a cable for said drum, a differential unit having an input shaft and two output shafts, means mounting said drum on one of said output shafts, adjustable braking means for the other of said output shafts, controllable driving means for said input shaft, and means continuously responsive to tension in said cable below a predetermined force for automatically controlling said driving means.

2. A no-power holding, low-inertia winch control system comprising a winch drum, a winch cable operatively associated with said drum, drive means for rotating said drum and hauling in said winch cable, speed control

means for said drive means, and means for controlling said drive means in a continuous manner in response to tension of said cable comprising a lever connected at one of its ends to said cable, and at its other end to said speed control means for controlling the speed of said drive means, and means for automatically limiting the maximum tension on said cable.

3. The invention as defined in claim 2 wherein said means for automatically limiting the maximum tension on said cable comprises a differential unit having an input shaft driven by said drive means, and having first and second output shafts, said first output shaft being operatively connected to said winch drum, and said second output shaft being provided with controllable shaft restraining means.

4. The invention as defined in claim 3 wherein said shaft restraining means comprises a brake.

5. The invention as defined in claim 3, and means associated with said drive means for permitting acceleration of said drive means to a predetermined minimum speed at no load.

6. The invention as defined in claim 4, wherein said means associated with said drive means comprises an automatic clutch.

7. A control system for a winch comprising a differential unit, said unit having an input shaft and a first and a second output shaft, means for adjustably restraining rotation of said first shaft, a winch drum mounted on said second shaft, a winch cable attached to said drum and adapted for connection to a load, drive means including an automatic clutch and an engine having a controllable carburetor, for said input shaft, a lever having a pulley mounted at one end, said pulley being engaged by said winch cable, a spring biased tension transmitting cable, said tension transmitting cable connecting the other end of said lever and said carburetor for opening said carburetor, and means for removing the slack and for adjusting the range of operation of said cable.

8. A control system for a winch comprising a differential unit having an input shaft and having a first and a second output shaft, drive means for said input shaft, control means for varying the power output of said drive means, a winch drum mounted on said first output shaft, brake means for adjustably restraining said second shaft, and means responsive to the load on said drum for adjusting said control means in a continuous manner, whereby the load on said drum is maintained constant.

9. A no-power holding, low-inertia winch system comprising: a source for producing a rotational force output, control means for controlling the power output of said source, differential means having an input from said source and two differential outputs, an adjustable brake connected to one differential output, a winch connected to the other differential output, and sensing means for sensing in a continuous manner the tension of a cable attached to said winch and for operating the control means accordingly whereby substantially constant cable tension is maintained.

10. The winch system of claim 9, and means connected to said source for permitting the output of said source to rotate in only one direction.

11. A control system for winch comprising: power means for producing differential, mechanical, outputs; an adjustable brake connected to one of the differential outputs; a winch connected to the other differential output; sensing means for sensing in a continuous manner the tension of a cable being hauled in by said winch and for producing a mechanical output which is a function of the tension deviation from a predetermined value; preadjustment means connected to said sensing means for establishing the predetermined value setting of said sensing means; and control means utilizing said mechanical output for controlling the power output from said power means whereby substantially constant tension of the predetermined value is maintained on said cable except when the tension exceeds the predetermined value even when the cable is not being hauled in.

12. The control system of claim 11, and a back stop device connected to said power means.

13. The control system of claim 12, and means connected to said sensing means for providing a visual indication of the tension on the cable.

References Cited in the file of this patent

UNITED STATES PATENTS

1,678,472	Johnson	July 24, 1928
2,170,360	Whelan	Aug. 22, 1939
2,422,274	Wilson	June 17, 1947

FOREIGN PATENTS

435,586	Germany	Oct. 13, 1926