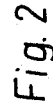


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Jan. 24, 1967

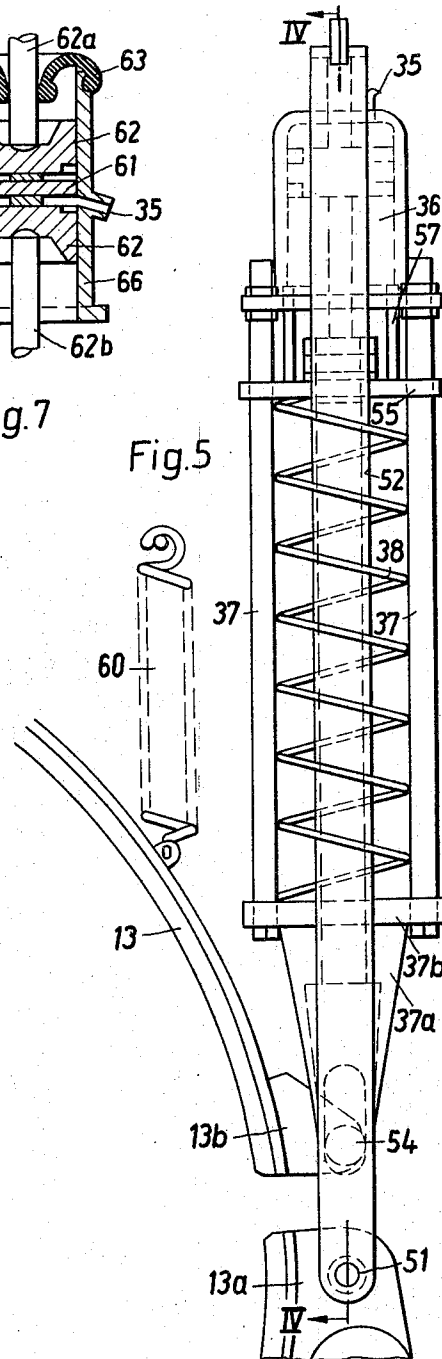
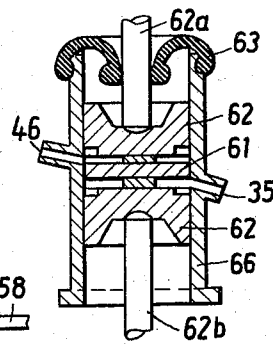
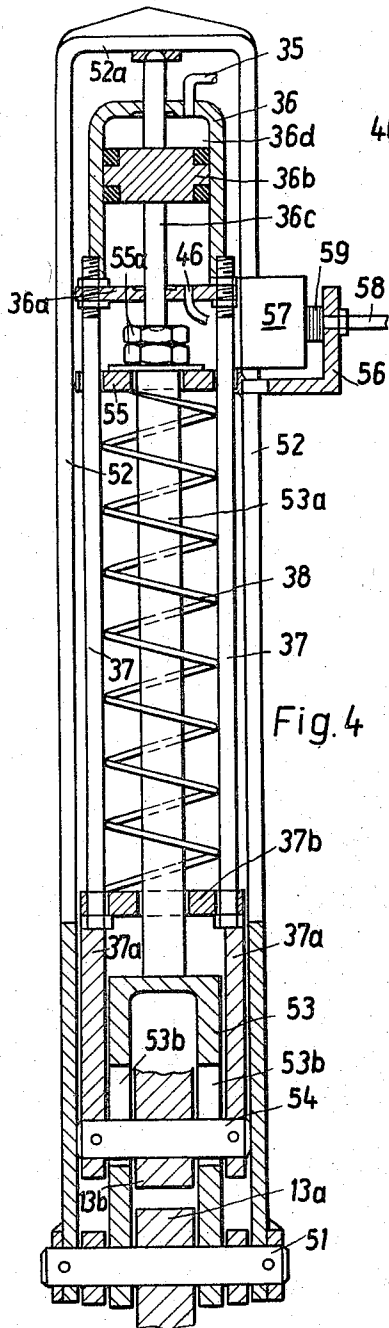
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CONTROL ARRANGEMENT

Filed Nov. 17, 1965

4 Sheets-Sheet 2



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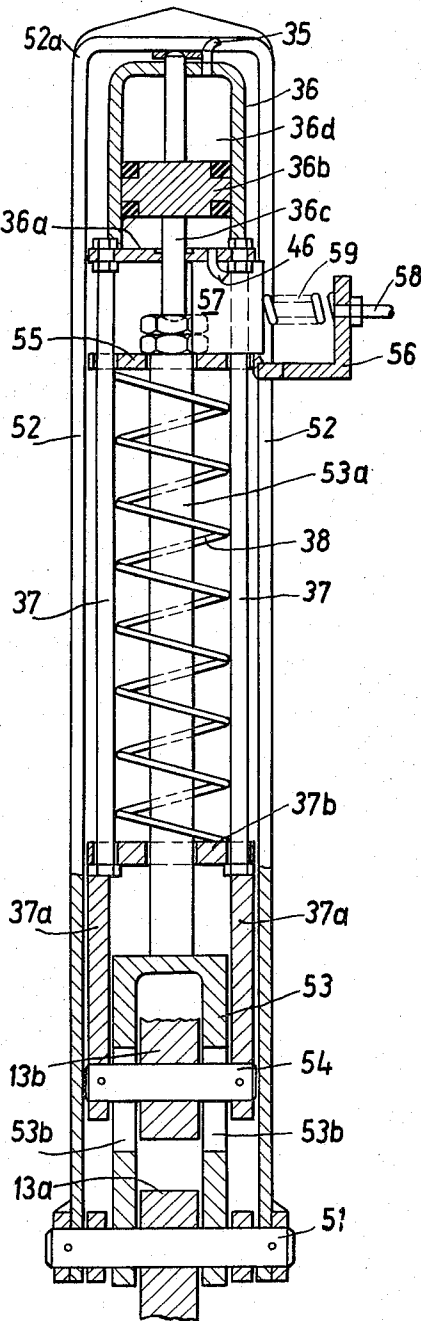
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CONTROL ARRANGEMENT

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Fig.6



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CONTROL ARRANGEMENT

Filed Nov. 17, 1965

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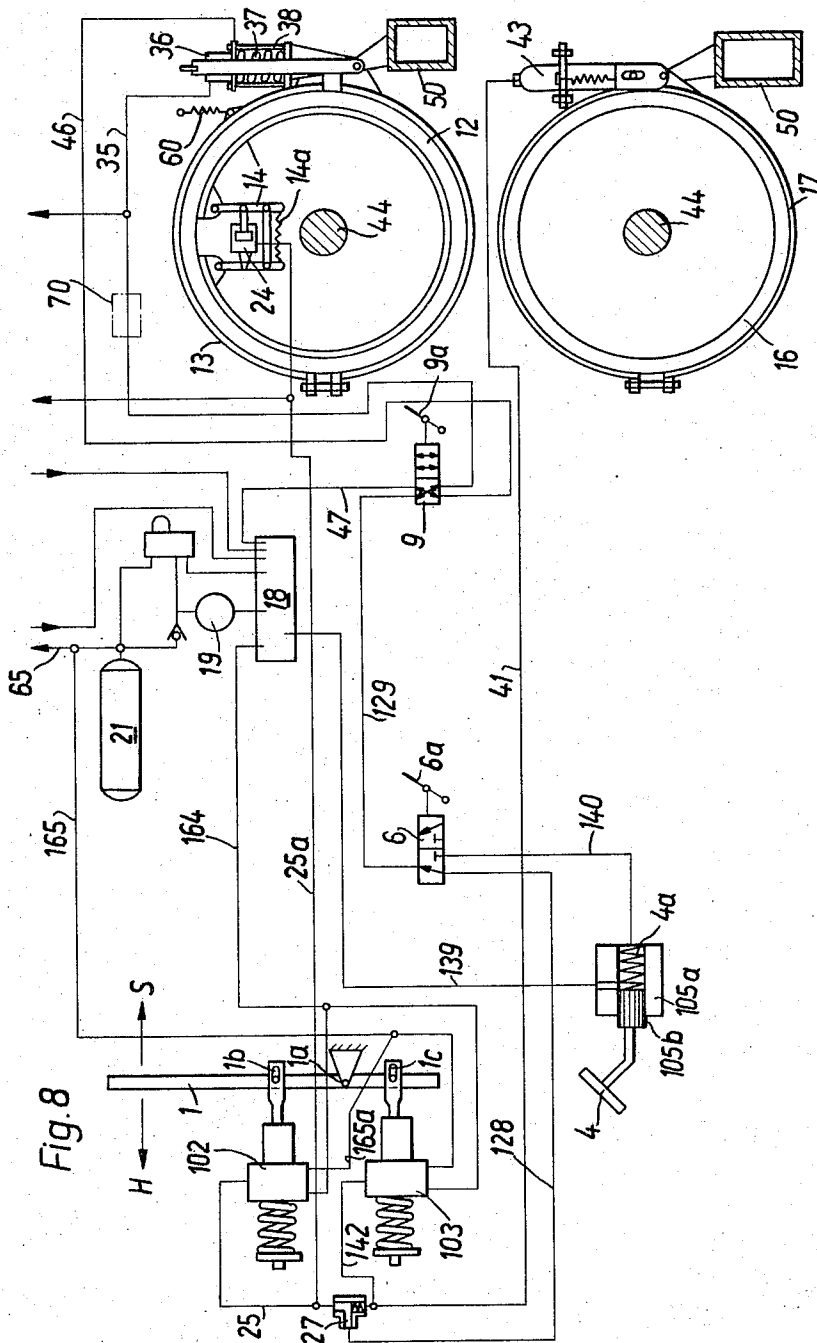


Fig. 8

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CONTROL ARRANGEMENT

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Filed Nov. 17, 1965, Ser. No. 508,195
Claims priority, application Germany, Nov. 17, 1964,
R 39,269

17 Claims. (Cl. 254-187)

The present invention relates to a fluid-operated control arrangement. More particularly, the invention relates to a control arrangement which is especially suited to regulate the operation of one or more winches on mobile cranes and similar machines. Such winches are used for lifting or lowering of loads as well as for operating a shovel, a dragline bucket or an analogous material moving or excavating element.

It is already known to provide a mobile crane with a control arrangement which regulates the operation of one or more winches so that each such winch may be converted from an operation which includes lifting or lowering of loads to an operation which includes excavating work, or vice versa. As a rule, heretofore known conventional control arrangements may be set up to carry out four different regulating operations namely:

(a) A winch having, for example, two cable drums is controlled by means of two actuating levers, one for each cable drum. The customary pedals or treadles are then blocked or removed and the brakes which control unwinding of cables from the respective cable drums are applied by means of springs. In order to release the brakes, the bias of the springs is overcome by hydraulic pressure fluid, i.e., the brakes are applied mechanically and are released hydraulically.

(b) The winch is controlled by a pedal and by an actuating lever for each cable drum. The brakes are applied mechanically and are released by means of a hydraulic pressure fluid in the same way as in the first setup.

(c) Each cable drum of the winch is controlled by a separate actuating lever and by a separate pedal, and the brake is applied by hydraulic pressure against spring action.

(d) Each cable drum of a multiple-drum winch is operated independently of the other drum or drums according to the setup (a), (b) or (c).

The setup (a) is utilized when the winch is used for lowering or lifting of loads. The setup (b) is used for lifting and lowering or for excavating work. The setup (c) is intended for use in excavating work, and the setup (d) is resorted to in special cases.

In order to convert a conventional control arrangement from the setup (a) to the setup (b), the personnel in charge must carry out a series of operations which are time consuming and require considerable skill. Thus, all connections between the actuating levers and the naves for pedals must be dismantled and removed. Also, the pedals (which are not needed in the setup (a) and are then replaced by fixed foot rests) must be installed and properly connected subsequent to removal of foot rests.

In converting a conventional control arrangement from the setup (a) to setup (c), the personnel must carry out all of the operations which are needed for conversion from the setup (a) to setup (b) and also the following: Cam disks must be detached from the pedal naves to be replaced by linkages which connect the pedals with signal transmitting hydraulic cylinders. Also, the brakes which are applied by spring pressure when the control arrangement is operated according to the setup (a) must be replaced by brakes which can be applied by hydraulic pres-

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sure. Still further, the entire hydraulic circuit must be partially evacuated before the arrangement is ready to operate in accordance with the setup (c).

The above outlined converting steps take up much time, especially because the space allotted for the parts of the control arrangement in a mobile crane or excavator is rather limited so that many of the parts are difficult to reach. Still further, the clutches and brakes as well as the actuating elements on the control stand must be readjusted which, too, involves much time and skilled labor. In many instances, the conversion of a conventional control arrangement involves additional operations to make sure that the setup is satisfactory for a particular type of lifting, lowering, dredging, shoveling or similar work.

In the setup (a), the overlapping of control operations involving coupling and release of the lowering brake or applying the planetary brake and releasing the lowering brake is effected by mechanical controls. Prior to beginning of an operation in accordance with a selected setup, the maximum load must be shortly lifted to test the control arrangement and to determine whether or not the load will begin to descend with the actuating lever is moved between its end positions. In many instances, the customary control cams which are mounted in the control stand and serve to regulate the sequence of operations must be readjusted prior to starting with the operation according to a selected setup.

Still further, a conventional control arrangement can operate properly only if the vehicle which mounts the winch or winches carries an ample supply of spare parts or attachments, such as are needed in certain (but not all) setups. This involves additional problems, especially when the vehicle is used on rough terrain, for example, at construction sites, in excavations and the like.

Accordingly, it is an important object of the present invention to provide a mobile crane which can be rapidly and conveniently converted to carry out load lifting, load lowering, excavating, other material shifting and similar operations.

Another object of the invention is to provide a crane of the just outlined characteristics wherein the conversion from one type to another type of setup may be effected without necessitating removal or attachment of component parts so that the conveyance on which the machine is mounted need not carry a supply of spare parts such as are used in one but not in all setups.

A further object of the invention is to provide a novel hydraulic and/or pneumatic control arrangement which may be used to regulate the operation of various assemblies and devices in the improved crane.

An additional object of the invention is to provide a novel operating unit for the braking device or devices of the improved crane.

Another object of the invention is to provide a novel system of braking devices which may be used for controlling the lifting and lowering of loads suspended on the cable or cables of winches in a machine of the above outlined character.

Still another object of my invention is to provide a novel hydraulic circuit which forms part of the aforementioned control arrangement and can be used in mobile cranes with one or more winches.

A concomitant object of the invention is to provide a crane which meets all regulations regarding the safety of its operation and which can be economically employed for excavating work, which can be used with optimum efficiency for each such type of work and which, to my knowledge, is the first truly universal machine capable of safely, economically and satisfactorily fulfilling all of the above outlined objects.

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Briefly stated, one feature of my present invention resides in the provision of a machine which is particularly suited for use as a mobile crane. The machine comprises a winch including a cable drum, a braking device for the cable drum comprising a brake drum operatively connected with the cable drum, a brake band surrounding the brake drum and having a fixed end portion and a second end portion, and an operating unit for moving the second end portion of the brake band toward and away from the first end portion to thereby apply or disengage the brake band from the brake drum. The operating unit comprises a double-acting cylinder coupled to the second end portion of the brake band, fixed piston means received in the cylinder, spring means for normally biasing the cylinder in a direction to apply the brake band, and releasable locking means for the spring means. The machine further comprises a preferably hydraulic control arrangement for regulating the operating unit and including a circuit having a pair of feed conduits connected with the cylinder of the operating unit, a source of pressure fluid installed in the circuit, actuating means for selectively operating the locking means, and control means for selectively admitting pressure fluid through the feed conduits so as to apply the brake band by the action of the spring means when the locking means is idle, to disengage the brake band when one of the feed conduits admits pressure fluid into the cylinder of the operating unit, and to apply the brake band by fluid pressure when the other feed conduit admits fluid into the cylinder of the operating unit while the locking means is operative.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved control arrangement itself, however, both as to its construction and the mode of operating the same, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings, in which:

FIG. 1 is a diagram showing a control arrangement which is constructed and assembled in accordance with a first embodiment of the present invention;

FIG. 2 is a fragmentary perspective view of a winch which is controlled by the arrangement of FIG. 1;

FIG. 3 is a diagram showing a portion of a modified control arrangement wherein one of the brake operating cylinders shown in FIG. 1 is replaced by a storing receptacle;

FIG. 4 is an enlarged longitudinal sectional view of a brake operating unit which is shown in operative position in which the brake band is applied by means of a spring, the section being taken in the direction of arrows as seen from the line IV—IV of FIG. 5;

FIG. 5 is a side elevational view of the unit as seen from the left-hand side of FIG. 4;

FIG. 6 illustrates the brake operating unit in a different position when the unit is ready to apply the brake band by hydraulic pressure;

FIG. 7 is a fragmentary longitudinal section through a modified operating unit; and

FIG. 8 is a diagram showing a third control arrangement.

The apparatus which is shown in FIGS. 1 and 2 comprises a first operator-controlled actuating member in the form of a lever 1 which is fulcrumed at 1a and resembles a balance beam. This lever 1 is utilized to operate two signal or impulse transmitting cylinders 2 and 3 in such a way that the cylinder 2 is idle when the cylinder 3 transmits a signal, or vice versa. The apparatus further comprises a second operator-controlled actuating member in the form of a depressible pedal or treadle 4 which controls a third signal transmitting cylinder 5a accommodating a differential piston 5. There is a first control valve 6 having an adjusting element 6a, 75

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a pressure regulator 7 having an adjusting cylinder 8, and a second control valve 9 having an adjusting element 9a. The just described parts of the control arrangement are connected to each other by various conduits or lines which will be described later, and such conduits also connect the aforementioned parts with the brakes and with the clutch of the winch. The winch comprises a cable drum or reel 10 for a length of convoluted flexible cable 23. The means for driving the drum 10 includes a toothed spur gear 11, a first brake drum 12 with a brake band 13 and a hydraulic clutch 14, and a motor (not shown) which can drive the cable drum 10 through the intermediary of the spur gear 11. A planetary transmission 15 cooperates with a second brake drum 16 and with a brake band 17 to lower the load which is suspended at the free end of the cable 23.

The hydraulic circuit of the control arrangement comprises an oil tank 18 or an analogous source of hydraulic fluid, a hydraulic pump 19 which draws fluid from the tank 18, and a pressure tank 21. A switch-over valve 20 is provided in a first conduit 20a which connects the tanks 18 and 21, and a one-way valve 22 is provided in a second conduit 22a which connects the conduit 20a with the valve 20 and with the pressure side of the pump 19. The valve 22 prevents return flow of compressed fluid through the conduit 22a.

When the winch of FIG. 2 is to be utilized to lift a load which is attached to the free end of the cable 23, its operation is initiated and controlled as follows:

The operator pivots the actuating lever 1 in a counterclockwise direction, as viewed in FIG. 1 (see the arrow H), whereby the lever turns about the fulcrum 1a and its upper motion transmitting pin 1b shifts the piston 2a in the signal generating cylinder 2 against the bias of a return spring 2b. The pin 1b is slidable in an elongated slot 2c provided in the piston rod 2d of the cylinder 2, but the spring 2b maintains the piston rod 2d in actual abutment with the pin 1b when the lever 1 is rocked in a counterclockwise direction. During such rocking movement, the lower motion transmitting pin 1c of the lever 1 slides in the elongated slot 3c of the lower piston rod 3d so that the piston 3a in the cylinder 3 remains idle.

The chamber 2e of the upper cylinder 2 is connected with a supply conduit 26 which receives oil from the tank 18 and, on depression of the piston 2a against the bias of the spring 2b, a certain quantity of oil is expelled through a discharge conduit 25 communicating with a connecting conduit 25a and with one inlet of a reversible valve 27. The fluid which is expelled from the chamber 2e of the cylinder 2 flows through the conduits 25, 25a and into the working chamber of a cylinder 24 forming part of the hydraulic clutch 14. The clutch 14 then automatically couples the spur gear 11 with the cable drum 10 so that the latter can take up the cable 23 in order to lift the load which is suspended on the cable. The valve 27 is reversed in automatic response to rising pressure in the conduit 25 and admits fluid into a supply conduit 28 and thence into a conduit 29 leading to the cylinder 8 of the pressure regulator 7. The conduits 28, 29 communicate with each other through the first control valve 6 whose adjusting element 6a is preferably mounted on the control panel of the driver's cabin. The setting of the valve 6 for lifting of loads is such that the conduit 30 is sealed. The pressure in the chamber of the cylinder 8 rises subsequent to a rise in pressure in the working chamber of the clutch cylinder 24, whereby the fluid entering the chamber of the cylinder 8 causes the piston rod 31 to adjust the pressure regulator 7 by moving in a direction to the right, as viewed in FIG. 1, and against the bias of springs 32 which are coupled to a crosshead 31a carried by the piston rod 31. The bias of the springs 32 may be adjusted by bolts 32a. The left-hand ends of these springs are anchored in a carrier 32b provided on the cylinder 8. The springs 32 also de-

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termine the initial pressure which prevails in the chamber of the cylinder 8 by biasing the piston which is connected to the rod 31 in a direction to the left, as viewed in FIG. 1. In other words, the selected bias of the springs 32 will determine the initial pressure of fluid in the conduit 29.

The regulator 7 receives pressure fluid through a conduit 33 which is connected to a conduit 65 serving to convey fluid from the pressure side of the pump 19. The conduit 65 is also connected with the pressure tank 21. Depending on its adjustment in response to axial displacement of the piston rod 31, the regulator 7 will permit pressure fluid to flow at a controlled rate from the conduit 33 into a conduit 34 and thence into a feed conduit 35 discharging into the upper chamber of a double-acting cylinder 36 for the brake band 13. The preferred construction and mounting of the brake cylinder 36 will be described in connection with FIGS. 4 to 6; it suffices to say here that pressure fluid issuing from the feed conduit 35 causes a series of coupling rods 37 to overcome the bias of a brake applying spring 38 and disengages the band 13 from the periphery of the brake drum 12 so that the clutch 14 can actually drive the cable drum 10 in response to rotation of the spur gear 11.

The cylinder 5a of the pedal 4 is connected with a conduit 39 leading to the conduit 26 and hence to the oil tank 18. The pedal 4 cannot be depressed because the control valve 6 seals a discharge conduit 40 which is also connected with the cylinder 5a so that the pedal may be used as a rigid rest for the foot of the operator. The drum 10 collects the cable 23 and thereby lifts the load as long as the control arrangement remains in the position of FIG. 1, i.e., as long as the lever 1 continues to compress the return spring 2b in the chamber 2e of the upper signal transmitting cylinder 2 and as long as the control valve 6 continues to permit flow of fluid between the conduits 28, 29 but seals the adjoining ends of the conduits 30 and 40.

In order to terminate the lifting operation, the person in charge simply rocks the lever 1 back to the neutral position shown in FIG. 1 so that the return spring 2b is free to expand and pushes the piston 2a in a direction to expose the discharge end of the supply conduit 26. The pressure in the cylinder 8 of the pressure regulator 7 decreases so that the springs 32 can retract the piston rod 31 back to its starting position. The regulator 7 then seals the conduit 33 from the conduit 34 so that the pressure in the brake cylinder 36 decreases whereby the spring 38 expands and applies the band 13 against the brake drum 12 to prevent further rotation of the cable drum 10. The spring 38 preferably applies the brake band 13 before the lever 1 returns to the neutral position of FIG. 1. As the lever 1 continues to move to such neutral position, the pressure in the conduits 28, 29 and 25a drops still further and the clutch 14 is disengaged in response to contraction of its spring or springs 14a so that the spur gear 11 can rotate independently of the cable drum 10.

If the winch of FIG. 2 is to lower the load which is suspended on the cable 23, the operator rocks the lever 1 in a clockwise direction, as viewed in FIG. 1 (see the arrow S), whereby the lower motion transmitting pin 1c shifts the piston 3a in the cylinder 3 against the bias of the associated return spring and seals the branch conduit 26a from a discharge conduit 42. At the same time, the piston 3a expels fluid from the chamber of the lower cylinder 3 and through the discharge conduit 42. The piston 2a remains in the position shown in FIG. 1 because the upper pin 1b slides in the slot 2c.

The fluid which is expelled from the chamber of the cylinder 3 also enters a conduit 41 which discharges into the cylinder 43 of the second brake including the drum 16 and band 17. Such fluid causes the band 17 to engage the periphery of the drum 16 so that the planetary transmission 15 is coupled to the gear 11 via shaft 44 and con-

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trols the speed at which the drum 10 can pay out the cable 23. One pinion 15a of the transmission 15 is shown in FIG. 2, and this pinion meshes with a sun wheel 15b which is rigid with the cable drum 10. When the cylinder 43 does not receive pressure fluid from the conduit 41, the band 17 allows the drum 16 to rotate with the sun wheel 15b.

The fluid which flows through the discharge conduit 42 automatically reverses the valve 27 so that the latter seals the discharge end of the conduit 25 and allows fluid flowing from the conduit 42 to enter the conduit 28 and thence the conduit 29 and the cylinder 8 of the pressure regulator 7. Thus, the latter again allows pressure fluid to flow at a controlled rate from the conduit 33 to the conduits 34, 35 and into one member of the cylinder 36. The coupling rods 37 are shifted against the bias of the spring 38 so that the band 13 is disengaged from the periphery of the brake drum 12 and the latter allows the cable drum 10 to rotate in a sense to lower the load which is suspended on the cable 23. The planetary transmission 15 controls the speed at which the cable 23 is being paid out during lowering of the load. Such speed also depends on the r.p.m. of the motor which drives the spur gear 11. The motor is reversible and can be operated at a plurality of speeds.

The band 17 is applied in a first step (i.e., immediately following movement of the lever 1 from its neutral position and in a clockwise direction, as viewed in FIG. 1), and the fluid which flows through the conduit 42 and valve 27 thereupon adjusts the pressure regulator 7 in the next following stage of operation.

In order to further reduce the force which is needed to rock the lever 1 in a clockwise or counterclockwise direction, the cylinders 2 and 3 may be replaced by suitable oil pressure regulators without in any way affecting the operation of the apparatus. The only difference will be that the pressure regulators will be connected to the conduit 65 instead of receiving fluid directly from the oil tank 18. Return flow of oil will take place through the return conduits 64b and 64c so that the storing receptacle 49 (to be described in connection with FIG. 3) may be dispensed with.

In order to convert the apparatus for operation which is controlled by the lever 1 and by the pedal 4 (while the spring 38 continues to be used as a means for mechanically applying the brake band 13 against the periphery of the brake drum 12), the operator must actuate the adjusting element 6a of the control valve 6 in such a way that the valve 6 seals the conduits 28, 29 from each other and connects the conduit 30 with the conduit 40. Upon such adjustment of the control valve 6, the cylinders 2 and 3 can send fluid only through the conduit 25a and on to the working chamber of the clutch cylinder 24 or to the conduit 41 and thence to the cylinder 43, depending upon whether the winch assembly is to lower or to lift the load.

On depression of the pedal 4, the larger piston of the differential piston in the cylinder 5a sends pressure fluid through the conduits 40 and 30 and on to the cylinder 8 of the pressure regulator 7. The latter then admits pressure fluid at a controlled rate against the piston 36b (see FIG. 4) in the cylinder 36 in order to compress the spring 38 and to disengage the band 13 from the brake drum 12. The pressure which is determined by the regulator 7 is felt in the cylinder 36 and is also transmitted through the conduit 45 to act against the smaller piston of the differential piston in the cylinder 5a of the pedal 4.

In both of the above described setups of the control arrangement, the lower chamber of the brake cylinder 36 discharges fluid through a second feed conduit 46, through the control valve 9 and conduit 47, and back into the oil tank 18.

If the control arrangement of FIG. 1 is to be converted for dredging or excavating work, the position of the control valve 6 remains unchanged, i.e., the same as in the setup (b), so that the conduits 30 and 40 are free to

communicate with each other. The control valve 9 is adjusted by the element 9a in such a way that the conduit 34 communicates with the conduit 46 and that the conduit 35 communicates with the conduit 47. When the pedal 4 is depressed, the cylinder 8 causes the regulator 7 to admit pressure fluid through the conduits 34 and 46 so that such fluid enters the lower chamber of the cylinder 36 and the brake band 13 is applied directly by hydraulic pressure in a manner to be described in greater detail in connection with FIGS. 4 to 6. The upper chamber of the cylinder 36 discharges fluid through the conduits 35, 47 and back into the tank 18. The pressure which develops in the conduits 46 and 34 is felt in the conduit 45 and is applied against the smaller piston of the differential piston in the cylinder 5a of the pedal 4 so that, by keeping his foot on the pedal, the operator feels that the pressure rises, i.e., that the brake band 13 is being applied in response to the pressure of hydraulic fluid.

The conduits 25b and 35b respectively branch from the conduits 25a, 35 and are connected to a solenoid valve for end switching. The conduits 64a to 64c are return conduits and the conduit 65 is a pressure line which connects to additional consumers of hydraulic pressure fluid.

In the embodiment of the control arrangement which is illustrated in FIG. 3, the signal transmitting cylinder 3 is connected with a conduit 48 leading to a storing receptacle 49 whose pressure and volumetric values are the same as those of the cylinder 43 for the brake band 17. This renders it possible to use in FIG. 3 a cylinder 3 which is identical with the cylinder 3 of FIG. 1. Also, and though the arrangement of FIG. 3 controls a winch which is without the brake drum 16, brake band 17 and cylinder 43, the person in charge must move the lever 1 through the same distances and must overcome the same forces as in the embodiment of FIG. 1. Otherwise, the conversion of the control arrangement shown in FIG. 3 for various setups takes place in the same way as described in connection with FIG. 1.

The numeral 50 denotes in FIG. 1 a frame member which supports the winch. For the sake of clarity, the brake drums 12, 16 and the corresponding brake bands 13, 17 are shown in FIG. 1 one below the other; actually, the two brake drums are coaxial with the cable drum 10 as clearly shown in FIG. 2.

The operating unit shown in FIGS. 4 to 6 is constructed and assembled in such a way that the control arrangement of the present invention can be readily converted for different operations without necessitating removal, replacement or substantial adjustments in the construction of the brake. Thus, all that is necessary is to adjust the control valve 9 by means of the element 9a whereby the brake band 13 can be applied against the brake drum 12 by spring pressure (spring 38) or by hydraulic pressure (when the fluid is admitted through the feed conduit 46 to enter the lower chamber of the cylinder 36).

In FIGS. 4 and 5, the operating unit for the brake band 13 is shown in a position in which the band 13 may be applied by the bias of the brake spring 38. The band 13 comprises a fixed first end portion 13a and a movable second end portion 13b. The fixed end portion 13a is connected to a bolt 51 which is mounted in an inverted U-shaped carrier 52 having an upper portion which straddles the cylinder 36. The bolt 51 is further mounted in an inverted U-shaped yoke 53. The movable second end portion 13b is reciprocable between the downwardly extending legs of the yoke 53 and is attached to a bolt 54. The latter is slidable in guide slots 53b provided in the legs of the yoke 53. An elongated abutment rod 53a is connected to the web at the upper end of the yoke 53 and extends toward the web 52a at the upper end of the carrier 52. The rod 36c of the piston 36b in the cylinder 36 is supported by or coupled to the free end of the rod 53a.

If the brake is to be released (in FIGS. 4 and 5, the brake is shown in operative position), the cylinder 36 receives pressure fluid through the feed conduit 35 so that

the upper cylinder chamber 36d is under pressure. The cylinder 36 then moves upwardly, as viewed in FIG. 4, by sliding along the piston 36b, and lifts the bolt 54 through the intermediary of coupling rods 37 which are attached to a bottom end wall 36a of the cylinder 36. The upper end of the piston rod 36c bears against the web 52a of the carrier 52 so that the piston 36b remains stationary and the bolt 54 moves upwardly by sliding in the slots 53b. The coupling rods 37 are disposed in the space enclosed by the legs of the carrier 52. The connection between the lower end portions of the rods 37 and the bolt 54 comprises a bridge 37a. During upward movement of the bolt 54, a crosshead 37b which is rigid with the bridge 37a bears against the lowermost convolution of the spring 38 and causes this spring to store energy. The upper convolution of the spring 38 bears against a second crosshead 55. The distance between the yoke 53 and the crosshead 55 may be varied by nuts 55a which mesh with the abutment rod 53a. The crosshead 55 is slidable along the coupling rods 37.

If the band 13 is to be applied against the periphery of the brake drum 12, the upper chamber 36d of the cylinder 36 is connected with the tank 18 so that the fluid can escape via conduit 35 whereby the spring 38 expands and moves the end portion 13b toward the fixed end portion 13a.

If the band 13 is to be applied by hydraulic pressure, the spring 38 is compressed by admission of fluid into the upper cylinder chamber 36d so that the cylinder 36 rises and the spring 38 is compressed while the end portion 13b of the band 13 moves away from the fixed end portion 13a. In the next step, the operator actuates the adjusting element 9a (see FIG. 1) of the control valve 9 to release a Bowden wire 58 which forms part of a locking device. This locking device further comprises a locking member or bolt 57 which is biased by a spring 59 so that it enters the space between the crosshead 55 and bottom end wall 36a, see FIG. 6. The bolt 57 is guided by a supporting bracket 56 which is welded or otherwise affixed to the crosshead 55. FIG. 1 shows that the Bowden wire is connected with the adjusting element 9a of the control valve 9 in such a way that the spring 59 is permitted to expand in automatic response to manipulation of the element 9a so that a single manipulation suffices to set the operating means of FIGS. 4-5 for application of the band 13 by hydraulic pressure. The adjusting element 9a is mounted in or on the control panel of the operator's cabin. The Bowden wire 58 is preferably released prior to actual adjustment of the control valve 9 so that, as soon as the valve 9 admits compressed fluid into the feed conduit 46, the lower chamber of the cylinder 36 receives pressure fluid and the conduit 35 is then connected with the tank 18. The cylinder 36 descends (because the piston 36b is fixed between the abutment rod 53a and web 52a) and causes the bolt 54 to move the end portion 13b toward the end portion 13a so that the band 13 is applied around the brake drum 12. The transmission of motion to the bolt 54 takes place through the bottom end wall 36a, coupling rods 37 and bridge 37a. Such movement of the end portion 13b toward the end portion 13a results in tensioning of a return spring 60 which tends to maintain the band 13 in disengaged position but is weaker than the brake spring 38.

In order to release the band 13, the operator actuates the lever 1 in a manner as described in connection with FIG. 1 so as to allow pressure fluid to escape from the lower chamber of the cylinder 36 whereby the return spring 60 contracts and moves the end portion 13b away from the end portion 13a. If the adjusting element 9a of the control valve 9 is then returned to the position of FIG. 1, the wire 58 withdraws the locking bolt 57 against the bias of the spring 59 and the operating unit of FIG. 6 is ready to operate again in the manner as disclosed in connection with FIGS. 4 and 5, namely, the spring 38 is again free to apply the band 13 against the brake drum 12.

The cylinder 66 of FIG. 7 differentiates from the cylinder 36 of FIGS. 4 to 6 in that it comprises a centrally located partition 61 which is bounded by two spacer elements and is located between two fixed pistons 62. The upper piston 62 is connected with a piston rod 62a which is secured to or abuts against the web 52a of the carrier 52. The piston rod 62b of the lower piston 62 abuts against the rod 53a in the same way as shown in FIG. 4. The feed conduits 35, 46 respectively communicate with cylinder chambers which are located at the opposite sides of the partition 61, and the upper end of the cylinder 66 is sealed against entry of foreign matter by an annular diaphragm 63. The cylinder 66 need not be provided with an end wall such as the end wall 36a of the cylinder 36. When the conduit 35 admits pressure fluid into the chamber which is located at the underside of the partition 61, the cylinder 66 will descend and will cause the end portion 13b to move toward the end portion 13a so that the band 13 is applied against the periphery of the brake drum 12. When the conduit 46 admits fluid into the chamber which is located at the upper side of the partition 61, the cylinder 66 will rise and will compress the spring 38. It is clear that the conduits 35, 46 communicate with the respective chambers during full stroke of the cylinder 66.

It will be noted that I provide a highly versatile machine which can be used as a crane or as an excavator, and wherein the conversion from one setup to another setup or vice versa can be carried out in a very simple and time-saving manner, i.e., by simply adjusting one or both control valves 6 and 9 whereby the locking or unlocking of the spring 38 takes place automatically by remote control (Bowden wire 58) in response to manipulation of the adjusting element 9a for the control valve 9. The wire 58 can convert the operating unit for the brake 12, 13 from mechanical to hydraulic application of braking force or vice versa. The improved control arrangement is equally useful in cranes wherein the winch comprises two or more cable drums. All that is needed in such multiplex winches is to simultaneously block or release the springs in each of the operating units.

It is further clear that the Bowden wire 58 may be manipulated independently of the adjusting element 9a for the control valve 9. Even such simplified and less automatic construction of the improved crane offers numerous important advantages over the heretofore known convertible cranes. However, the construction which is shown in the drawings is normally preferred because it precludes the possibility of errors, i.e., the spring 38 is automatically locked or released in response to adjustment of the control valve 9.

In many heretofore known hydraulic control arrangements, the manipulation of various levers and other actuating elements necessitates the exertion of considerable forces. This is due to the fact that, in the setup (a), the actuating lever on the control panel must perform two functions, namely, coupling the cable drum 10 with the transmission and applying the braking device. Therefore, such conventional control arrangements normally comprise expensive and complicated pneumatic or hydraulic servomotors or analogous devices which assist in manipulation of the actuating lever. Also, and when a conventional control arrangement operates in accordance with the setup (a), the load which is suspended on the cable or cables of the cable drum or drums is temporarily out of control when the actuating lever is moved between its end positions so that the load will begin to descend by gravity against the operator's wish.

This is avoided by the advent of my present invention in that the brake band 13 is disengaged from the drum 12 in indirect response to a sufficient rise in pressure which prevails in the clutch cylinder 24. Also, the clutch 14 is disengaged only when the pressure in the cylinder 36 of the operating unit for the braking device 12, 13 drops, i.e.,

when the spring 38 is already free to apply the band 13. This is due to the provision of the pressure regulator 7 and control valve 9. The initial bias of springs 32 for the regulator 7 may be selected in such a way that the regulator begins to regulate the pressure in dependency on fluid pressure in the cylinder 24 or 43, and only when the clutch 14 or the braking device 15, 16, 17 is applied. Inversely, the clutch 14 or the braking device 15-17 can be disengaged only when the braking device 12, 13 is applied. Therefore, the load is under full control at all times, even during such intervals when the actuating lever 1 in or on the control panel is being shifted from neutral to an end position or vice versa.

For operation of the control arrangement in accordance with the setup (a), the springs 32 of the pressure regulator 7 are adjusted with utmost precision to determine the exact moment when the device 7 begins to regulate the pressure in the hydraulic circuit. Such precision adjustment must be carried out only once and is necessary to determine the overlapping of control functions. The regulator 7 can control and vary the pressure gradually so that the braking device 12, 13 may be applied or disengaged with utmost accuracy and that the opposing moments are relatively small, i.e., the takeover of load by the braking device will be effected smoothly. In certain instances, it is desirable to change the bias of springs 32 upon the cylinder 8 of the pressure regulator 7, for example, in order to conform the overlapping of control functions to the magnitude of loads. This is achieved in that the bias of the springs 32 can be varied at will by admission of fluid into the cylinder 8, preferably in dependency on the magnitude of load which is carried by the cable 23.

The control arrangement of FIG. 3 exhibits the important advantage that, by actuating the lever 1, the operator in charge has the same feel as if the winch were controlled by a planetary brake. During lowering of loads, the receptacle 49 causes the lever 1 to create in the hand which manipulates this lever the same sensation as if the cylinder 43 of the operating unit for the brake 15-17 were actually installed in the machine.

The function of the control valve 6 is to allow for a rapid conversion from the setup (a) to setup (b). This control valve is mounted in the supply conduit 28 between the reversible valve 27 and the cylinder 8 of the pressure regulator 7 so that, in the setup (a), it connects the regulator with one of the cylinders 2, 3, depending on the direction (H or S) in which the lever 1 is moved from neutral position. In the setup (b), the cylinders 2, 3 are sealed from the cylinder 8 but the latter is connected with the cylinder 5a so that the pedal 4 may actuate the regulator 7 whereby the latter controls the braking device 12, 13 through the intermediary of the control valve 9. In such setup, the valve 6 seals the cylinders 2, 3 from the cylinder 5a so that the lever 1 then merely serves to control the clutch 14 and the braking device 15-17, depending upon whether the signal is transmitted by the cylinder 2 or 3. Thus, in the setup (a), all of the operations are controlled by the lever 1 and the pedal 4 serves as a foot rest whereas, in the setup (b), the operations are controlled by the lever 1 and by the pedal 4.

The differential piston 5 enables the operator to sense the pressure with which the brake 12, 13 is applied by the pedal 4. This two-stage piston 5 can be replaced by two separate pistons of different diameters and a spring therebetween. When the crane is used for excavating or shoveling work, the larger-diameter piston of the differential piston serves to control the regulator 7 whereas the smaller-diameter piston controls the pressure in the conduit 45 and hence in the cylinder 36. Consequently, the fluid pressure acting upon the smaller-diameter piston is felt by the foot which rests on the pedal 4. The cylinder 5a is preferably dimensioned in such a way that there is no volumetric change in the conduit 45 when the pedal 4 is depressed.

The reversing valve 27 insures that the stream of pressure fluid which applies the clutch 14 is not the same as the fluid stream which applies the braking device 15-17. This valve 27 automatically seals the conduits 25, 25a from the conduits 41, 42 when the one or the other of the cylinders 2, 3 sends fluid through the supply conduit 28. The valve 27 further insures that the same pressure regulator 7 can control the disengagement of the brake band 13 regardless of whether the load on the cable 23 is raised or lowered.

Referring finally to FIG. 8, there is shown a third hydraulic control arrangement which is shown in a condition ready to operate in accordance with the setup (a). The control valves 6 and 9 are adjusted in such a way that a conduit 140 is sealed and that the feed conduit 46 communicates with the conduit 47 so that the lower chamber of the cylinder 36 can discharge into the tank 18. The pedal 4 is not in use. If the crane is to lift a load, the actuating lever 1 is rocked in the direction indicated by the arrow H. Instead of controlling two signal transmitting cylinders (such as the cylinders 2 and 3 of FIG. 1, the lever 1 of FIG. 8 controls alternatively two pressure regulators 102, 103. In response to rocking in the direction of the arrow H, the lever 1 operates the pressure regulator 102 whereby the latter connects the branch 165a of a pressure conduit 165 which branches from the conduit 65 with a return conduit 164 after the pressure fluid has completed the work. The conduit 165 receives pressure fluid and the conduit 164 returns spent fluid into the tank 18. The fluid pressure which is necessary for regulating the lifting operation is transmitted through the conduits 25, 25a and directly to the cylinder 24 of the clutch 24. Thus, the clutch 14 is applied and couples the driving element 11 of the prime mover with the cable drum 10, not shown in FIG. 8. At the same time, fluid pressure in the conduit 25 is communicated through the reversible valve 27, conduit 128, control valve 6, conduit 129, feed conduit 35, control valve 9 and on to the upper chamber of the cylinder 36 so that the braking device 12, 13 is disengaged subsequent to application of the clutch 14 because the coupling rods 37 cause the movable end portion 13b of the brake band 13 to move away from the fixed end portion 13a against the bias of the spring 38. The cable drum 10 begins to rotate and lifts the load which is attached to the cable 23.

In order to terminate the lifting operation, the person in charge returns the lever 1 to the neutral position of FIG. 8 so that the pressure fluid can flow from the cylinders 24 and 36, through the corresponding conduits, through the pressure regulator 102 and through the conduit 164 back to the tank 18. The clutch 14 is then disengaged by the spring 14a and the brake band 13 is applied by the spring 38 whose bias is stronger than that of the spring 60. The band 13 is applied before the lever 1 returns to its neutral position, and the band 13 is also applied before the spring 14a is allowed to disengage the clutch 14.

For lowering of a load, the lever 1 is rocked in the direction indicated by the arrow S. This actuates the pressure regulator 103 whereby the pressure conduit 165 can communicate with the conduits 142 and 41 to admit pressure fluid into the cylinder 43 of the operating unit for the braking device 15-17. The band 17 is now applied against the brake drum 16. The valve 27 is reversed in a fully automatic way so that the pressure fluid can again flow through the conduits 128 and 129, control valves 6 and 9, and into the feed conduit 35. The drum 16 is now braked and the planetary transmission is coupled with the gear 11 through the intermediary of the shaft 44. The sun wheel of the planetary transmission is fixed to the cable drum 10 so that the load descends at a speed determined by the r.p.m. of the prime mover which drives the gear 11. Such lowering takes place as soon as the pressure in the hydraulic circuit rises sufficiently to effect dis-

engagement of the brake band 13 subsequent to application of the brake band 17.

In order to operate the control arrangement in accordance with the setup (c), i.e., to control the operation by the actuating lever 1 and also by the pedal 4 and to apply the braking device 12, 13 by fluid pressure against the bias of the spring 60, the operator adjusts the control valves 6 and 9 by manipulating the adjusting elements 6a and 9a. The conduit 128 is then sealed so that, when the pedal 4 is depressed, fluid entering via conduit 139 flows through the conduit 140, control valve 6, conduit 129, control valve 9, and feed conduit 46 into the lower chamber of the cylinder 36 to hydraulically apply the brake band 13 against the periphery of the brake drum 12. The upper chamber of the cylinder 36 discharges fluid through the conduits 35, 47 and back into the tank 18.

The coupling and braking moments are correlated in such a way that the load is controlled in each intermediate position including the neutral position of the lever 1, i.e., that the load cannot descend by gravity at the time the operator does not wish to start such descent.

It is further within the scope of the present invention to select the various control elements in such a way that the control arrangement will constitute a combined pneumatic and hydraulic or purely a pneumatic arrangement. Also, a pressure reducing valve 70 (shown by broken lines) can be installed in the feed conduit 35 to change the exact moment when the control operations overlap. The valve 70 may be replaced by a conventional braking force regulator.

The control arrangement of FIG. 8 constitutes a simplification of the control arrangement which is shown in FIG. 1. In this simplified control arrangement, the pressure regulators are connected with the source or sources (19 and/or 21) of pressure fluid in such a way that, in response to manipulation of the actuating lever 1, the conduit 25a transmits pressure fluid directly into the cylinder 24 of the clutch 14 and that the conduit 41 transmits pressure fluid directly into the cylinder 43 of the operating unit for the planetary braking device. Also, the valves 27, 6 and 9 transmit pressure fluid to the cylinder 36 of the operating unit for the braking device which includes the brake band 13. The cylinder 105a of the pedal 4 can send pressure fluid to the lower chamber of the cylinder 36. The piston 105b of the pedal 4 is biased by a suitable spring 4a which normally holds it in starting position.

The control arrangement of FIG. 8 does not require the pressure regulator 7 of FIG. 1 and/or the receptacle 49 of FIG. 3. Also, the hydraulic circuit is much simpler because several of the conduits shown in FIG. 1 can be dispensed with. Furthermore, the cylinder 105a need not accommodate a differential piston but a simple piston 105b which is connected to the pedal 4. Still further, the force required to manipulate the lever 1 may be reduced to a minimum, namely, to such an extent that the operator must overcome only frictional forces.

Another difference between the control arrangements of FIGS. 1 and 2 resides in that, for the setup (a), the cylinder 36 of FIG. 8 receives pressure fluid directly from one of the pressure regulators 102, 103. In the setup (b) or (c), the cylinder 36 of FIG. 8 receives pressure fluid directly from the cylinder 105a of the pedal 4.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the means and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is:

1. In a machine of the character described, particularly in a mobile crane, a winch comprising a cable drum;

a braking device for said cable drum including a brake drum operatively connected with said cable drum, a brake band surrounding said brake drum and having a fixed end portion and a second end portion, and an operating unit for moving said second end portion toward and away from said fixed end portion to thereby apply or disengage said band from said brake drum, said operating unit comprising a double-acting cylinder coupled to said second end portion, fixed piston means received in said cylinder, spring means for normally biasing said cylinder in a direction to apply said band, and releasable locking means for said spring means; and a fluid-operated control arrangement for regulating the operation of said unit including a circuit having a pair of feed conduits connected with said cylinder, a source of pressure fluid installed in said circuit, actuating means for selectively operating said locking means, and control means for selectively admitting pressure fluid through said feed conduits so as to apply the band by the action of said spring means when said locking means is idle, to disengage said band when one of said feed conduits admits pressure fluid into said cylinder, and to apply said band when the other feed conduit admits fluid into said cylinder while said locking means is operative.

2. A structure as set forth in claim 1, wherein said control arrangement further comprises adjustable control valve means provided in said circuit and adjusting means operatively connected with said actuating means and with said control valve means for adjusting said valve means simultaneously with adjustment of said locking means.

3. A structure as set forth in claim 1, wherein said operating unit further comprises a U-shaped carrier coupled to the fixed end portion of said band and enclosing said cylinder, a yoke coupled to said fixed end portion and straddling the second end portion of said band, a rod assembly connected with said yoke, with said carrier and with said piston means and slidably supporting said cylinder, a crosshead provided on said rod assembly, and coupling means connecting said cylinder with the second end portion of said band, said spring means being operative between said crosshead and said coupling means to urge said cylinder toward said yoke and to thereby bias said second end portion toward said fixed end portion.

4. A structure as set forth in claim 3, wherein said coupling means comprises a bridge connected to said second end portion, a second crosshead connected to said bridge, and a plurality of coupling rods connecting said second crosshead with said cylinder, said spring means constituting an expansion spring and being disposed between said crossheads.

5. A structure as set forth in claim 3, wherein said locking means comprises a bolt movable between said crosshead and said cylinder when the cylinder is moved in a direction to disengage the brake band, and resilient means for biasing said bolt to such position, said actuating means including remote control means for withdrawing the bolt against the bias of said resilient means.

6. A structure as set forth in claim 5, wherein said remote control means includes a Bowden wire.

7. A structure as set forth in claim 1, further comprising a reversible drive for said drum including a rotary drive member coaxial with said drum and a hydraulic clutch for selectively coupling said drive member to said drum, said clutch including resilient means for normally disengaging the same and a cylinder connected in said circuit for applying the clutch in response to admission of pressure fluid, said braking device being applied for lifting of loads on the cable of said cable drum and further comprising a second braking device which is applied for lowering of loads, said second braking device comprising a second brake drum, a second brake band surrounding said second brake drum, a planetary transmission coupling said second brake drum with said drive mem-

ber, and a second operating unit including a cylinder connected in said circuit for applying said second band to thereby actuated said transmission in order to control the rotational speed of said cable drum.

8. A structure as set forth in claim 7, wherein said control arrangement further comprises an adjustable pressure regulator installed in said circuit and having an adjusting cylinder and resilient means for selecting the initial adjustment of said regulator in such a way that, in dependency on the pressure prevailing in the cylinder of said clutch or in the cylinder of said second unit, said regulator begins to regulate the pressure in said circuit only when said clutch or said second brake band is applied by means of an actuating member and via signal transmitting cylinder means in said circuit.

9. A structure as set forth in claim 8, wherein the bias of said resilient means is variable by admission of pressure fluid into said adjusting cylinder, preferably in dependency on the load carried by the cable of said cable drum.

10. A structure as set forth in claim 1 for use in connection with winches which are without planetary brakes, wherein said control arrangement further comprises signal transmitting cylinder means, actuating means for said signal transmitting cylinder means, and a storing receptacle provided in said circuit and connected with said signal transmitting cylinder means, the pressure and volumetric values of said receptacle corresponding to those of a cylinder in a planetary brake.

11. A structure as set forth in claim 1, wherein said control arrangement further comprises a pair of signal transmitting cylinders, an actuating member for operating one of said signal transmitting cylinders at a time to thereby initiate lifting or lowering of loads suspended on the cable of said cable drum, a reversible valve, discharge conduits connecting said signal transmitting cylinders with said reversible valve and further conduits connected with said discharge conduits, said reversible valve being arranged to respectively seal said further conduits and said discharge conduits from each other.

12. A structure as set forth in claim 11, wherein said circuit further comprises a supply conduit connected with said reversible valve to deliver fluid in response to actuation of either one of said signal transmitting cylinders, a first adjustable control valve connected in said supply conduit, a pressure regulator between said control valve and the cylinder of said operating unit, a further cylinder having a piston provided with a pedal, conduit means connecting said further cylinder with said control valve and with said feed conduits and a second adjustable control valve connected between said further cylinder and said feed conduits, said first control valve being adjustable to a first position to thereby seal said signal transmitting cylinders from said pressure regulator.

13. A structure as set forth in claim 12, wherein the piston of said further cylinder is a differential piston.

14. A structure as set forth in claim 13, wherein said first control valve is adjustable to a second position in which said further cylinder is sealed from said pressure regulator so that said pedal may serve as a foot rest.

15. A structure as set forth in claim 7, wherein said control means comprises a pair of pressure regulators connected with said source of pressure fluid, a third conduit directly connecting said pressure regulators with the cylinder of said clutch, a fourth conduit connecting said pressure regulators with said feed conduits, control valve means and a reversible valve provided in said fourth conduit, a fifth conduit connecting said pressure regulators with the cylinder of said second operating unit, and actuating means for selectively operating one of said pressure regulators at a time.

16. A structure as set forth in claim 15, wherein said control means also comprises a further cylinder having

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a spring-biased piston provided with a pedal, a sixth conduit connecting said further cylinder with a tank provided in said circuit, and a seventh conduit connecting said further cylinder with said control valve means in such a way that said control valve means can seal said fourth conduit and then connects said seventh conduit with one of said feed conduits.

17. A structure as set forth in claim 15, further comprising a pressure relief valve in one of said feed conduits.

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References Cited by the Examiner

UNITED STATES PATENTS

2,427,471	9/1947	Osgood	-----	254-185
2,947,397	8/1960	Pietsch	-----	254-185
3,244,404	4/1966	Bender	-----	254-185

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