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(54) **Load raising and lowering apparatus**

(57) Apparatus for raising and/or lowering loads, especially for operation of a winch raising and lowering scenery on a stage, comprising an hydraulic motor (10) which drives the winch (100) and has an output transmission to one or more lead screws (32) having cam devices (34) which are threaded thereon to be driven along said screws in order, at the lower or upper stop positions for the load, to engage a flow control valve (26) which controls the fluid supply to the motor so as to effect gradual deceleration and acceleration of the load. A separate fluid control valve (24) provides for speed regulation between the end stop positions, and the flow control valve (26) is operable independently thereof. A clutch means (48) disengages the lead screws (32) from the motor output to enable an independent drive of the winch which enables adjustment of the stop positions.

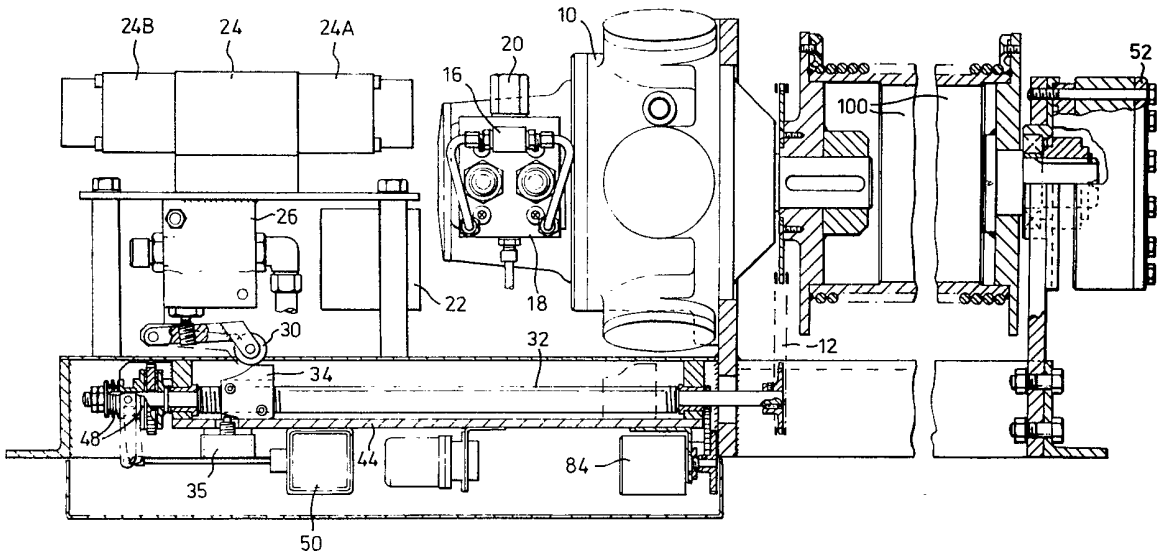


Fig.1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

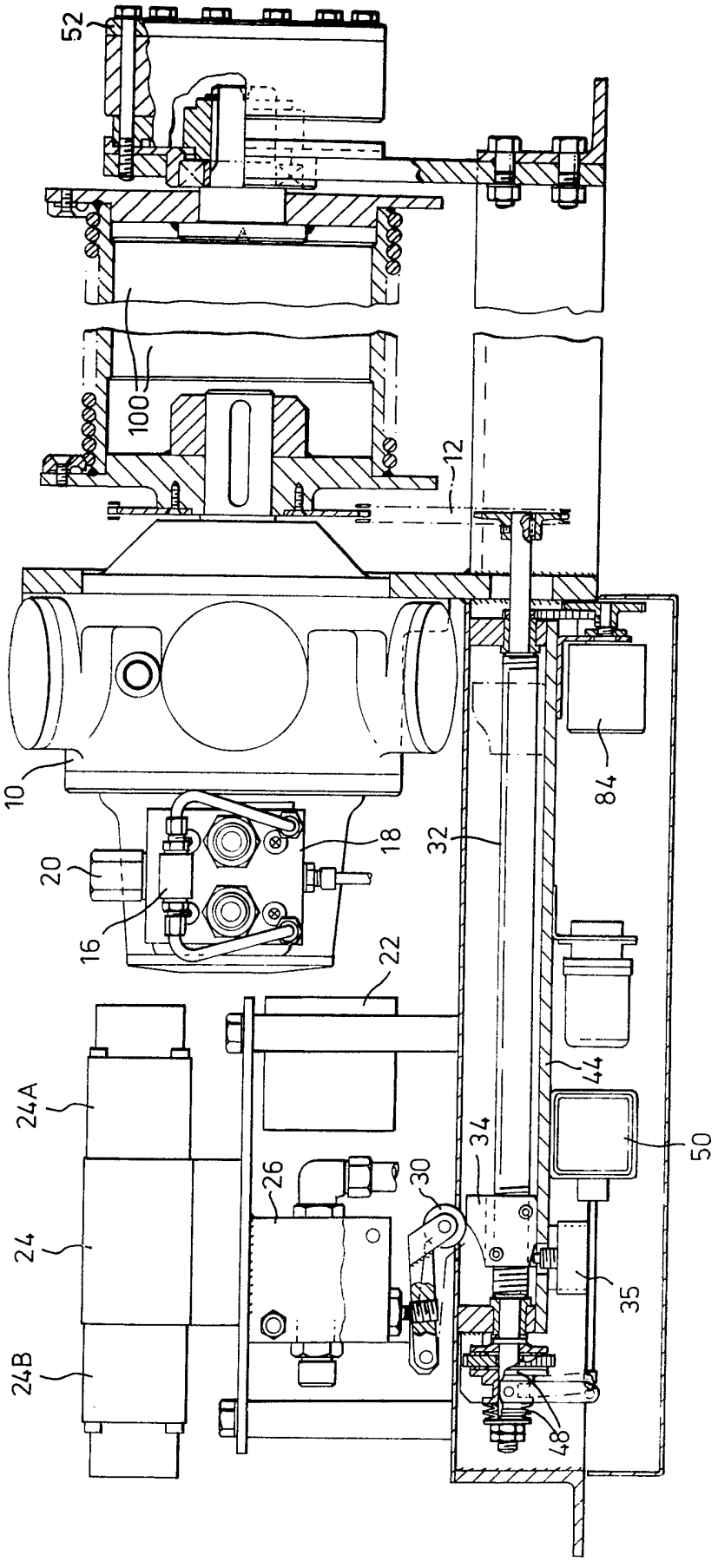


Fig.1.

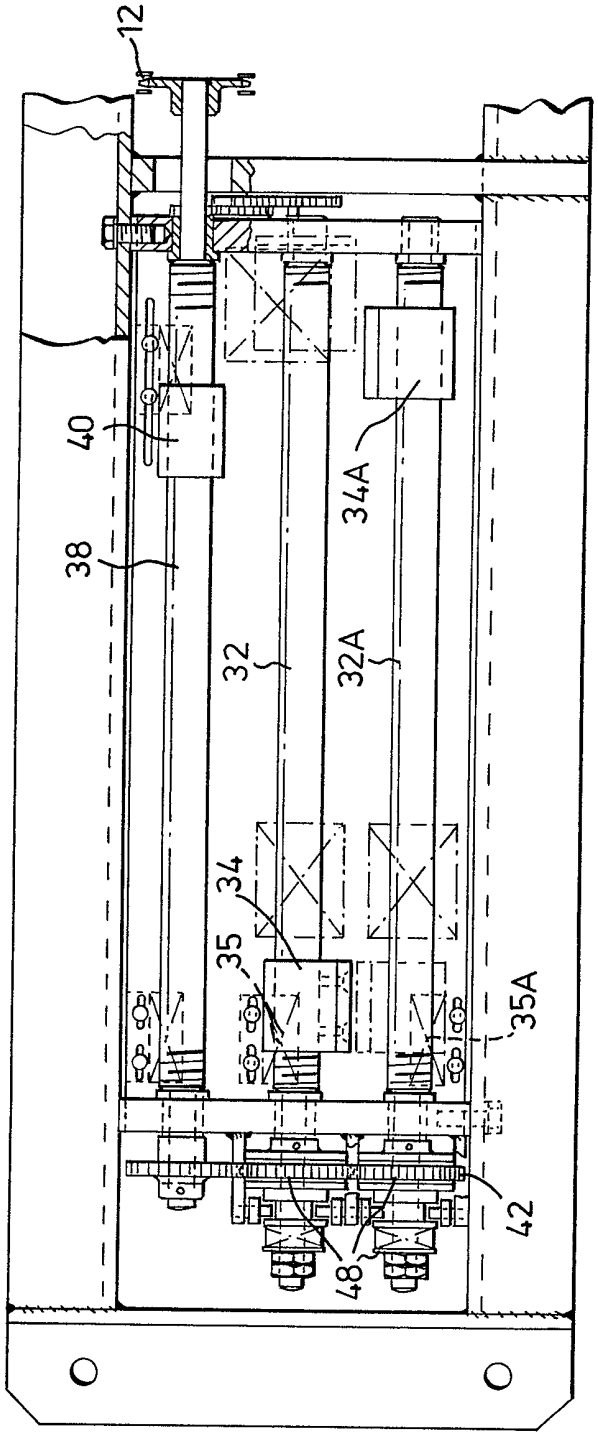


Fig. 2.

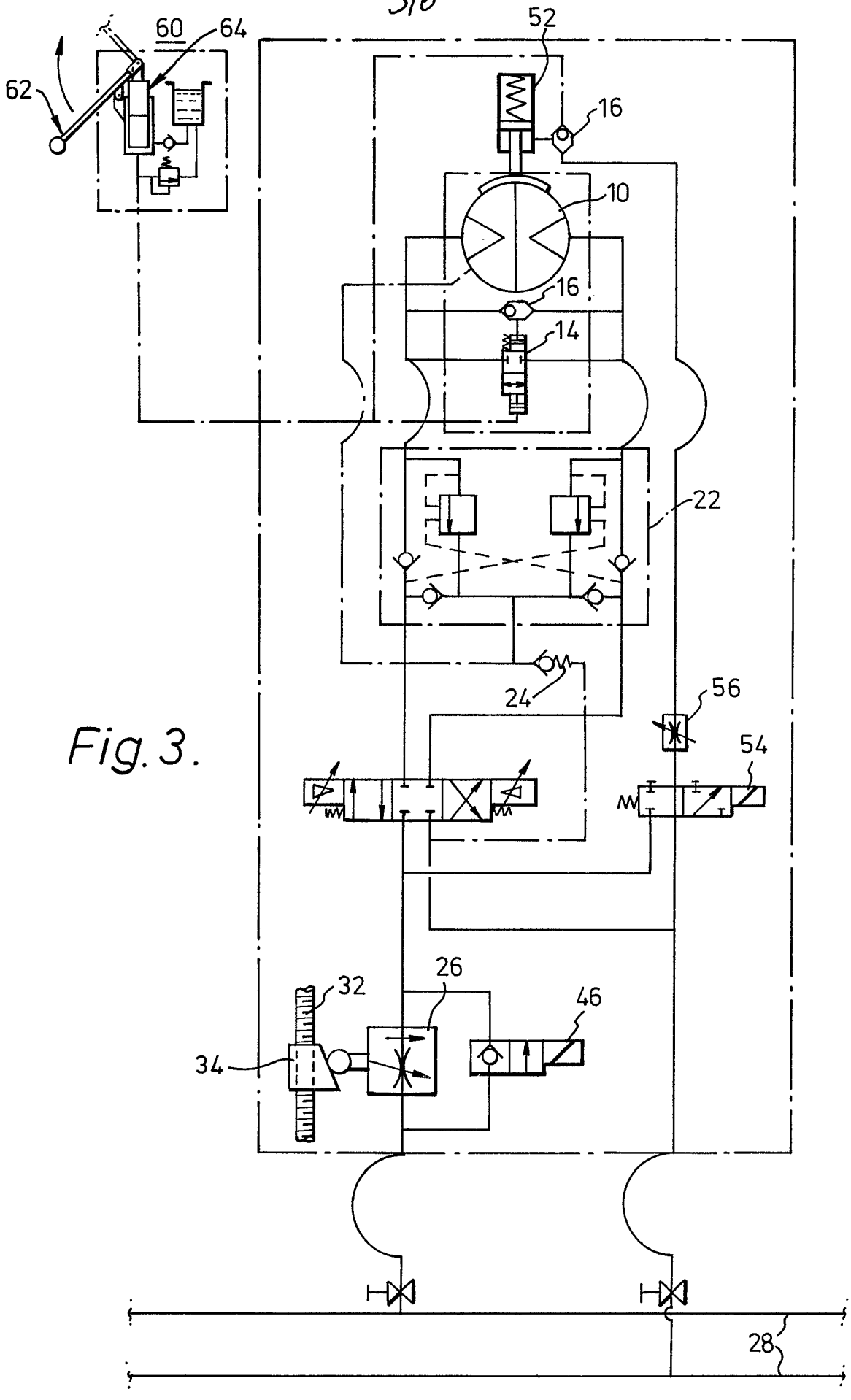


Fig. 3.

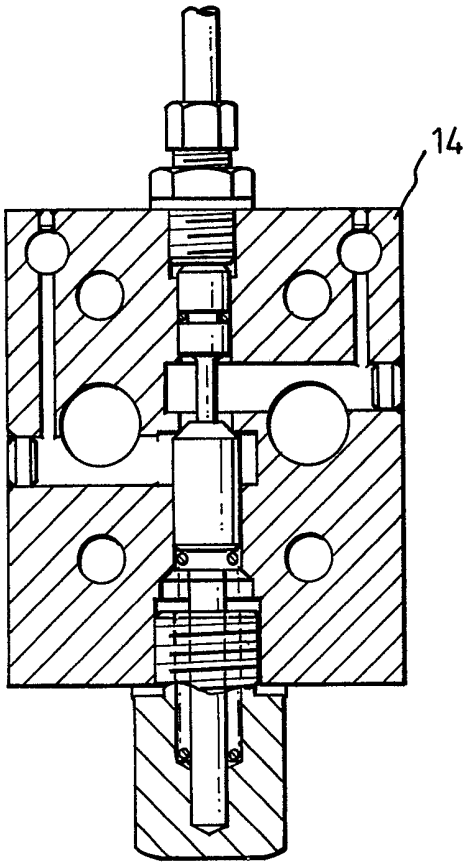


Fig. 4A.

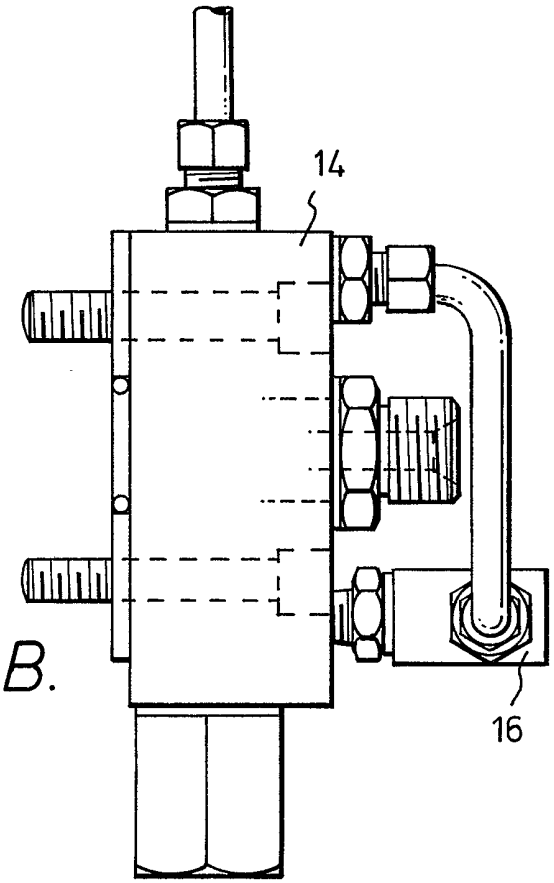


Fig. 4B.

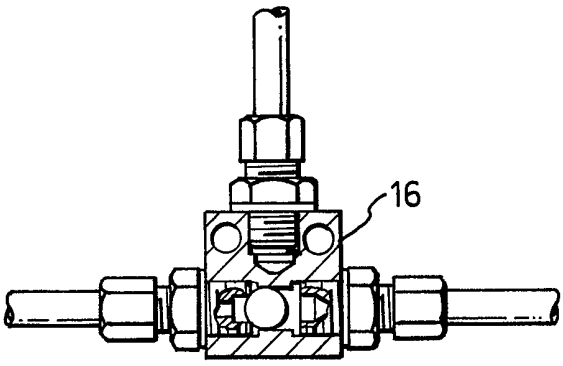


Fig. 4C.

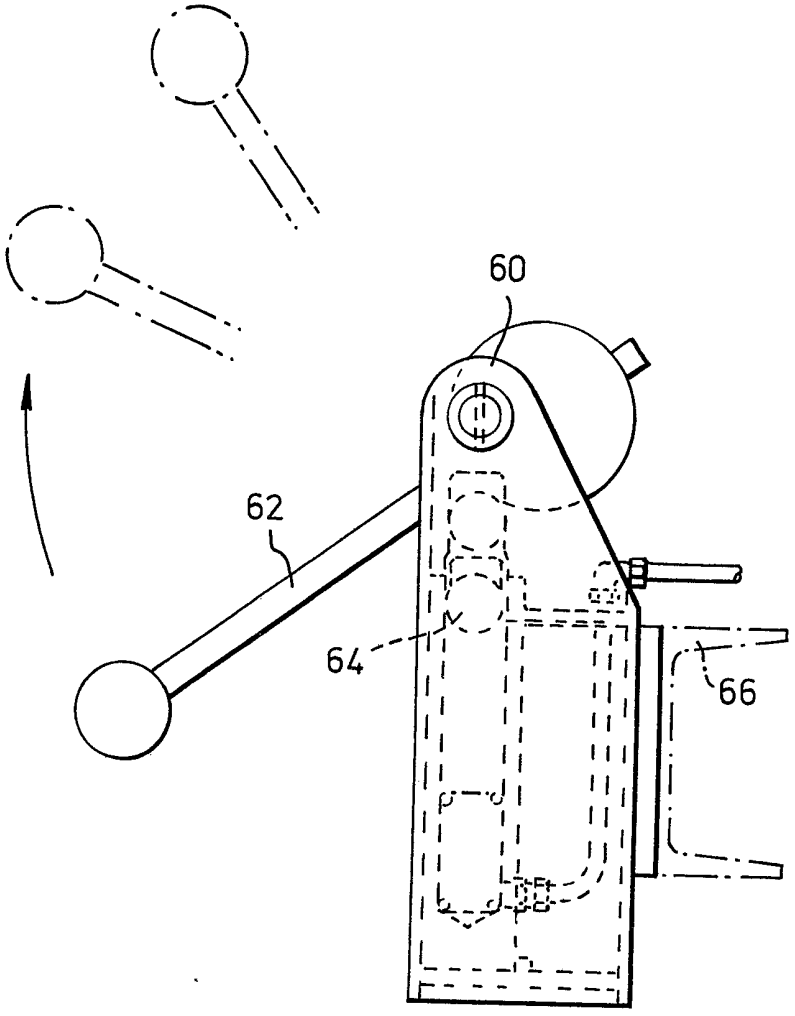


Fig. 5.

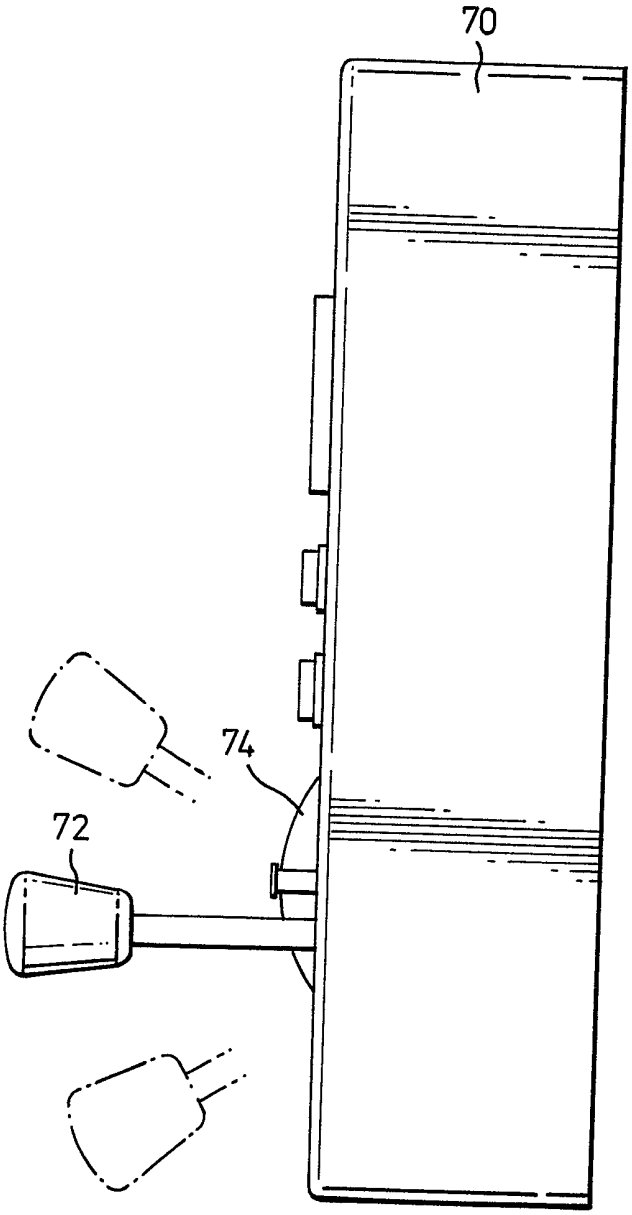

70
74
72

Fig. 6A.

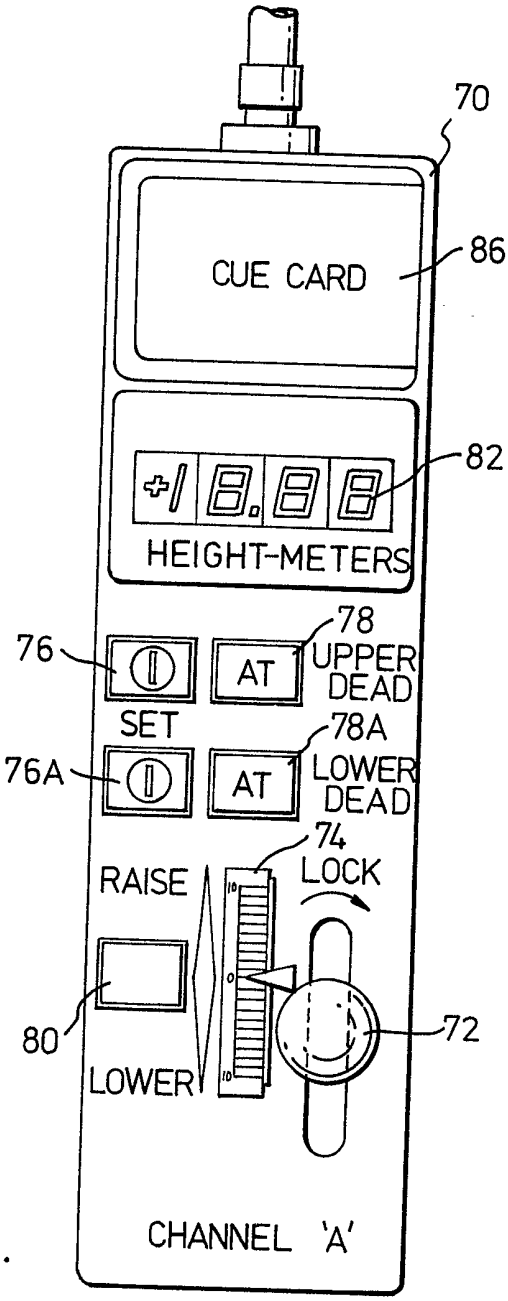

70
CUE CARD
86
+1 8.88
82
HEIGHT-METERS
76
78
AT
UPPER DEAD
SET
78A
76A
AT
LOWER DEAD
74
RAISE
LOCK
80
72
LOWER
CHANNEL 'A'

Fig. 6B.

SPECIFICATION

Apparatus for raising and/or lowering loads

This invention relates to apparatus for raising and/or lowering loads, and has particular applicability to the raising and lowering by a winch, more especially a winch for raising and/or lowering a beam or hook which supports scenery to be raised from and lowered into position on a theatrical stage.

Although scenery to be raised and lowered on stage is conveniently approximately counterbalanced, nevertheless the effort and frequency of such scenery changes is substantial. For this reason, a powered winch is to be preferred, especially on a large stage. With powered operation, however, a problem can arise in stopping and starting movement, especially if sudden stops and starts, which can be damaging as well as disconcerting to the audience, are to be avoided.

It is a primary object of the present invention to provide apparatus enabling a solution to this problem.

In accordance with the present invention, there is provided apparatus for raising and/or lowering a load, comprising a prime mover, transmission means for coupling the prime mover to the load, an adjustable control device connected to the prime mover to control the speed thereof, a lead screw coupled to the prime mover output or transmission means, and a cam device, either said control device or preferably said cam device being in screw-threaded engagement with the lead screw and held against rotation to be driven along the lead screw when the prime mover is operative, said control device having an adjustment element engaged by said cam device in order to provide gradual stopping and starting of the prime mover at a chosen stop position at which movement of the load is to be stopped.

The prime mover is preferably reversible, and first and second lead screws and cam devices thereon provide for adjustment of the control device to provide gradual stopping and starting at stop positions at the ends of a range of movement through which the load can be moved in either direction.

It is clearly desirable to provide means for adjusting the stop positions to change the range of movement of the load, and such stop positions adjusting means can conveniently comprise a clutch operable to declutch either one lead screw from the transmission means so that the load can be set in a new position for the same position of either one cam device on its lead screw. Thus, having reached a preset stop position, the appropriate lead screw can be declutched, and the drive of the load continued, under power, until the load reaches the new position at which it is to be stopped. Re-engagement of the clutch will then reset the stop position as determined by the lead screw and cam device.

While the adjustable control device does control the speed of the load, it only does so during deceleration and acceleration. There is preferably provided a speed regulating device for the prime mover for controlling the speed thereof between the stop positions at which the adjustable control device is operative, said control device acting to provide gradual starting and stopping over a constant distance independently of the setting of the speed regulating device.

In a practical arrangement, the prime mover is an hydraulic motor, or conveniently a linear hydraulic actuator, and the adjustable control device is a flow control valve connected in the hydraulic fluid supply line to said motor or linear actuator. The speed regulating device may then be a proportional spool valve connected in the fluid supply line in series with the flow control valve. This spool valve may also constitute a reversing function for reversing the fluid supply to the motor or actuator. The spool valve is conveniently controllable by a pair of solenoids, the spool position being determined by the relative magnitudes of the solenoid supply currents. Electric control of the hydraulics is preferred for a reason which will be apparent later.

The apparatus preferably includes an hydraulic brake associated with the motor, a restrictor valve preferably being provided in the fluid supply line to the brake for effecting gradual application and lifting thereof.

The invention also concerns the combination of the above-described apparatus with the winch, the apparatus including a remote control device having an hydraulic fluid link to the hydraulic motor and brake to effect release thereof and permit manual operation of the winch.

One or more additional lead screws and cam devices thereon may be provided for adjusting the control device or an additional such control device to effect gradual starting and/or stopping of the motor at one or more stop positions intermediate the end stop positions. Alternatively, the apparatus may include an additional adjustable control device movable on an additional lead screw to be adjusted by a cam device at a stop position intermediate the end stop positions.

Preferably, the valve or valves associated with the hydraulic supply circuit for the motor are electrically operable valves controllable from an all electric control unit located at a remote position. Clearly, the use of an all electric control unit facilitates its remote location. Furthermore, the control unit may include a control module bearing control elements and indicators for the hydraulic supply circuit, said control module being portable on a flying lead. Further features of the portable control unit will be later described.

A practical arrangement of apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a general cross-sectional view of the apparatus, primarily showing mechanical layout;

Figure 2 is a part plan primarily showing the lead screws and cam devices thereon;

Figure 3 shows the hydraulic supply circuit to the motor;

Figures 4A, *4B* and *4C* show hydraulic valves incorporated in the hydraulic supply circuit;

Figure 5 shows a manual override control device;

and

Figures 6A and *6B* show an electric control module.

The illustrated apparatus is especially intended to control a winch 100 used to raise and lower scenery on stage. The winch 100, which raises and lowers a counter-weighted scenery supporting beam, or non-counterweighted hook, is driven by a radial piston, hydraulic motor 10 which also provides an output transmission in the form of a chain drive 12. Hydraulic supply to the motor 10 is through an hydraulic circuit shown in Figure 3, and includes an open circuit valve 14 (see also Figure 4A) and a shuttle valve 16 (see also Figure 4B) attached to the motor manifold. The sub-assembly of these two valves is designated 18 in Figure 1; the reference 20 denotes a pressure gauge port. The hydraulic fluid is supplied to the valve sub-assembly 18 through a motion control and cross relief valve assembly 22 (see Figure 3) which is fed from a direction control and speed regulating valve assembly 24 (again see Figure 3). This basically comprises a three position, pressure compensated, proportional spool valve operable by solenoids 24A, 24B. The spool position is determined by the relative magnitudes of the control currents to the solenoids.

Fluid is fed to the speed regulating valve assembly 24 through an acceleration/deceleration speed control valve 26, the operation of which is a feature of primary interest in the present invention. This last mentioned valve assembly 26 is fed from the hydraulic supply lines 28, pressurised from one or more variable volume pumps. These supply lines, as indicated at the bottom left-hand side of Figure 3, continue to other, similar, hydraulic motor supply circuits, the motors of which operate respective winches for raising and lowering other items of scenery.

Valve 26 is a pressure compensated, proportional characteristic, flow control valve adapted by means of an adjusting element 30 for cam operation. In the present invention, adjustment of the element 30 is by means of a cam device mounted on a lead screw. In fact, as will be apparent from Figure 2, the element 30 is movable by either one of two cam devices 34, 34A mounted on respective lead screws 32, 32A. Thus, it will be appreciated that controlled starting and stopping of the winch (gradual deceleration and acceleration) is desirable not only when the scenery is lowered but also when it is raised, i.e. it is desirable not only at the lower stop position but also at the upper stop position. The respective lead screw/cam device combinations 32, 34 and 32A, 34A control stopping and starting respectively at the lower and upper stop positions. Cams 34 or 34A control deceleration down to a relatively low approach speed. At this point, limit switches 35 or 35A are actuated, de-energising solenoids 24A or B (directional control) and solenoid 54 (brake application). Then, by moving a control lever in the opposite direction, solenoids 24A or B and 54 are re-energised and the motor 10 accelerates out of the stop position.

The lead screw 38 carries a stop 40 which defines the end of travel limits for the apparatus (the stop actuates limit switches for closing down the motor supply and applying the brake). At its other end, the lead screw 32 is coupled through gearing 42 to the lead screw 32A. The end of travel limits lead screw 38 is driven from the chain transmission 12 from the motor 10. Thus, when the motor is in operation to drive the winch, the lead screws 32, 32A are driven in rotation. The cam devices 34, 34A in screwthreaded engagement with the lead screws are held against rotation on guides, shown at 44 in Figure 1, whereby such cam devices 34, 34A are driven along the lead screws 32, 32A, respectively in opposite directions. Thus, at the lower or upper stop position, the cam device 34 or 34A engages the adjusting element 30 of the valve 26 in order to provide controlled operation of the motor. More particularly, as either end of the range of movement of the load approaches, the appropriate cam device 34 or 34A causes the hydraulic fluid flow through the valve 26 to be gradually reduced to a value at which the motor 10, and thus the load, is stopped. When the motor 10 is restarted (in the reverse direction) gradual acceleration thereof takes place as increased fluid flow develops through the valve 26 as the cam device 34 or 34A moves away.

Clearly, the stop positions at which the valve 26 is rendered operative are determined by the positions of the cam devices 34, 34A on the lead screws 32, 32A and limit switches 35, 35A, as compared to the position of the load. Thus, in order to adjust the stop positions, e.g. to meet the requirements of scenery items of differing sizes, each lead screw 32, 32A is provided with a clutch 48. Each clutch 48 is operable by a solenoid 50. A lead screw 32 or 32A is declutched, using key switches 76 or 76A (Figure 6B). This key switch also energises a bypass valve solenoid 46 and electrically overrides the limit switch 35 or 35A, allowing the winch to be driven, in the normal manner, in either direction until the load is in the required new position, when the key switch 76 or 76A is released.

Associated with the motor 10, and in fact acting on the winch 100, is an hydraulic release, fail safe, disc brake 52. As shown in Figure 3, hydraulic release of the brake 52 is effected through a solenoid operable, two position valve 54, which provides hydraulic fluid to the brake through a restrictor valve 56, which ensures gradual application and gradual lifting of the brake, and through a shuttle valve 16, also shown in Figure 4C.

Provision for controlled stopping and starting at intermediate positions may be made by one or more additional lead screws and cam devices thereon, operating the same or an additional flow control valve. Alternatively, the additional valve may be threaded on the lead screw for cooperation with a fixed cam device. This reverse procedure may also be adopted in respect of the end stop position cam device 34, 34A and the valve 26 previously described, but is clearly less desirable in view of the flexible hydraulic connections required. Override switches will be provided to enable intermediate stop positions to be disregarded.

Figure 3 also shows an override control device 60, also shown in Figure 5, for enabling manual opera-

tion of the winch 12. This device 60 has a hand operable lever 62 which in effect drives a pump 64. The initial movement of lever 62 causes the brake 52 to release. Any out of balance force induced by the load or counter balance weight is then carried by the motor 10. If this force is within reasonable limits (i.e. the physical effort of one man, say 25 kg.), it will be possible to continue the movement of lever 62, effectively opening valve 14 and allowing the motor 10 to rotate freely on open circuit. However, should the out of balance force be greater than say 25 kg., a feed back pressure from either motor port will be applied to valve 14 via shuttle valve 16 inhibiting valve 14 from open circuit condition, and safely sustaining the winch until the load has been suitably balanced. The override control device will be located in a remote position, usually being fixed to the fly rail 66 in the fly gallery.

Figures 6A and 6B show an all-electric control module 70 for actuating the various solenoid operable valves of the hydraulic supply circuit (Figure 3) to the motor 10. The all electric nature of this module enables it to be remotely located, conveniently being attached by flying lead to a control unit.

The module 70 has a lever 72 for direction and speed control, a speed indicator 74 and switches 76 and 76A and indicators 78 and 78A for enabling the stop positions to be changed. The switches 76 are preferably key operable, so that risk of accidental changes of the stop positions is eliminated. Additionally, the module has a push-button 80 enabling the module to be isolated from the system. A height indicator 82 (load position indicator) is also provided (fed from a potentiometer 84 driven by the lead screw 34 (see Figure 1)) and, finally, a cue card holder 86 for cue cards which advise the operator of the programme of scenery changes.

It will be appreciated that the above described arrangement is by way of example only and may be modified in various ways within the scope of the invention as defined by the appended claims. More especially, the invention is not limited to apparatus for controlling stage winches, and can have other applications in which an electric prime mover with an associated electric supply circuit may be preferred. In such a case, various modified arrangements of the lead screws, cam devices and adjustable control device or devices will clearly be possible.

CLAIMS

1. Apparatus for raising and/or lowering a load, comprising a prime mover, transmisson means for coupling the prime mover to the load, an adjustable control device connected to the prime mover to control the speed thereof, a lead screw coupled to the prime mover output or transmission means, and a cam device, either said control device or preferably said cam device being in screw-threaded engagement with the lead screw and held against rotation to be driven along the lead screw when the prime mover is operative, said control device having an adjustment element engaged by said cam device in order to provide gradual stopping and starting of the prime mover at a chosen stop position at which movement of the load is to be stopped.

2. Apparatus according to claim 1, wherein the prime mover is reversible, and first and second lead screws and cam devices thereon provide for adjustment of the control device to provide gradual stopping and starting at stop positions at the ends of a range of movement through which the load can be moved in either direction.

3. Apparatus according to claim 2, wherein means are provided for adjusting the stop positions to change the range of movement of the load.

4. Apparatus according to claim 3, wherein said stop position adjusting means comprises a clutch operable to declutch either one lead screw from the transmission means so that the load can be set in a new position for the same position of either one cam device on its lead screw.

5. Apparatus according to any of claims 2 to 4, including a speed regulating device for the prime mover for controlling the speed thereof between the stop positions at which the adjustable control device is operative, said control device acting to provide gradual starting and stopping over a constant distance independently of the setting of the speed regulating device.

6. Apparatus according to any of claims 2 to 5, wherein the prime mover is an hydraulic motor and the adjustable control device is a flow control valve connected in the hydraulic fluid supply line to said motor.

7. Apparatus according to claim 6, wherein the hydraulic motor is a double acting, linear, hydraulic actuator.

8. Apparatus according to claim 6 or claim 7 when appendant to claim 5, wherein the speed regulating device is a proportional spool valve connected in the fluid supply line in series with the flow control valve.

9. Apparatus according to claim 8, wherein said spool valve also constitutes a reversing valve for reversing the fluid supply to the motor.

10. Apparatus according to claim 8 or claim 9, wherein the spool valve is controllable by a pair of solenoids, the spool position being determined by the relative magnitudes of the solenoid supply currents.

11. Apparatus according to any of claims 6 to 10, including an hydraulic brake associated with the motor.

12. Apparatus according to claim 11, including a restrictor valve in the fluid supply line to the brake for effecting gradual application and lifting thereof.

13. Apparatus according to any of claims 10 to 12, in combination with a winch to which the motor transmission means is coupled.

14. Apparatus as claimed in claim 13 including a remote control device having an hydraulic fluid link to the hydraulic motor and brake to effect release thereof and permit manual operation of the winch.

15. Apparatus according to any of claims 6 to 14, including one or more additional lead screws and cam devices thereon for adjusting the control device or an additional such control device to effect gradual starting and/or stopping of the motor at one or more stop positions intermediate the end stop positions.

16. Apparatus according to any of claims 6 to 14, including an additional adjustable control device movable on an additional lead screw to be adjusted by a cam device at a stop position intermediate the end stop positions.

17. Apparatus according to any of claims 6 to 16, wherein the valve or valves associated with the hydraulic supply circuit for the motor are electrically operable valves controllable from an all electric control unit located at a remote position.

18. Apparatus according to claim 17, wherein the control unit includes a control module bearing control elements and indicators for the hydraulic supply circuit, said control module being portable on a flying lead.

19. Apparatus for raising and lowering a load substantially as hereinbefore described with reference to the accompanying drawings.

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