

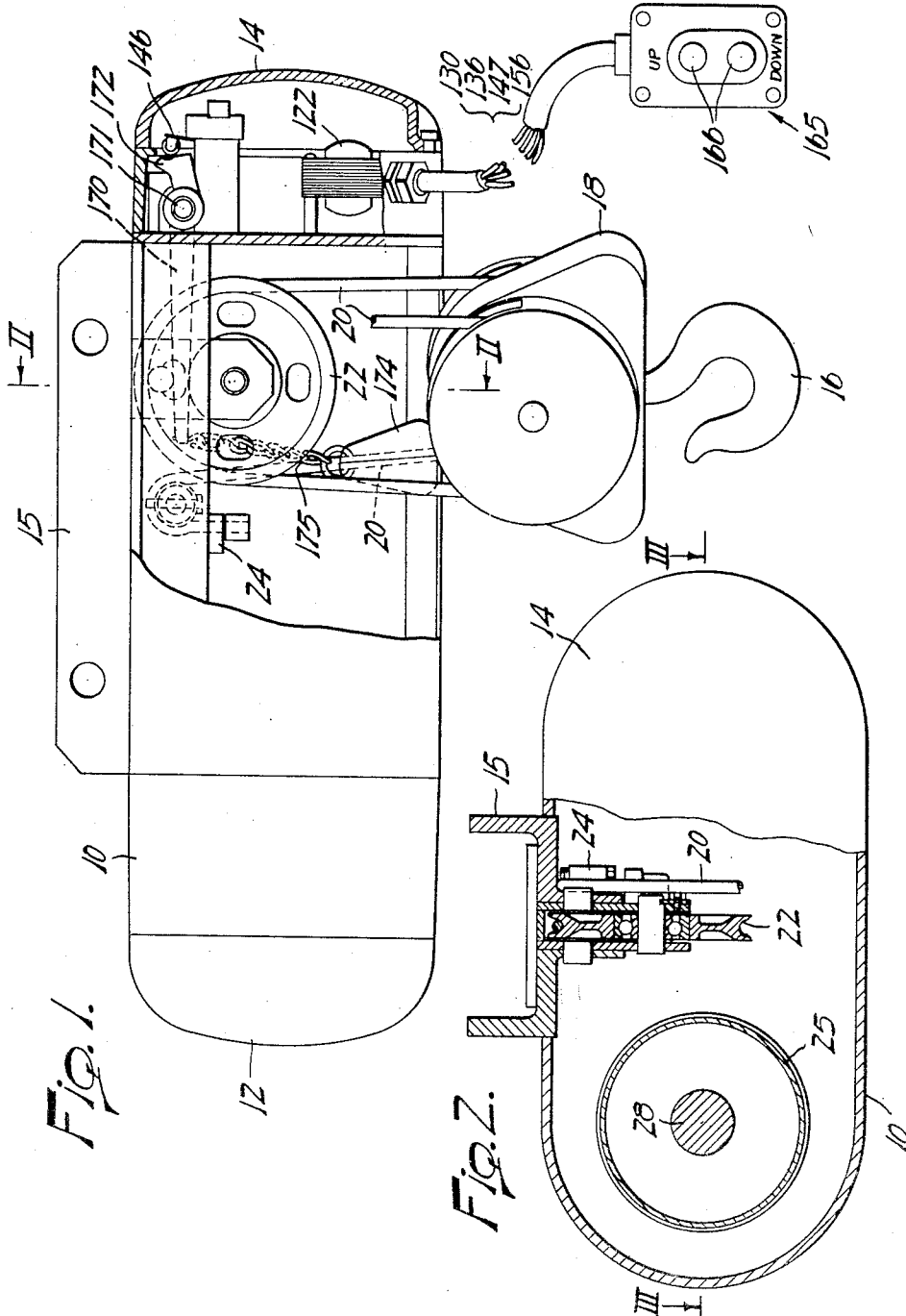
Nov. 23, 1954

H. F. PARKER
VARIABLE SPEED HOIST

2,695,086

Filed May 10, 1949

4 Sheets-Sheet 1



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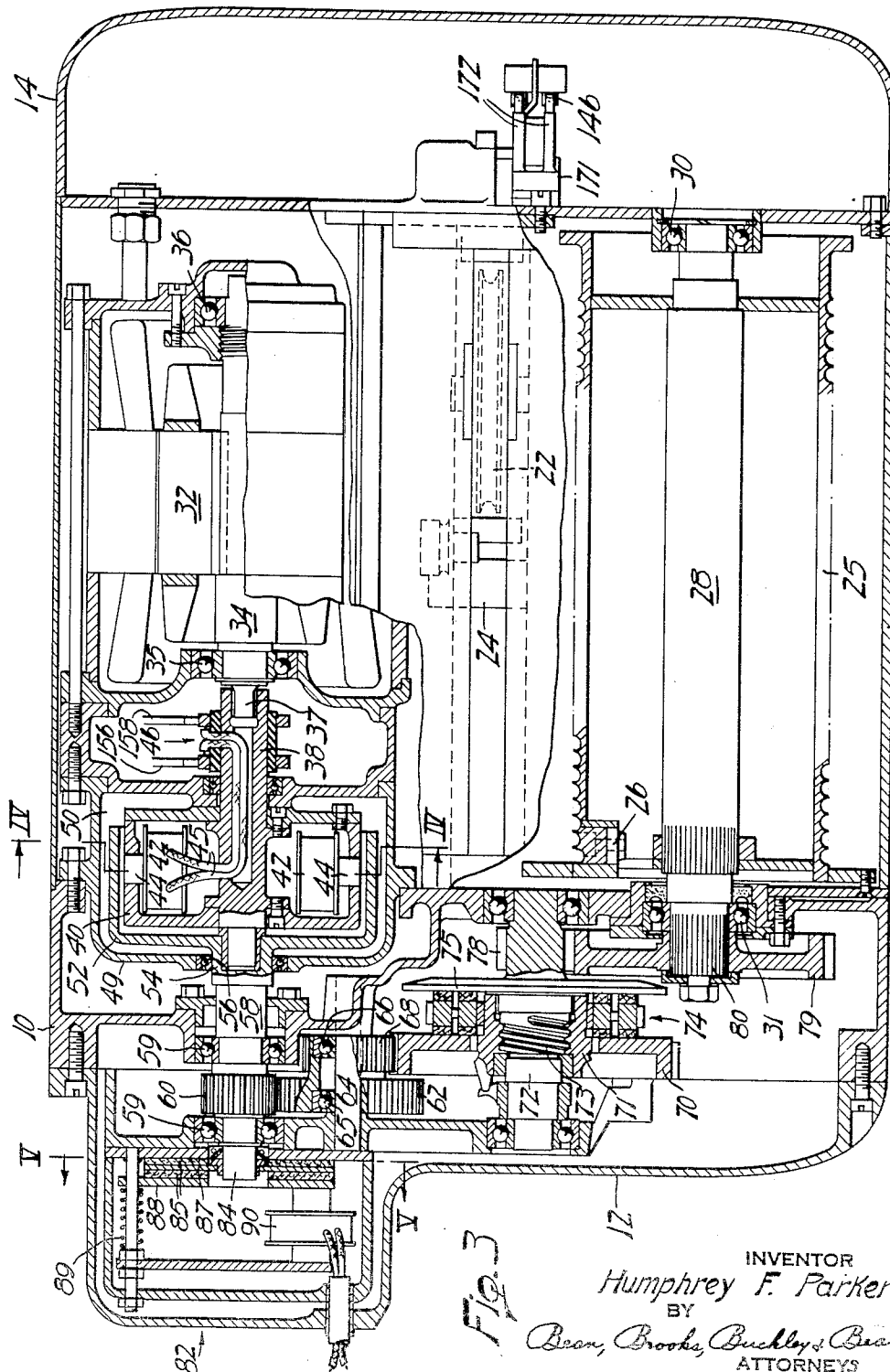
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4 Sheets-Sheet 2



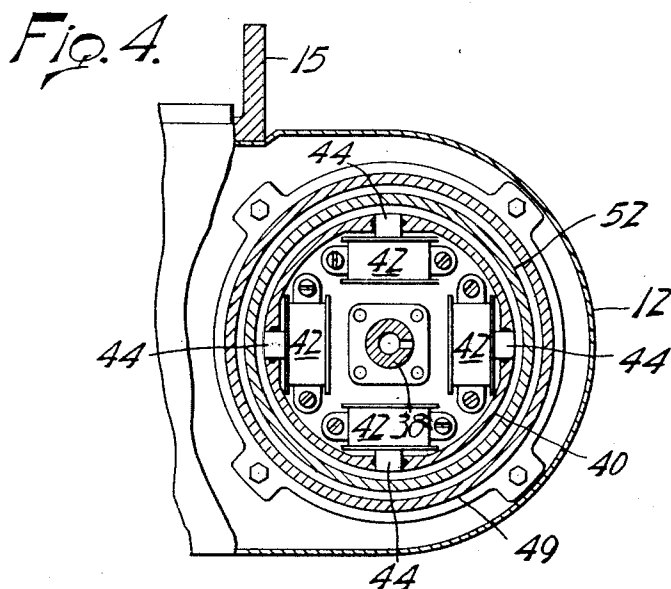
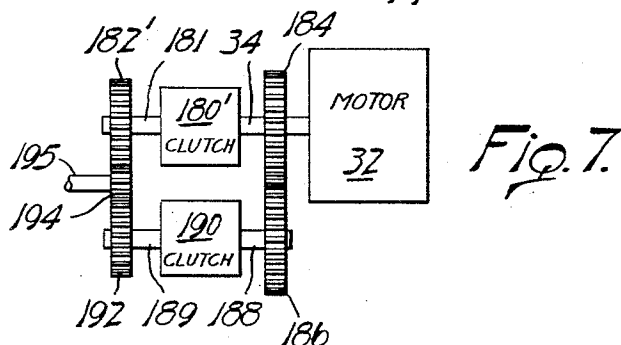
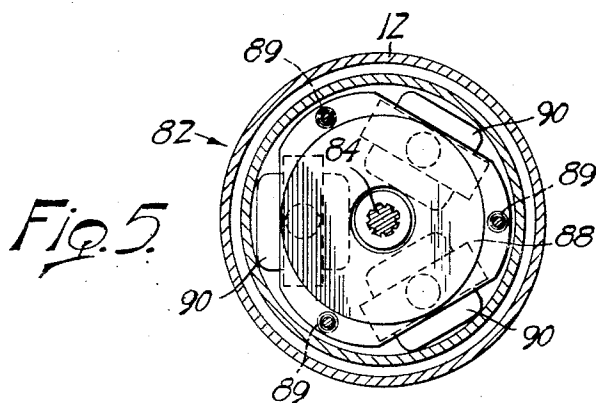
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VARIABLE SPEED HOIST

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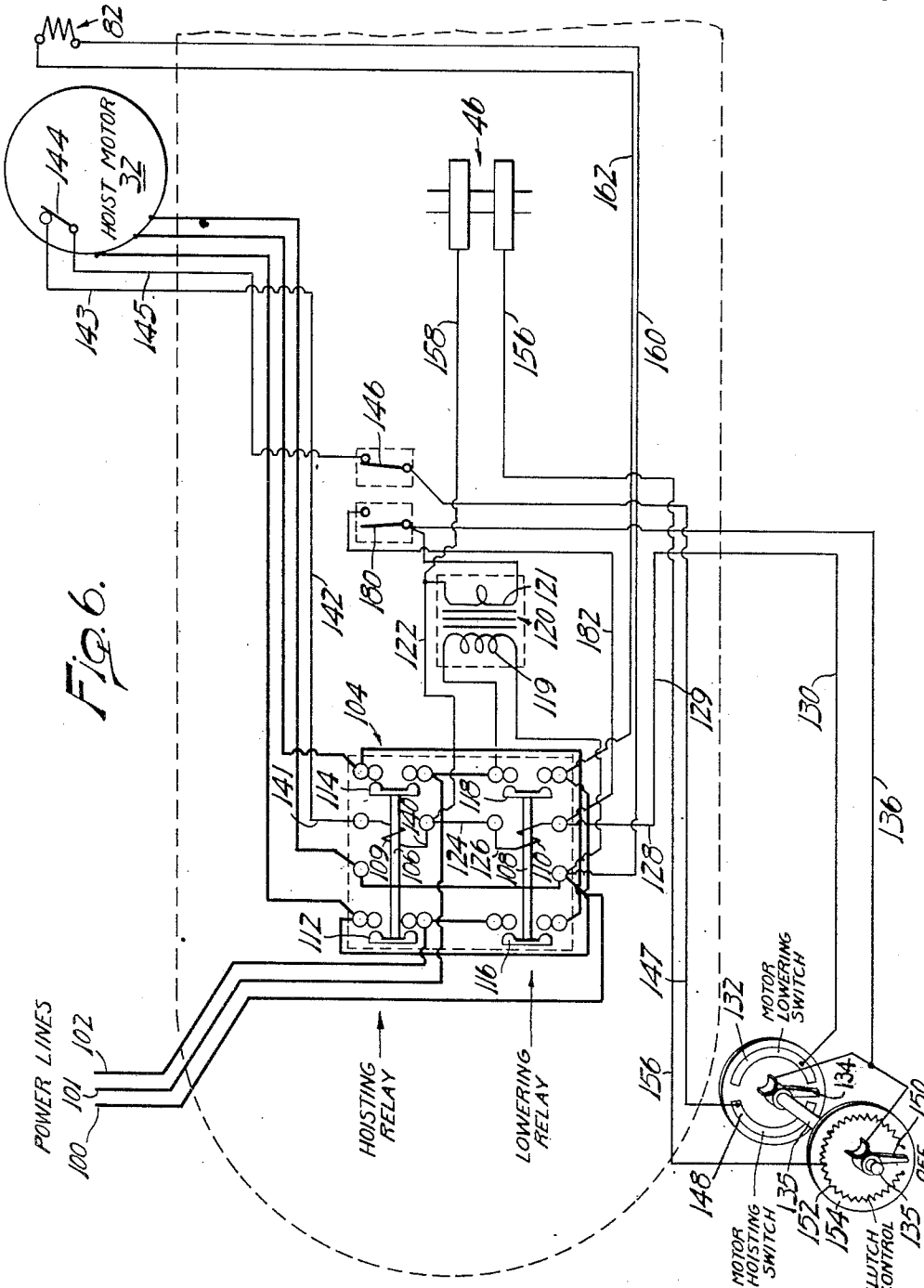
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VARIABLE SPEED HOIST

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4 Sheets-Sheet 4



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2,695,086

VARIABLE SPEED HOIST

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Application May 10, 1949, Serial No. 92,481

7 Claims. (Cl. 192—.02)

This invention relates to electric hoists, and more particularly to means in such hoists providing for improved variable speed operation thereof.

One of the objects of the invention is to provide an improved variable speed electric hoist employing as the prime mover thereof a relatively inexpensive standard type "constant speed" electric motor and providing an operative speed range between "creeping" and full speeds.

Another object of the invention is to provide an improved hoist mechanism whereby improved variable speed operation is obtainable in conjunction with any constant speed type prime mover element.

Another object of the invention is to provide in a variable speed electric hoist mechanism improved means for converting a constant speed motor output torque into a variable speed output torque, while at the same time providing inherent overload protection.

Another object of the invention is to provide in a hoist mechanism a novel torque transmitting means which eliminates need for means absorbing kinetic energy of the rotor of the driving motor when stopping the hoist so as to obtain improved instantaneous control.

Another object of the invention is to embody in a hoist mechanism improved power transmission means providing improved cushioning operation, thereby avoiding damage due to undue acceleration or shock loading or the like.

Other objects and advantages of the invention will appear in the specification hereinafter.

In the drawings:

Fig. 1 is a side elevation, partly in section, showing some of the major components of a hoist of the invention;

Fig. 2 is a fragmentary section taken along line II—II of Fig. 1;

Fig. 3 is a horizontal section, on an enlarged scale, taken along line III—III of Fig. 2;

Fig. 4 is a fragmentary section, taken along line IV—IV of Fig. 3;

Fig. 5 is a section taken along line V—V of Fig. 3; and

Fig. 6 is a diagram of the electric control circuit of the device; and

Fig. 7 is a diagrammatic illustration of the hoist motor and clutch and gear system.

The invention is illustrated in the drawing, by way of one example thereof, in conjunction with an electric hoist mechanism comprising generally a housing 10 having end cover plates 12—14 and a suspension bracket 15 by which the device is adapted to be hung upon any suitable stationary or travelling support. The load lift element of the mechanism is indicated to comprise a lift hook 16 which extends from a double sheave block 18 through which is reeved a flexible cable 20. The cable trains over an idle pulley 22 and one end of the cable is fixed to a stationary frame portion of the mechanism as indicated at 24 while the opposite end of the cable trains around a lifting drum 25 and is fixed thereto as indicated at 26 (Fig. 3). The drum 25 is carried by a shaft 28 and bearings 30—31 mounted upon the housing 10.

The housing 10 also mounts thereon the power supply motor which is indicated generally at 32, the armature shaft 34 of which is carried in bearings 35—36. The motor 32 may be of any desired type, but for the purposes of the invention, for example, a simple alternating current motor of the squirrel cage type operating at substantially constant speed may be adequate. However, in general precise control is more important in the low speed

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phase of the available range and therefore it may be considered desirable to employ the invention in conjunction with a multi-speed motor such as a two-speed squirrel cage motor or even a wound rotor A. C. motor. In the latter case, the inherent motor characteristics enable variable speed to be obtained during the higher speed range of operation, and the fluid-magnetic clutch element of the invention functions as a supplement thereto providing variable speed control in the lower speed range. However, in the interest of simplification of the specification herein, a motor of the single speed squirrel cage type is illustrated and referred to in the wiring diagram. The motor shaft 34 is formed with a spline connection end portion 37 which couples with the power input shaft 38 of a fluid-magnetic clutch device. The clutch mechanism includes an annular housing 40 which encircles and is fixed to the shaft 38; the housing 40 being formed of any suitable non-magnetic material and mounting there-within a plurality of electro-magnets 42. The magnets 42 have their pole pieces 44 disposed radially of the housing 40, and the magnet coils are electrically interconnected with a power source as through means of conductors 45 leading through the shaft 38 and thence to a slip-ring and brush device which is indicated generally at 46. Thus, the conductors 45 are arranged to be in series with conductors which comprise a power supply circuit as will be explained more fully hereinafter in connection with the description of Fig. 6.

A casing structure 49 is mounted within the housing 10 so as to enclose the clutch rotor housing 40 while providing a gap therebetween as indicated at 50. Thus, the housing 40 comprises the driver element of the clutch device because of its connection to the motor shaft through the shaft 38; and the driven element of the clutch device is provided as indicated at 52 to be in the form of a cup-like member having its cylindrical rim portion disposed within the gap 50 between the stationary casing 49 and the rotor housing 40. The hub portion 54 of the member 52 is journaled in a casing bearing 56 and keyed to a power output shaft 58 which is journaled within the housing 10 by means of bearings 59—59. The shaft 58 mounts a pinion 60 which engages a spur gear 62 carried by a stub shaft 64 which is journaled upon bearings 65—66. The shaft 64 also carries a pinion 68 which meshes with a spur gear 70 which is formed integral with the hub portion 71 of a screw type friction brake device which also includes a shaft 72 which is in threaded engagement at 73 with the gear hub 71. The type brake referred to and illustrated is also illustrated and described in full detail in Parker et al. Patent No. 2,325,917; and the ratchet-friction annulus unit thereof is illustrated in the present drawing at 74 as being disposed between the gear 70 and a face plate 75 which is formed integrally with the shaft 72. The shaft 72 also mounts a pinion 78 which meshes with a spur gear 79 which is keyed to the drum shaft 28, as indicated at 80.

A suitable mixture of a fluid vehicle and magnetic material in powdered or granule form, such as a mixture of lubricating oil and iron filings or the like, is disposed within the gap portion 50 interiorly of the casing 49, and is supplied in such quantity that it will substantially fill the portion of the gap 50 which is occupied by the rim portion 52 of the driven element. As is presently known in the fluid-magnetic clutch art, whenever such mixture of fluid and magnetic particles is magnetized, as by energization of the coils 42, the magnetic particles magnetically interlock and thereby operate to stiffen the mixture and bond the members 40—52 together. The degree of this clutching action depends upon the degree of energization of the coils 42 and the corresponding degree of magnetization of the mixture; and thus a variable slippage clutch is provided wherein the degree of slip is a function of the degree of magnetization of the driving parts. Thus, it will be appreciated that upon appropriate energization of the coils 42, the motor 32 of the hoist mechanism of the present invention may operate at full speed while the winding drum 25 is caused to operate at any desired speed within the range from a "creeping" speed up to full speed corresponding to the motor speed.

Thus, it will be understood that whenever the motor 32

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is running with the clutch device energized the motor torque will be transmitted through the gear mechanism to the winding drum 25; the friction brake device being adapted to operate automatically upon discontinuance of power applications through the gear mechanism to "hold" the load at any position of elevation thereof. Then, upon reapplication of power through the gear 76 the friction brake device automatically releases to permit the winding drum to be driven in the desired direction.

The fluid-magnetic type clutch provides certain important inherent advantages when used in a hoisting mechanism of this type because this type clutch mechanism provides extremely sensitive speed control effects through use of a relatively simple control device and upon application of only small amounts of control power. Also, the variable speed range is of enlarged scope, and provides an important and unique characteristic in that the clutching action in this type mechanism definitely breaks down under over-loading of the device, so that the hoist mechanism of the invention for example embodies inherently an overload protection, and it is unnecessary to provide some additional overload protection device.

In some cases it may be considered desirable to provide an extra safety or "holding" brake in addition to the friction brake device illustrated at 74, and in such case a suitable magnetic brake device as indicated generally at 82 (Figs. 3 and 5) may be coupled to the clutch output shaft 58 as indicated at 84. As shown, the brake includes friction disc members 85—85 at opposite sides of a plate 87 which is keyed to the shaft 58, and a pusher plate 88 which is biased by springs 89 to ram the friction discs and plate together so as to brake the gear mechanism. Electromagnets 90 are mounted upon the frame and arranged to pull upon the plate 88 so as to withdraw it and release the friction discs whenever current is passing to the driving motor 32; and thus the brake device 82 operates automatically whenever the motor is deenergized to "hold" the gear mechanism against rotation in any direction.

Fig. 6 illustrates diagrammatically a power control system for the hoist mechanism; the system illustrated being of a type suitable for use in conjunction with a constant speed squirrel cage type motor as indicated at 32 in Fig. 3 of the drawing. In the wiring diagram the power supply leads are indicated at 100—101—102, and are arranged to connect to the motor 32 through a multiple relay switch device which is indicated generally at 104. The relay device comprises generally a "hoisting" control armature 106 and a "lowering" control armature 108, which are operated by solenoid coils 109—110, respectively. The hoist control armature 106 is provided with contactors 112—114, and the lowering control armature 108 is provided with contactors 116—118.

The primary coil 119 of a transformer 120 is connected in series with the power leads 100—101, and one end of the secondary winding 121 of the transformer is connected through means of conductors 122, 124, 126, the solenoid coil 110, conductors 128, 129, 130; and thence to one end of a conductor segment 132 upon which slides a control brush 134 which extends radially from a control switch shaft 135. The brush 134 is connected in series with a conductor 136 which leads back to the opposite end of the secondary winding 121 of the transformer 120. Thus, it will be appreciated that whenever the switch shaft 135 is rotated to cause the brush 134 to sweep in contact with the segment 132, the circuit including the transformer output coil and the solenoid coil 110 will be closed, whereby the contacts 116—118 of the relay unit will be held over in "closed" position, thereby causing the circuit from the power supply leads to the motor 32 to be closed in such manner as to cause the motor to run in reverse or load lowering direction.

The conductor 122 leading away from the transformer 120 also connects through conductor 140, the solenoid coil 109, and conductors 141, 142, 143, thermostatic switch 144, conductor 145, normally closed limit switch 146, and conductor 147 to one end of another contact segment 148 of the directional control switch unit. As in the manner of the arrangement of the segment 132, the segment 148 is also disposed for sweeping contact with the brush 134 of the control shaft 135, so that whenever the latter is rotated so as to bring the brush into contact with the segment 148 a circuit to the motor 32 will be closed so as to cause the latter to run in forward or load hoisting direction.

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The control switch shaft 135 also mounts a brush 150 which is arranged to sweep against a resistance conductor 152 carried upon a face plate 154. The brush 150 is electrically connected to the conductor 136, and at its midpoint the resistance conductor 152 is electrically connected to a conductor 156 which leads to one of the brush-slip ring elements of the unit 46 (Fig. 3). The other brush of the slip ring unit connects to a conductor 158 which returns to the transformer 120, whereby it will be understood that rotation of the control shaft 135 in either direction away from the brush "off" position will cause the brush 150 to sweep the rheostat 152 so as to cause current at varying voltages to be delivered to the clutch coils 42.

Thus, the control shaft 135 may be arranged to be manually operated by any suitable means such as a crank lever attached thereto, or by a double rack and pinion arrangement whereby a double push button type switch actuator as indicated for example at 165 (Fig. 1) may be employed for hoisting and lowering control. In any case the control will be arranged so that when the shaft is in neutral or "off" position as shown in Fig. 6 all of the operative circuits will be open. Then upon rotation of the shaft in one direction as by pressure upon one of the buttons 166 the brush 134 will contact one of the segments 132—148 so as to energize the motor for operation in the direction corresponding to the direction of rotation of the control shaft 135. Then upon application of further pressure to the control button and consequent further rotation of the control shaft, the brush 150 will be caused to contact and traverse the rheostat element 152 in such manner as to close the circuit to the clutch control magnets 42 and to progressively reduce the resistance in the clutch control circuit as the control shaft is turned further away from its "off" position.

Thus, it will be appreciated that for "hoisting" operation of the mechanism the control shaft will be moved in clockwise direction as viewed in Fig. 6 whereupon the motor will first be fully energized while the clutch is substantially disengaged whereby the starting motor inrush current load is minimized. Then upon further rotation of the control shaft the clutch mechanism will become energized so as to induce therein a progressively increasing degree of clutching action. Similar operation of the control shaft in opposite direction will of course provide a similar type load lowering operation.

As shown in Fig. 6, a conductor 160 leads from power line 100 and a conductor 162 leads from the contactors of the relay devices, so that automatically upon closing of either one of the relay devices a current will flow through the circuit comprising the conductors 160—162 and the coil system of the magnetic brake unit 82, thereby releasing the "holding" brake automatically upon energization of the motor.

As explained hereinabove, the hoist control circuit includes a normally closed limit switch 146 for automatically stopping the hoisting operation whenever the upper limit thereof is reached. Such limit switches are of course well known and may be arranged to be actuated by any suitable means; and in the drawing the switch 146 is illustrated for example to be actuated by means of a lever arm 170 which pivots upon the hoist frame at 171 and is formed with a cam end 172 arranged for contact with the actuating element of the switch 146 (Fig. 1). The lever 170 is maintained normally inoperative by means of a counterweight 174 suspended therefrom by a chain 175; the hoisting cable 20 being slipfitted through a centrally bored portion of the counterweight 174. Thus, as the hoist block 18 approaches the upper permissible limit of travel it bears against the counterweight 174 and lifts the latter so as to relax the chain 175, whereupon the lever 170 pivots so that the cam portion 172 operates the switch 146 to open the hoisting control circuit. Should the hook block continue its upward travel after the opening of switch 146 (as for example by failure of the brake 82 to operate due to wear or incorrect adjustment), a second cam keyed to shaft 171 acts to close momentarily the normally open switch 180. A circuit is thereby provided from transformer secondary coil 121, thru conductors 122, 124 and 126, coil 110, conductor 182 and switch 180 back to transformer coil 121, thereby energizing relay 110 and closing the lowering circuit to the hoist motor 32, instantaneously reversing or "plugging" said motor and positively lowering hook block 18 until rotation of shaft 171 reopens switch 180.

It is a particular feature of the hoist mechanism of the invention that the operator is given at all times extremely sensitive control of the hoisting operation within the range including "creeping" and full speed operations regardless of the speed at which the motor runs, such as is unobtainable in other hoist mechanisms employing for example electro-magnetic or other type clutch devices in lieu of the fluid-magnetic type clutch device as used in the case of the present invention.

To illustrate the performance characteristics of the mechanism of the present invention, typical operations thereof may be described as follows: Assuming a situation wherein a load is suspended from the hoist while the hoist control is in "off" position; the motor is dead and the fluid-magnetic clutch is disengaged. However, the screw brake 74 and the magnetic brake 82 are both engaged so as to doubly insure "holding" of the load. If the hoist control button is now pushed part way in, the motor will become energized and the rotor will come quickly up to running speed while minimum inrush currents are applied thereto because the clutch is not yet energized and there is no connection between the rotor shaft and the balance of the mechanism. The magnetic brake 82 has by now been released, but the screw brake 74 is still engaged and continues to hold the load under the supervision of the operator.

Then, as the hoisting control button is further depressed, current flows to the coils of the fluid-magnetic clutch, thereby energizing the latter so as to create a torque between the clutch parts tending to lift the load. However, no lifting of the load occurs until the torque is sufficiently increased by further depression of the control button to the point where the clutch torque overcomes the opposing torque created by the load upon the gear mechanism, and held by the ratchet 74 and pawl (not shown). Further increase in torque causes rotation of the gear 70 and shaft 72; the ratchet 74 then moving away from engagement with the pawl, and the load being then assumed by the motor and the hoist drum commences to rotate in the hoisting direction. Still further depression of the hoisting control button progressively reduces the resistance in the clutch energizing circuit so that the hoisting drum 25 is gradually accelerated up to a speed corresponding to the full motor speed; the clutch parts being effectively locked together whenever the control button is fully depressed.

Upon attainment of the desired load elevation the hoisting control button is released by the operator whereupon the motor and the fluid-magnetic clutch are simultaneously deenergized. At the same time the magnetic brake 82 is deenergized whereupon the spring elements thereof operate to "set" this brake against rotation of the gear train. The tendency of the load to unwind the cable drum then results automatically in setting of the screw brake 74, whereupon the brake devices 74-82 cooperate to "hold" the load. It is a particular feature of the arrangement of the invention that immediately upon release of the hoisting control button the motor is disconnected from the hoisting mechanism as explained hereinabove, whereby the inertia of the rotor is not transmitted to the hoisting mechanism in opposition to the braking action of the magnetic brake 82. Thus, it will be understood that the invention provides an improved sensitivity of control and at the same time avoids overloading of the motor and brake and gear parts.

Lowering operations are similarly accomplished by pushing the "down" control button, whereupon the motor is first energized to run in reverse direction while the fluid-magnetic clutch remains deenergized. The magnetic brake 82 is simultaneously energized and released, but the screw brake 74 continues to "hold" the load. Further depression of the control button then energizes the coils of the fluid-magnetic clutch, and when the control button is depressed to result in development of sufficient clutch torque, the motor will operate to release the screw brake 74, thus permitting lowering of the load at slow speed. Further depression of the control button results in a correspondingly increased degree of clutch engagement, and if the button is pressed to full lowering speed position the hoist will lower the load at a speed corresponding to the full speed of the motor. Then, upon release of the "down" control button the motor and the fluid-magnetic clutch device will be instantaneously deenergized while the magnetic brake 82 is "set." Because the motor inertia is not transmitted through the

clutch the brake 82 sets instantaneously and provides a drag through the gear system which immediately operates to cause the brake 74 to "set." Thus, cessation of the lowering operation is instantaneous, and the brake devices 74-82 "set" immediately and thereupon cooperate to safely hold the load.

Thus, it will be appreciated that, as in the case of the hoisting operation, the control characteristics during the lowering operation are of improved type such as may not be obtained by mechanisms of the prior art, and that a main feature of the control system of the invention is that it provides an extremely sensitive control of the load under all hoisting and lowering and stopping and starting operations.

Whereas, in the hereinabove specification the mechanism has been illustrated and described in conjunction with a reversible direction motor, it is also a feature of the present invention that the mechanism thereof may be powered by a unidirectional motor in combination with a reversing gear and duplex clutch arrangement. For example, as illustrated diagrammatically in Fig. 7 of the drawing, the basic gear arrangement of the hoist mechanism may comprise in combination with the motor 32 and the motor shaft 34, a first fluid-magnetic clutch 180' having its output shaft 181 keyed to a gear 182'. The motor shaft 34 also mounts a gear 184 which meshes with a reversing direction gear 186 which drives a counter-shaft 188. The shaft 188 is selectively engaged with an output shaft 189 by means of a second fluid-magnetic clutch 190; and the output shaft 189 is keyed to a gear 192. The gears 182' and 192 are arranged to mesh with a pinion 194 which is keyed to the hoist drive shaft 195 such as would correspond to the shaft 58 of the form of the mechanism illustrated in Fig. 3. Thus, the shaft 195 of Fig. 7 would mount a gear corresponding to the pinion 60 of Fig. 3 for driving the hoist drum 25 whenever the motor 32 and one of the clutches 180'-190 are energized. Thus, it will be appreciated for example that with the reversing gear arrangement of Fig. 7, upon simultaneous energization of the motor 32 and the clutch 180', while the clutch 190 is deenergized, the motor 32 will operate to drive the shaft 195 in one direction. Similarly, upon simultaneous energization of the motor 32 and the clutch 190, while the clutch 180' is deenergized, the motor will operate to drive the shaft 195 in the opposite direction; and in any case the control features of the invention will be obtained.

Use of the reversing gear arrangement of Fig. 7 would result in simplification of the electrical control relay mechanism because only a single relay would be required; the resistor control of the fluid magnetic clutch as illustrated in the lower left hand corner of Fig. 6 being divided into a pair of resistors at opposite sides of the "off" position with appropriate leads from the two resistor elements to the corresponding clutch coil control circuits. On the other hand the motor control switch would be consolidated into a single element, in series with a single motor control relay; whereby upon rotation of the control shaft 135 in one direction away from "off" the motor would be energized and then one of the clutches would be energized. Rotation of the control shaft in the opposite direction would result in energization of the motor for operation in the same direction, while the other clutch would then be energized, so as to provide alternate reverse direction control of the motor torque while employing only a uni-directional motor. The other brake and gear and automatic switch control devices of the hoist mechanism would be similar to the arrangement shown in Fig. 3; and thus it will be appreciated that a hoist mechanism embodying the reversing gear arrangement of Fig. 7 would be mechanically complicated but electrically simplified compared to the arrangement of Fig. 3.

Although only a few embodiments of the invention have been illustrated and described herein, it will be apparent to those skilled in the art that the invention is not so limited but that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a hoist mechanism, in combination, an electric motor, a load shaft, a fluid-magnetic clutch device interconnecting said motor and said load shaft, electro-magnetic brake means operable when de-energized to hold said load shaft against rotation, and a control de-

vice for said motor and said brake means and said clutch device, said control device comprising energizing circuit means and a single manually operable circuit control member having an open circuit position for de-energization of said motor and said clutch device and said brake means and movable therefrom to a closed circuit position in which is effected full immediate energization of said motor and of said brake means for releasing the hold of the latter and in which selectively variable energization of said clutch device is effected to vary the speed of said load shaft independently of the motor speed, said manually operable control member being so constructed and arranged that said clutch device is at minimum voltage energization at initial full energization of the motor.

2. In a hoist mechanism as set forth in claim 1, a second brake means operatively connected between the load shaft and said clutch and adapted to hold said load shaft against operation until said shaft is driven from said clutch device.

3. In a hoist mechanism, in combination, an electric motor, a load shaft, gear means connected to said load shaft, fluid-magnetic clutch means interconnecting said electric motor and said gear means, a torque-responsive brake means connected to said gear means and arranged to hold said gear means against operation when said magnetic clutch is under a reduced voltage insufficient to drive the gear means, and control means for said motor and said fluid-magnetic clutch means, said control means comprising energizing circuit means including a manually operable control member adjustable to provide constant energization of said motor simultaneously with variable energization of said clutch means, whereby the speed of said load shaft can be varied by varying the energization of said clutch means independently of the energization of said motor and while the motor is maintained at full running speed.

4. In a hoist mechanism, in combination, an electric motor, a load shaft, a fluid-magnetic clutch device interconnecting said electric motor and said load shaft, an electro-magnetic brake operable to hold said shaft, means including control means for simultaneously energizing and de-energizing said motor and said brake, means for energizing said fluid-magnetic clutch device including a manually operable control member adjustable to provide variable energization of said clutch device to vary the speed of said load shaft independently of the motor speed, and means interconnecting said clutch control member and said motor and brake control means for simultaneous manual operation thereof, said last means being so constructed and arranged that the energization of the motor to full speed operation is effected when the fluid-magnetic clutch is at initial minimum operating voltage.

5. In a hoist mechanism, in combination, an alternating current motor, a load shaft, fluid-magnetic clutch

means interconnecting said motor and said load shaft, motor energizing circuit means including phase shifting means for reversing the direction of motor rotation, circuit means for energizing said fluid-magnetic clutch means, and a manually operated controller for said motor energizing circuit means and said clutch means energizing circuit means, said controller having an open circuit position and being movable therefrom to a closed circuit position causing first the full energization of said motor in a selected direction of motor rotation, and simultaneously minimum energization of said fluid-magnetic clutch means with further movement of said controller progressively increasing the energization of said clutch means, whereby the speed of the hoist mechanism may be varied while maintaining full motor speed providing smooth hoist operation.

6. In a hoist mechanism, in combination, an electric motor including a rotor shaft, a fluid-magnetic clutch device including coacting rotatable members, an operative coupling between said motor shaft and one of said members, a second shaft operatively coupled to the other one of said members, a load shaft, a gear train drive between the second shaft and said load shaft, an electro-magnetic brake operatively coupled with the second shaft and maintained in applied position when the motor is deenergized, said brake including a control magnet which when energized effects release of the brake, means for effecting energization of said control magnet simultaneously with the energization of said motor, and means for applying minimum energization voltage to said fluid-magnetic clutch device simultaneously with full energization of said motor and thereafter for varying the energization of the magnetic clutch without changing the energization of the motor.

7. The invention according to claim 6 with a second brake means, said second brake means being interposed between the gears of said gear train and operative to hold said load shaft against turning under torque strains applied by means other than said motor.

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