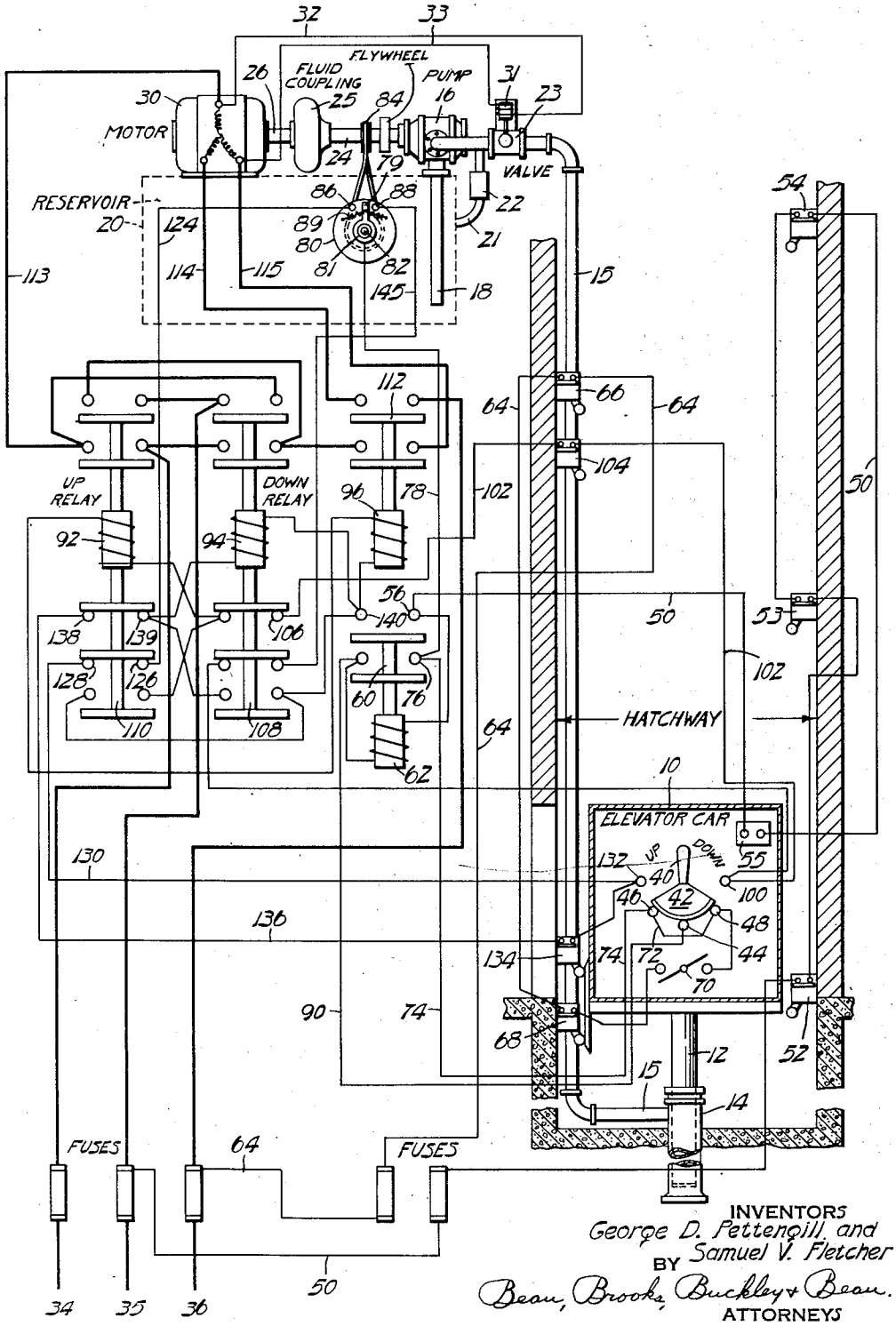
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HYDRAULIC ELEVATOR DRIVE AND CONTROL

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HYDRAULIC ELEVATOR DRIVE AND CONTROL

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This invention relates to improvements in electrically powered hydraulic elevator systems; the term "hydraulic elevator" as used herein being intended to relate to a passenger and/or freight carrying elevator traveling within a hatchway and comprising a cage or car carried by a piston rod extending from a cylinder which is supplied with fluid from a pump.

It is an object of the present invention to provide an improved type of hydraulic elevator drive and braking mechanism embodying an improved motor and pump interconnection means and an improved motor-pump electrical control system which is of such character as to provide overall improved elevator car acceleration and deceleration characteristics as well as "up" and "down" speed control, while employing the most economical type electric motor and avoiding need of complicated and expensive motor speed control apparatus.

Another object of the invention is to provide an improved hydraulic elevator drive mechanism which provides a smoother starting operation while imposing lower inrush currents on the driving motor windings.

Another object of the invention is to provide a new and improved hydraulic elevator drive mechanism which supplies a novel and improved braking action for stopping the elevator car.

Another object of the invention is to provide a unique application and development of "electric braking" principles in hydraulic elevator drive devices.

Another object of the invention is to provide a unique and improved hydraulic elevator driving mechanism which gives improved "up" and "down" speed control and performance.

Another object of the invention is to provide an improved hydraulic elevator driving and braking system which makes it possible to obtain "automatic levelling" of the car through means of a minimum of control arrangements.

Another object of the invention is to provide a new and improved driving motor-to-pump coupling arrangement in hydraulic elevator drives and the like, whereby to obtain smoother starting and stopping of the elevator car.

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

In order to attain the objects and advantages set forth hereinabove the invention contemplates an elevator drive unit comprising a relatively low cost single winding type reversible A. C. motor of suitable horsepower; a traction type torque transmitter connecting the motor to the load; a

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reversible positive displacement pump supplying fluid from a reservoir to the elevator cylinder; a flywheel; a "holding" valve in the line between the pump and the cylinder; and where necessary, a suitable speed reduction gear unit interconnecting the driven portion of the torque transmitter and the pump. Within the concept of the present invention it is essential that the motor be adaptable to A. C. plugging service; that is, adaptable to sudden reversal as to phase relation, and that the torque transmitter be adapted to "slip" while the motor is "plugged" or when coming up to speed so as to avoid excessive inrush of starting currents through the motor windings, and to avoid uncomfortable deceleration-acceleration of the elevator car. It is also essential that the torque transmitter be of such nature as to impose high drag forces from the plugged motor upon the pump system during the initial high speed stage of elevator car deceleration preliminary to a stopping operation; and it is further essential, for the purposes of the invention, that the torque transmitter be designed to impose relatively low drag forces upon the pump during the later stages of elevator car deceleration, incidental to a stopping operation.

The invention contemplates a novel motor torque control system which obtains final stopping of the elevator car through "electrical braking" of the motor which is connected to the pump, thereby requiring only a minimum duty hydraulic line valve device for "holding" purposes only. The torque transmitter may be of some suitable traction type, such as for example a "fluid coupling" device employing the hydrokinetic principle or a hydraulic system of the torque converter type, or an electromagnetic clutch, or a suitable variable slip mechanical clutch, or the like. However, I presently prefer to employ for this purpose a "fluid coupling" device because of its mechanical simplicity and ruggedness and economy and ease of operations, as well as because of its operational characteristics which so particularly adapt it to the problem as will be explained more fully hereinafter.

Referring now to the drawing, the figure is a diagrammatic representation of an elevator driving and braking and control mechanism embodying the invention, and as illustrated therein the elevator car 10 is mounted upon a piston rod 12 which slip-fits into a cylinder 14. Although the elevator car hatchway is not shown it will be understood of course that the car may be of any suitable type and will be arranged to travel in its hatchway upon suitable guides,

all in accord with conventional elevator principles. A conduit 15 connects at one end into the cylinder 14 and at its opposite end into the discharge port of a directionally reversible positive displacement type pump 16. The intake port of the pump 16 is connected to a conduit 18 leading into a fluid reservoir 20, and a bypass conduit 21 leads from the conduit 15 around the pump 16 into the reservoir. The conduit 21 includes a pressure relief valve 22, and a holding valve 23 is provided in the line of the conduit 15 ahead of the take-off to the conduit 21. The impeller of the pump 16 is connected to a shaft 24 on which is mounted a flywheel and which in turn is keyed to the driven element of a traction coupling device which is illustrated generally at 25. The driving element of the traction coupling 25 is fixed to the armature shaft 26 of the elevator driving motor 30. The motor 30 is illustrated herein to be of the three-phase single speed A. C. type, and the valve 23 is arranged to be electromagnetically actuated by means of a solenoid 31 which is normally spring-biased into valve-closed position but energized through means of conductors 32—33 leading from the motor terminals into valve open position whenever the motor 30 is energized.

In the drawing the circuits carrying power to the motor 30 are shown in heavy lines, commencing with supply mains 34—35—36 and thence leading through circuit controlled relays, the operation of which will be explained fully hereinafter. It will of course be understood that the invention is applicable to various types of driving motors and control systems, and that the drawing herein purposely illustrates only a relatively simple or "basic" motor control system providing minimum elevator control features. Thus, the drawing herein shows a control system embodying the usual hatchway door contact switches; an elevator car gate switch; normal limit switches; terminal limit switches; a car safety switch, and the usual manual control switch in the elevator car. However, further accessory features may be readily added to the control system shown in the drawing herein as will be readily understood by those skilled in the art, so as to include for example automatic operation from hall buttons, automatic leveling, automatic door operation, and so on.

Referring again to the drawing; whereas the power circuits are shown in heavy lines, the control circuits are shown in lighter lines, and the manual car control switch is indicated at 40 as comprising a lever pivotally mounted on the elevator car wall. The lever 40 carries a conducting segment 42 which, when the lever is in its neutral position interconnects contact terminals 44—46—48 of the control circuit. Commencing at the lower left hand corner of the drawing, it will be seen that a control circuit feed is picked up from supply main 35 by a control conductor 50 which includes in series therewith an appropriate number of hatchway door contact switches, depending upon the number of doors in the hatchway. In the drawing, for purposes of illustration, it is indicated that there are three doors in the hatchway equipped with door contact switches, as indicated at 52—53—54, respectively. The conductor 50 also includes the elevator car gate contact switch 55 and then terminates at a normally open terminal 56 of a sequence control switch 60. The switch 60 is actuated by a relay coil 62 as will be explained hereinafter.

The second control circuit feed originates at supply main 36 and leads therefrom through conductor 64 and thence through the upper terminal limit switch 66 and thence through the lower terminal limit switch 68 and thence through the car safety switch 70 to the controller terminal contact 48. The contact terminals 46—48 of the controller switch are interconnected by a conductor 72, and hence the second control circuit continues on through terminal 46 and through conductor 74 to a second normally open contact 76 of the sequence relay switch 60. Another conductor 78 leads from the contact 76 to the terminal armature 79 of a two-way normally open motion responsive switch 80. The armature of the switch 80 is connected such as by means of a friction coupling device 81 of the fluid coupling type to a shaft 82 which is in turn geared to the pump drive shaft 24 as by means of a sprocket-chain system 84. Hence, whenever the pump drive shaft is rotating in one direction the armature of the switch 80 will be thrown over against one of either of the contact terminals 86—88 of the switch; while upon reversal of the direction of shaft rotation the switch armature will be thrown over against the other contact terminal of the switch. However, when the pump drive shaft is stopped the armature of the switch 80 moves to its neutral or non-contacting position, as under the influence of spring means 89.

Thus, it will be seen that when the car controller 40 is in its neutral position, as shown in the drawing, the segment 42 thereof interconnects the contacts 44—46—48 thereby creating a control feed from either terminal 46 or 48 to terminal 44 which is connected through conductor 90 to the relay coil 62 of the sequence control switch 60. Thus, when all of the hatchway doors and the elevator gate are closed (with the car controller in neutral position) the relay coil 62 is energized and lifts the switch device 60 so as to bridge the contacts thereof. By means of the lower pair of contacts of the switch the circuit of the relay coil 62 remains energized and the relay switch holds itself closed, while the bridging of the upper pair of contacts of the relay switch provides feed for the motor control relay coils 92—94—96.

Thus, if the car controller handle 40 is moved over to the "up" position the segment 42 will clear the contacts 44—46 and will interconnect the contact 48 with another contact 100, thereby providing a closed circuit from terminal 100 through conductor 102, and thence through the upper normal limit switch 104 and thence to contact 106 of a normally closed relay switch 108 and thence through the relay coil 92 of a relay switch 110. This will energize the coil 92, thereby lifting the relay switch 110, whereupon the upper power control contacts thereof will close. At the same time the auxiliary contacts at the bottom of the switch 110 will close, providing a closed circuit to the relay coil 96 on the relay switch 112. This lifts the switch 112, whereupon it will be seen that the power control contacts of switches 110—112 are both closed, whereby a three phase power supply is established to the motor 30 through power conductors 113—114—115. The motor will thereupon turn to drive the pump to force fluid from the reservoir into the cylinder 14 so as to raise the elevator car, the motor torque being transmitted through the fluid coupling 25. The fluid coupling device 25 thereupon operates to provide a particularly "soft" acceleration effect because of its inherent tend-

ency to slip at slow speeds and to gradually increase in torque transmitting efficiency as the speed increases.

As explained hereinabove, the solenoid device **30** is automatically energized coincidentally with energization of the motor **30** through conductors **32—33** leading from two of the motor terminals so as to open the valve **23** whenever the motor **30** is energized, while the valve automatically closes whenever the power to the motor is interrupted, thereby holding the elevator.

The upward travel of the elevator car may, of course, be interrupted either by contact of any suitable member extending from the car, such as a cam, with the upper normal limit switch arm, or by manual movement of the control handle **40** away from its "up" position. Assuming, for example, the control handle to have been returned by the operator to its neutral position, the feed through the segment **42** between the contacts **48—100** is thereby interrupted, and the circuit including the coil **92** in the up travel relay unit is now deenergized. Momentarily, however, the inertia of the car and the drive mechanism will continue the upward travel of the car, and therefore the armature of the traction switch **80** is still biased to keep the "up" travel contacts closed. Thus, the feed from the controller contact **46** forms a closed circuit through the conductors **74—78** and the traction switch **80** and the conductor **124** and the contact **126** of the relay switch **110**. As the switch **110** drops, due to deenergization of the coil **92** as explained hereinabove, the circuit through the contact **126** is thereupon completed through switch contact **128**, conductor **130**, controller contact **132**, and thence through the lower normal limit switch **134**, and then back through conductor **136** through contacts **138—139** of the relay switch **110**, to the coil **94** of the down control relay switch **108**, and thence through contacts **140—56** of the switch **60** and thence through conductor **50** to the supply main **35**.

Thus, the down control relay switch **108** and the main line conductor switch **112** are both lifted, thereby completing a three-phase power supply to the motor **30**, but in reverse phase relationship to the direction of the previous operation of the motor. The motor is thereby "plugged" or reversed, and drags upon the pump drive mechanism and its flywheel to decelerate the latter in the manner of a braking device; the traction coupling device **25** permitting varying rates of slip between the motor and the pump, depending upon the relative speeds thereof.

It is with respect to this braking performance of the motor **30** during deceleration of the elevator car travel that the novel torque transmitting characteristics of the traction coupling device, such as for example of the so-called "fluid coupling" type, become manifest and provide an improved electrical braking or "plugging" performance when using a motor of the relatively economical single speed A. C. type. For example, when the controller is moved to neutral position the driving mechanism is at first traveling at relatively high speed, and the tendency of the pump end of the drive mechanism to overrun the motor end of the mechanism is at first strenuously resisted because of the nature of the operation of the fluid coupling device at high speeds. Thus, at this stage the motor imposes a high degree of drag upon the drive mechanism, thereby tending to quickly brake the car travel. However, as the rate of car travel is reduced, the coupling

25 becomes less efficient as a torque transmitter, and a progressively softening dragging effect is supplied by the motor to the pump, with the result that as the elevator car slows down and approaches the stop the deceleration rate smooths off, thereby avoiding violent deceleration shock in connection with the stopping operation.

When the pump is brought to rest the traction switch **80** will open, thereby interrupting the circuit to the contact **106** and the circuit to the relay switch coil **94**, permitting the switch **108** to drop. This interrupts the power supply to the motor and to the solenoid valve **23**, whereupon the latter is closed to hold the elevator car at rest.

It will be appreciated that if, instead of manual return of the controller to neutral position as explained hereinabove, the elevator car is permitted to rise until the car cam opens the upper normal limit switch **104**, the circuits to the coil **92** of the switch **110** will be interrupted; and that the switch **80** will thereupon assume control of the system to cause reversal of the motor so as to effect the braking action explained hereinabove and to finally stop the elevator car with the holding valve **23** applied.

Downward car travel control is effected by the mechanism illustrated upon manual manipulation of the controller **40** into its "down" position as shown in the drawing, whereupon the control circuits are completed to energize the "down relay" and the main line switch **112** to complete a three-phase power supply to the motor in reversed phase relation. The switch **80** then closes in the down direction upon starting of the elevator travel upon centering of the car control handle **40**, or opening of the lower normal limit switch **134**, the relays **108—112** will be deenergized, whereupon control circuit feed will be established through switch **80** and conductor **145** to the coil **92** of the up relay **110**, which will in turn energize relay **112** and cause the motor to be "plugged." The elevator mechanism will be thereby braked as explained hereinabove until it comes to rest at which time the armature of switch **80** assumes its neutral position. The control circuit feed is then broken to the "up relay" **110**, which then falls out and deenergizes the motor **30** and causes the valve **23** to be set.

Thus, it will be understood that it is a particular feature and advantage of the invention that acceleration of the elevator car travel is acquired through a traction-type coupling which prevents violent acceleration effects, and that braking of the car travel is acquired by "plugging" the single speed A. C. motor and transmitting the drag therefrom to the elevator pump drive shaft through the traction coupling device which delivers in improved manner a counter-torque operating to retard and stop the car. Thus, a nearly constant rate of deceleration is obtained and no violent deceleration effects are experienced, and the car comes to a "soft" stop because of the braking characteristics of the "plugged" motor operating in cooperation with the novel coupling element of the driving system.

What is claimed is:

1. In a hydraulic elevator drive and braking control system, a directionally reversible alternating current electric motor, a directionally reversible positive displacement pump, a fluid conduit interconnecting said pump and the cylinder of said hydraulic elevator, a fluid coupling device interconnecting the drive shaft of said motor and

said pump, and a power supply control system for said motor including manual switch means operable to cause energization of said motor, switch means operable to reverse said motor to impose a counter-torque through said coupling device to halt the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor.

2. In combination, a hydraulic elevator cylinder, a directionally reversible positive displacement pump in operative connection with said cylinder, a reversible alternating current electric motor, a traction type coupling device interconnecting the drive shaft of said motor and said pump, and a power supply control system for said motor including manual switch means operable to start said motor to run in either direction and operable to reverse the phase relation of said motor while running to impose a counter-torque through said traction coupling device to halt the elevator travel, and switch means operable automatically upon halting of said travel to deenergize said motor.

3. In a hydraulic elevator drive and braking control system, a reversible alternating current electric motor, an elevator driving pump, a fluid coupling device interconnecting the drive shaft of said motor and said pump, and a power supply control system for said motor including manual switch means operable to cause energization of said motor, switch means operable to reverse said motor when running to impose a counter-torque through said coupling device to halt the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor.

4. In a hydraulic drive and braking system for elevators, a reversible alternating current motor, an elevator drive pump, a traction type coupling device interconnecting the drive shaft of said motor and said elevator drive pump, a conduit connecting said pump to the elevator cylinder, a valve in the line of said conduit, and a power supply control system for said motor including switch means operable to cause energization of said motor, switch means operable to reverse said motor when running to impose a counter-torque through said traction coupling device to brake the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor and to close said valve.

5. In a hydraulic elevator drive and braking control system, a reversible alternating current electric motor, an elevator drive pump of positive displacement type, a fluid torque converter interconnecting the drive shaft of said motor and said elevator drive pump, and a power supply control system for said motor including manual switch means operable to cause energization of said motor, switch means operable to reverse said motor to impose a counter-torque through said converter to halt the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor.

6. In combination, a hydraulic elevator pump of positive displacement type, a reversible alternating current electric motor, a torque converter coupling device interconnecting the drive shaft of said motor and said pump for actuating the latter, and a power supply control system for said motor including manual switch means operable to start said motor to run in either direction and operable to reverse the phase relation of said motor while running to impose a counter-torque through said traction coupling device to halt the elevator travel, and motion responsive switch means operable automatically upon halting of said travel to operate to cause deenergization of said motor.

7. In a hydraulic elevator drive and braking control system, a reversible alternating current electric motor, an elevator drive pump of positive displacement type, a fluid torque converter interconnecting the drive shaft of said motor and said elevator drive pump, and a power supply control system for said motor including manual switch means operable to cause energization of said motor, switch means operable to reverse the phase relation of said motor when running to impose a counter-torque through said converter to halt the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor.

8. In a hydraulic drive and braking system for elevators, a reversible alternating current motor, an elevator drive pump of positive displacement type, a fluid torque converter device interconnecting the drive shaft of said motor and said elevator drive pump, and a power supply control system for said motor including switch means operable to cause energization of said motor, switch means operable to reverse the phase relation of said motor when running to impose a counter-torque through said fluid torque converter to brake the elevator travel, and means operable automatically upon halting of said travel to deenergize said motor.

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