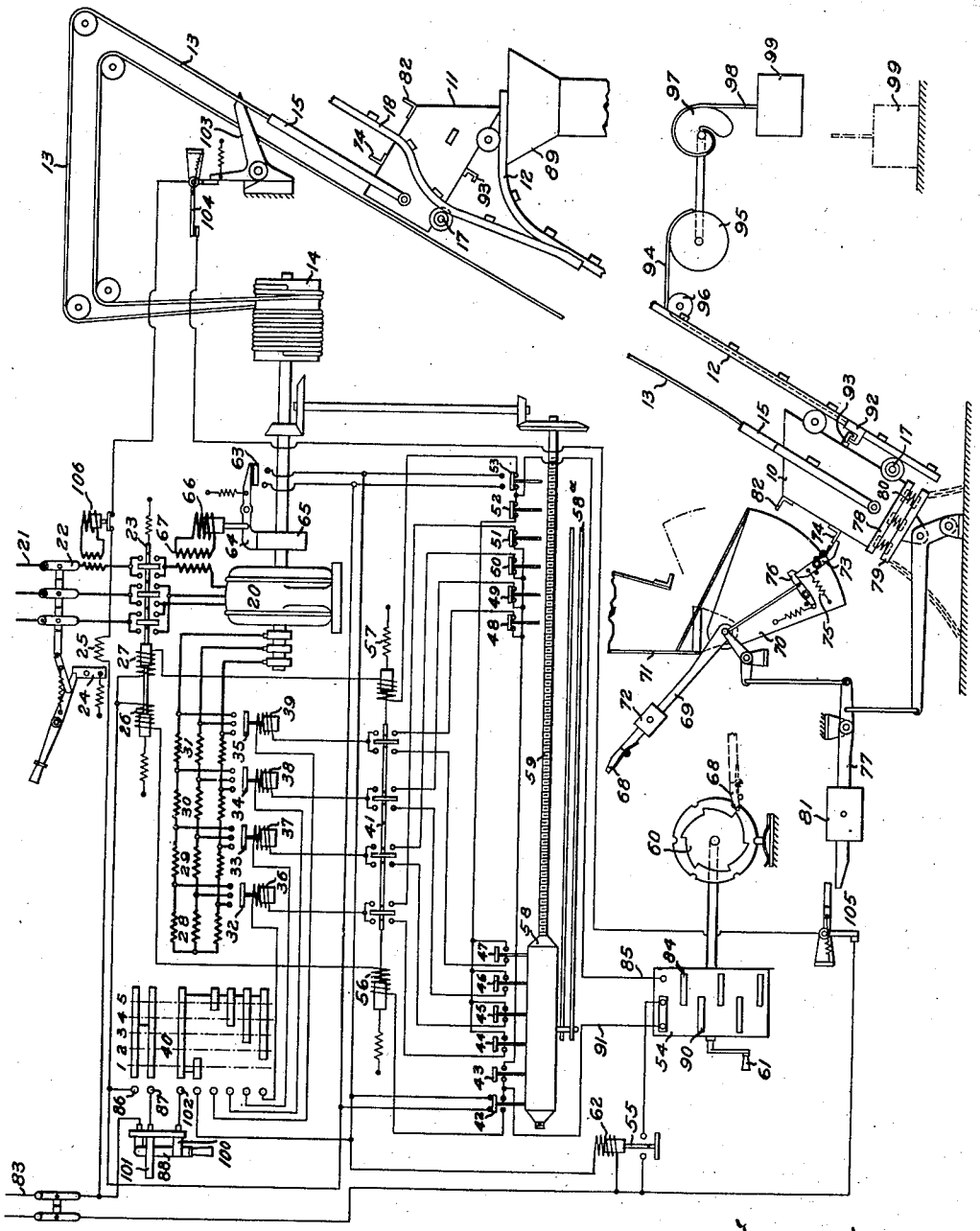
R. C. NEWHOUSE.

SYSTEM OF HOIST CONTROL.

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1,331,780.

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Inventor

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by

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UNITED STATES PATENT OFFICE.

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SYSTEM OF HOIST CONTROL.

1,331,780. Specification of Letters Patent. Patented Feb. 24, 1920.

Original application filed June 17, 1911, Serial No. 633,798. Divided and this application filed October 2, 1916. Serial No. 123,788.

To all whom it may concern:

Be it known that I, RAY C. NEWHOUSE, a citizen of the United States, residing at Wauwatosa, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Systems of Hoist Control, of which the following is a specification.

My invention relates to electrically operated skip hoists.

It is the object of my invention to provide a skip hoist system, for hoisting stone, coal, ore, etc., which is normally completely automatic in its operation but may be manually controlled when desired.

In attaining this object I have provided a system involving a number of novel features. The movement of the skips is preferably obtained by an electric motor, and the motor is controlled by the closing of the gate of the bin from which the material to be hoisted is supplied to the skip at the bottom of the hoist. The automatic operation of the motor is always in the proper direction to raise the loaded skip and lower the empty skip, the motor being reversible for this purpose. The closing of the bin gate occurs when the load in the skip at the bottom of the hoist reaches a predetermined value. Although the operation is normally entirely automatic, the operator may at any time assume control and obtain any desired movement of the skips within their limits of movement. There are also provided a number of safety features.

The broad features of my invention are claimed in my copending application, Ser. No. 633,798, filed June 17, 1911, of which the present application is a division, the latter being directed more to an exposition and definition of the features of electrical operation and control of the hoist system.

The various novel features of my invention will appear from the description and drawings, and will be particularly pointed out in the claims.

The single figure of the drawing shows diagrammatically one embodiment of my invention.

The two skips 10 and 11 operate on the usual tracks 12, these tracks 12 being arranged so that the skips pass each other without interference and yet each skip, when at the bottom of the hoist, occupies substantially the same place as does the other skip under the same circumstances. The operating cable or cables 13 extend in the usual manner around the winding drum 14, and its ends are fastened to bails 15 pivoted to the skips near their rear ends. This manner of pivoting the bails 15 allows the automatic tipping of the skips as they reach the top. To obtain this tipping, the rear axle of each skip is provided with additional wheels 17, which engage the auxiliary track 18 when the skip is at the top of the hoist. As a skip approaches the top, its front axle follows the curved upper end of the main track, while its rear axle follows the auxiliary track 18, the skip being thus automatically dumped; the skip 11 is shown dumping.

The hoisting drum 14 is operated by the motor 20, preferably being directly connected thereto. This motor may be of any desired type, being shown as an induction motor of the wound rotor type. Its primary circuit is supplied from a three phase line 21, through a circuit-breaker 22 and a reversing switch 23. The circuit-breaker 22 is biased to open position, but is held in closed position by a latch 24. The latch in turn is biased to unlatching position, but is held in latching position by a solenoid 25 located in a circuit which under normal conditions is always closed. The circuit of this solenoid may be called the emergency control circuit; all the others are normal control circuits. Upon the deënergization of the solenoid 25 for any reason, the circuit-breaker 22 opens. The reversing switch 23, is preferably of the oil-immersed double-throw, multiple type, and is biased to open position. It is movable to its two closed positions by solenoids 26 and 27, respectively. In the rotor circuit of the motor 20 are resistance sections 28, 29, 30 and 31, which may be short-circuited by switches 32, 33, 34 and 35, operated by solenoids 36, 37, 38 and 39, respectively. The solenoids 26, 27, 36, 37, 38 and 39 are controlled by a manually operated master control switch 40, an electrically operated, multiple, double-throw switch 41, a set of switches 42 to 53, inclusive, a master direction switch 54, and a main safety switch 55.

The master controller 40 has an off and five operative positions, and normally stands in the fifth position. It is not used in the

normal operation of the system, but is provided to enable the operator to take control of the system when he so desires.

The double-throw switch 41 is movable to its two positions by solenoids 56 and 57, which are respectively in series with the solenoids 26 and 27 of the reversing switch 23. It has one pole for each of the solenoids 36, 37, 38 and 39 and when in its two positions respectively puts such solenoids under the control of the switches 52 and 44 to 47, inclusive, or 43 and 51 to 48, inclusive.

The switches 42 to 53, inclusive, are biased to their lower positions, as by gravity, but may be raised to their upper positions by a taper-ended nut 58 traveling along a threaded rod 59 driven through suitable reducing gearing from the shaft of the motor 20. Guides 58[a] prevent the nut 58 from turning. The switches 42 and 53 have upper and lower closed positions, while the switches 43 to 52, inclusive, are closed only when in their lower positions. The switches 42 and 53 in their lower positions are in the circuits of the solenoids 56 and 26, and 57 and 27, respectively. The switches 43 and 52 are in the circuits of the switches 51 to 48, inclusive, and 44 to 47, inclusive, respectively. The switches 51 to 48, inclusive, or the switches 44 to 47, inclusive, according as the double-throw switch 41 is to the right or to the left, are in the respective circuits of the solenoids 36 to 39, inclusive. The switches 42 to 53 may be spaced as desired, evenly or unevenly; and the position of the switches 43 and 52 in the series may often be varied. The master direction switch 54 has on its shaft a ratchet wheel 60, the number of teeth of the ratchet wheel corresponding to the number of positions of the switch 54. This number is an even number, the switch in alternate positions closing the circuit to the switches 42 and 43, and 52 and 53, respectively; thus oppositely controlling the direction of operation of the motor 20. The switch 54 is normally automatically operated, through the ratchet wheel 60, in a manner hereinafter described. It may also be operated manually by a handle 61. This handle is not used normally.

The main safety switch 55 is biased to open position, as by gravity, but may be moved to and held in closed position by a solenoid 62. In order to complete the circuit of this solenoid, either the master controller 40 must be in position 1, the switch 42 must be in its upper position, the switch 53 must be in its upper position, or a switch 63 must be closed; if none of these conditions exist, the switch 55 opens and deënergizes all the normal control circuits. The switch 63 just referred to is closed whenever a mechanical brake 64, coöperating with a disk 65 on the shaft of the motor 20, is released, and the brake 64 is released by a solenoid 66 whenever current is being supplied to the motor 20, the solenoid 66 being connected to the motor circuit through current transformers 67.

The automatic operation of the ratchet wheel 60 above referred to is obtained by a finger 68 hinged on the balance arm 69 of the gate 70 of the supply bin 71. The bin gate 70 is biased to closed position by an adjustable weight 72 on the balance arm 69, the closed position of the bin gate being indicated in dot and dash lines. During the last part of the closing movement of the bin gate 70, the finger 68 strikes one of the teeth of the ratchet wheel 60 and moves the master direction switch 54 from one position to the next. The bin gate 70 carries a pivoted finger 73, which is in the path of an arm 74 on the top of each skip. The finger 73 is biased into the path of the arm 74 by a light spring 75 and most of the time is held there by a latch 76, which latter is connected by suitable connecting mechanism to the balance beam 77 of a scale upon which the skip at the bottom of the hoist rests and is released upon a sufficient deflection of said beam. The platform of this scale consists of two parallel plates 78 and 79, the former being mounted on the other by a nest of springs 80. On the balance beam 77 is an adjustable weight 81 for predetermining the load taken by a skip.

An indicated, the bin gate is in the form of a shell or shield having side pieces through which it may be rotatably mounted for such movement from open position, indicated in the drawings, as causes swinging of the shell or shield upwardly over and around and in comparatively close contact with the outer edge of the discharge chute of the bin so as to constitute an obstruction in the path of material discharging from the bin. The gate moves upwardly to the position indicated in dot and dash lines.

Assume that the parts are in the position shown, the arm 74 on the skip 10 having engaged the finger 73 and opened the bin gate 70 as such skip approached the bottom of the hoist. Immediately upon the opening of the bin gate, the stone, ore, or other material to be hoisted, begins to run from the bin 71 into the skip 10, which may be provided with a lip 82 to prevent any of the material from falling between the gate and the skip. The circuit-breaker 22 is closed. The switches 23 and 41 are in their middle or off positions. The brake 64 is applied. The traveling nut 58 is at the extreme left hand limit of its movement, holding the switches 42 to 47, inclusive, in their upper positions. The switches 48 to 53, inclusive, are in their lower positions. The resistance switches 32 to 35, inclusive, are in their lower or open positions.

To make the system operate automatically

at full speed the master controller 40 is placed in position 5, and left there while the automatic operation is to continue. The switch 42 being in its upper position and the master controller 40 being in an operative position, the solenoid 62 is energized and the main safety switch 55 is held in its closed position.

As the skip 10 fills, the plate 78 of the scale platform is depressed, first compressing the springs 80, and then engaging and depressing the plate 79 of the scale platform and raising the weight 81. When the load in the skip 10 reaches a predetermined value, the tilting of the balance beam 77 releases the latch 76, and the finger 73 momentarily swings past the arm 74 to allow the weight 72 to close the bin gate 70. This shuts off the supply of material to the skip 10. As the bin gate approaches its closed position, the finger 68 strikes one of the teeth of the ratchet wheel 60 and moves the master direction switch 54 forward to the next position beyond that which it occupies. This completes a control circuit which extends from one side of the control supply line 83, through the switch 55, the contact 84 on the switch 54, the conductor 85, the switch 53 in its lower position, the solenoids 57 and 27, the contacts 86 and 87 on the master controller 40, and the switch 88, to the other side of the line 83. The resultant energization of the solenoids 57 and 27 closes the switches 41 and 23 to the left, thus putting the resistance switches 32 to 35, inclusive, under the control of the switches 52 and 44 to 47, inclusive, and completing the primary circuit of the motor 20 for operation in the one direction. The completion of this primary circuit energizes the solenoid 66 to release the brake 64 and close the switch 63.

The motor 20 now starts slowly, driving the winding drum 14 and the rod 59; thus causing the skip 10 to start upward, the skip 11 to start downward, and the traveling nut 58 to start to the right. The hinged end of the finger 73, which finger has been brought back by the spring 75 into the path of the arm 74 and is reëngaged by the latch 76 as soon as the skip 10 has started upward, allows such arm to pass without effect as the skip 10 rises. As the nut 58 moves to the right, it first allows the switch 42 to drop from its upper to its lower position, thus breaking one maintaining branch for the circuit of the operating solenoid 62 of the switch 55 and making a potential circuit for the solenoids 56 and 26. The circuit of the solenoid 62, however, remains complete at the switch 63, which is closed at this time; and the potential circuit for the solenoids 56 and 26 is open at the switch 54. As the nut 58 continues its movement to the right, it next allows the switch 43 to drop to its lower or closed position, thus completing another potential circuit, through the switch 43 and the switches 51 to 48, inclusive, for the solenoids 36 to 39, inclusive; this potential circuit is open both at the switch 54 and the switch 41. The dropping of the switches 42 and 43 does not affect the speed of the motor 20.

The continued movement of the nut 58 to the right next causes the switch 44 to drop. This completes a circuit which branches from the conductor 85 and extends through the switches 52, 44, and 41 to the operating solenoid 36, the circuit continuing through the master controller 40. The resultant energization of this operating solenoid 36 closes the switch 32, thus cutting out the first section, 28, of the resistance in the rotor circuit of the motor 20. This causes the motor to increase in speed. As the nut 58 continues its movement to the right, the switches 45, 46, and 47 drop in succession similarly completing the circuits for the solenoids 37, 38, and 39 and causing such solenoids to close their switches 33, 34, and 35 to cut out the resistance sections 29, 30, and 31 successively. This brings the motor 20 up to full speed.

Such full speed continues until the skip 10 approaches its upper limit of movement and the skip 11 its lower limit of movement. At the same time, the traveling nut 58 approaches its right hand limit of movement. The tapered end of the nut 58 now raises the switches 48 to 53, inclusive, successively. The raising of the first four of these switches produces no effect, as these four switches are for use in starting the motor 20 in the opposite direction. The lifting of the switch 52 breaks the circuits for the solenoids 36 to 39, inclusive, thus deënergizing said solenoids and causing the switches 32 to 35, inclusive, to open to cut all the resistance sections 28 to 31, inclusive, into the rotor circuit of the motor 20 to check the speed thereof. The lifting of the switch 53 deënergizes solenoids 57 and 27, thus causing the switches 41 and 23, to move to their middle or open positions and interrupting the supply of current to the motor 20. The interruption of this supply of current causes the deënergization of the solenoid 66 and the setting of the brake 64. The resultant opening of the switch 63 does not deënergize the solenoid 62 and cause the switch 55 to open, because the circuit of such solenoid is now maintained by the switch 53 in its upper position.

The motor 20 and the two skips now stop, the skips 10 and 11 having now reached their upper and lower limits, respectively. The skip 10 in approaching its upper limit has tipped to dumping position, the wheels on its front axle having followed the curve at the upper end of the main track 12 and the auxiliary wheels on its rear axle having

followed the auxiliary track 18. The material is thus dumped from the skip into the receiving bin 89. The arm 74 of the skip 11, as the latter has approached its lower limit of movement, has engaged the finger 73 and swung the bin gate 70 to open position, whereupon the supply bin 71, unless empty, immediately begins to discharge material into the skip 11.

When the skip 11 is filled with a predetermined load, the finger 73 is again released from the latch 76 and the bin gate 70 again swings closed. At the end of this closing movement, the finger 68 engages the next tooth of the ratchet wheel 60, and swings it and the master direction switch 54 forward to the next position. This brings the contact 90 of said switch into operation, and completes a circuit which extends from one side of the line 38 through the switch 55, the contact 90 of the switch 54, the conductor 91, the switch 42 in its lower position the solenoids 56 and 26, the contacts 86 and 87 of the master controller 40 and the switch 88 to the other side of the line 83. The resultant energization of the solenoids 56 and 26 causes the switches 41 and 23 to close to the right, thus putting the solenoids 36 to 39, inclusive, under the control of the switches 43 and 51 to 48, inclusive, completing the primary circuit of the motor 20 for operation in the opposite direction from that above described, and releasing the brake 64.

The motor 20 now starts in such opposite direction, raising the skip 11, lowering the skip 10, and moving the traveling nut 58 to the left. As this movement of the nut 58 continues, the switches 53 to 48 inclusive, drop in succession, and the resistance sections 28, 29, 30, and 31 are cut out in a manner substantially the same as that already described.

The action of the switches 53 to 48, inclusive, corresponds to the previous action of the switches 42 to 47, inclusive, already described. As the parts reach their other limits of movement, the switches 47 to 42, inclusive, are raised successively, the first four of these performing no function and the last two corresponding in their action to that of the switches 52 and 53 as the nut 58 approaches its right hand limit, as already described. The skip 10, which is now approaching the bottom, opens the bin gate 70 in the last part of its downward movement. From this point the cycle above described is repeated continuously as long as any material is left in the supply bin 71. Then it automatically stops.

During the last part of the travel of the ascending skip, the movement of this skip is not in a direction parallel to the main track 12 but, rather, in such a direction that the skip consumes less energy of the driving motor. As the most efficient operation of the hoisting system is secured with a fairly constant torque on the driving motor, it is advisable to provide means for absorbing at least some of the energy not needed during the final tripping movement of the ascending skip. Again, considerable energy must be absorbed in order to arrest the movement of the descending skip. Of course, the nested springs between the parts 78 and 79 of the platform, are effective to absorb a portion of the energy; but, while it might be possible to provide a spring platform structure of such dimensions as to absorb the total energy of the descending skip, nevertheless, such an arrangement would be rather costly and cumbersome. Therefore, to supplement the effect of the springs, in absorbing energy of the descending skip and in transmitting energy to the ascending skip in starting, to accelerate the same, a novel scheme is provided which accomplishes the purpose in an economical manner.

There is provided between the rails of the track 12, near the bottom thereof, a hook 92, which can slide in suitable guide rails lengthwise of the track 12. This hook extends upward from the track into the path of some suitable projecting part of the skip, such as one of the axles or a hook 93 firmly fastened to the body of the skip. The sliding hook 92 is attached by a sturdy cable 94 to a circular sheave 95 the cable 94 extending over one or more pulleys 96 to a convenient location for such sheave 95. This circular sheave 95 is mounted on the same shaft or otherwise firmly connected to a spiral sheave 97, on the periphery of which is a cable 98 attached to a heavy weight 99. When either skip approaches the end of its downward movement, the hook 93 on such skip engages the sliding hook 92, and winds the cable 98 around the spiral sheave 97, thus raising the weight 99 and storing energy in it. The pulley 95 and the sheave 96 are preferably of such relative size as to afford a speed reduction between the skip and the energy-absorbing weight 99, such an arrangement causing considerably less shock to the apparatus at the beginning of the weight-lifting operation. This effect is further heightened by the spiral sheave 97, the lever arm through which the weight 99 acts being considerably less when the same is at its lowest point than when at its highest point, that is, equal increments of angular travel of the sheave cause unequal increments of travel of the weight, the increment of travel of the weight being least at the beginning of its lift. In other words, the mechanical advantage of the skip on the weight is decreased as the weight moves

upward. The weight thus assists in bringing the skip to a standstill, this action being obtained, because of the spiral sheave 97, without any violent jerks on the mechanism or any undue strains on the cables 94 and 98. The energy stored in the lifted weight 99 is returned to the skip when the latter starts on its upward movement, thus relieving the motor 20 of some of its starting load. The rate at which this energy is returned to the skip is a gradually decreasing one, thus relieving the starting load on the motor 20 mostly at the beginning of the movement of the latter and gradually decreasing as the motor and skips gain in speed and the extra starting load diminishes.

It will be apparent that the spring platform abutment or the energy absorbing weight may be of such dimensions and so disposed, or both of these elements may be of such relative dimensions and so relatively disposed, that the load on the motor, while it is in operation, may be practically constant, that is, of the value required for moving the skips during the intermediate part of their travel, at which part the effort of the driving motor is unaffected by any of the energy absorbing means.

If at any time during the operation of the system, the operator desires to take control, he may do so by manipulating the master controller 40 and the master direction switch 54. If the skips are at their limits of movement, and the traveling nut 58 is at one of its limits of movement, the motor 20 may be started by moving the master direction switch 54 by hand forward to the next position. This produces the same effect as the closing of the bin gate 70, and the motor accelerates automatically as the nut 58 moves away from its extreme position. If the motor is in motion and it is desired to stop the skips, the master controller 40 is moved backward to the off position, thus breaking the circuits for the solenoids 36, 37, 38 and 39, the solenoids 26 and 56 or 27 and 57 whichever pair is energized, and the solenoid 62. This interrupts all the normal control circuits, and the resultant opening of the reversing switch 23 interrupts the primary circuit of the motor and causes the setting of the brake 64. If a complete stopping of the skips is not desired, the master controller 40 may be moved less than all the way to the off position, its movement back from positions 5, 4, 3, 2 and 1 causing successively the deënergization of the solenoid 39, the solenoid 38, the solenoid 37, the solenoid 36, and those of the solenoids 26, 27, 56, 57, and 62 which then happen to be energized and thus opening the switches operating thereby.

To start the skips again in the same direction in which they have been traveling, the master controller 40 is moved forward step by step to any desired position, the successive positions causing successively the closing of the primary circuit and the cutting out of the resistance sections 28, 29, 30, and 31. If it is desired to start the motors in the opposite direction, the master direction switch 54 is moved forward to the next position and then the master controller 40 is moved forward from off position, the results being the same as above described save that the motor revolves in the opposite direction. When once started, the system will at once take up and continue the automatic operation already described, the parts automatically stopping when they reach their limits of movement and starting again when the skip at the bottom becomes sufficiently loaded. Automatic operation of the system at less than full speed may be obtained by placing the master controller 40 in some operative position short of position 5.

Should the operator move the master direction switch from one position to the next while the parts are in motion, he will cause the breaking of the primary circuit of the motor 20, the setting of the brake 64, the opening of the switch 63, and the dropping of the switch 55, thus breaking all the normal control circuits and stopping the motor and the skips. They cannot be started again until the master controller 40 is moved to position 1, thus completing the circuit of the solenoid 62 and causing the reclosing of the switches 55 and 63. Then the motor will start and will attain a speed determined by the position to which the master controller 40 is advanced.

The switch 88 is provided for manually stopping the motor and skips independently of the master controller 40. By opening the switch 88, the blade leaves the contacts 100 and 101 successively. On leaving the contact 100 it deënergizes all the resistance controlling solenoids 36 to 39, inclusive. By leaving the contact 101, somewhat later, it deënergizes the solenoid of the switch 23, thus causing the breaking of the primary circuit of the motor. This avoids the jar which would be given the motor if the primary circuit were broken before the resistance in the rotor circuit were cut in. The switch 88 is generally located at some convenient point at a distance from the master controller 40. This switch may be omitted if desired, in which case the contact fingers 87 and 102, and their coöperating contact segments on the master controller drum, could be combined, the combined finger being connected directly to one side of the line 83.

Should the parts already described get out of order or fail to work for any reason, it is possible that the motor would overwind the cable 13 on the drum 14. It might

even break the cable. In order to take care of this, a latch 103 is placed in the path of each of the bails 15 slightly beyond the normal upper limit of movement thereof. In case of overwinding, the bail 15 strikes the latch 103 and moves it in a counter clockwise direction. This snaps open the switch 104 in the emergency control circuit, which is that of the holding solenoid 25 of the circuit-breaker 22, thus causing the tripping of such circuit-breaker and the breaking of the circuit of the motor 20. This stops the motor. In order to prevent the skip at the top of the hoist from falling in case the cable has been broken by the over-winding, the latch 103 at once automatically swings back beneath the cross-bar of the bail 15. If the skip starts to drop, this latch will therefore catch the bail and prevent such dropping.

If the cable 13 breaks while the system is in operation, both skips may fall to the bottom of the hoist. The first skip to reach the bottom would open the bin gate 70, and would probably be traveling with so much momentum that it would raise the weight 81 sufficiently to trip the latch 76 and allow the bin gate to close and move the switch 54 one step forward. This would usually cause deënergization of the solenoid 62 and the opening of the switch 55, thus breaking all the normal control circuits as well as the primary circuit of the motor. In order to provide additional protection, a snap switch 105 is arranged to be tripped by the balance beam 77 of the hoist scale as the latter is swung upward from the impact of a falling skip on the scale platform. This switch 105 is also in the emergency control circuit, or that of the solenoid 25, and its opening produces the same results as does the opening of the switch 104. The disposition of the switch 105 relative to the weighted beam 77 is such that ordinary operation of the beam, due to the weight of a loaded skip, is not capable of causing actuation of the switch to open position. The nest of springs 80 is for the purpose of preventing the lesser impacts, occurring in the ordinary operation of the system, from tripping the latch 76 and the switch 105, for absorbing the last of the momentum of a descending skip, and for giving an ascending skip a kick at starting.

Should the voltage of the main supply circuit 21 fail for any reason while the motor is in operation, the solenoid 66 is immediately deënergized. This causes the setting of the brake 64 and the opening of the switch 63. The opening of this switch 63, the traveling nut, of course, being somewhere else than in an extreme position causes the deënergization of the solenoid 62 and the opening of the switch 55. This breaks all the normal control circuits as well as the primary circuit of the motor 20. Similarly, if the voltage on the control supply circuit 83 fails for any reason while the motor is in operation, the solenoid 62 is at once deënergized as are all the other control circuits. This causes the switch 55 to open, the resistance in the rotor circuit of the motor to be cut in, and the primary circuit of the motor to be broken both at the reversing switch 23 and the circuit breaker 22. In either of these cases, the system cannot be started in operation again until the switch 55 is closed; and in order to close the switch 55 the master controller must be moved back to its first position.

Any suitable protective means may be provided for protection against overloads. In case of any overload in the arrangement illustrated, a series relay 106 opens the circuit of the solenoid 25 and thus causes the opening of the circuit-breaker 22. In some cases, the circuit-breaker 22 may be dispensed with and the switches 104, 105, and 106 put in some other suitable circuit, as in the circuit of the solenoid 62.

I have described my hoisting system in what I now consider to be its preferred form. Many of the features described can be used without others, or in specifically different systems, and many features may readily be modified. I aim to cover all features of my invention, whether separately or in combination, which do not depart from the spirit and scope of my invention as set forth in the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In combination, an electric motor, a reciprocable device operable by said motor, and independently operable switches controlled by said reciprocable device near each limit of its movement, two of said switches at said respective limits of movement controlling the motor circuit to influence the direction of motion, and one or more others of said switches at each limit of movement controlling the acceleration of the motor.

2. In combination, an electric motor, a reciprocable device operable by said motor, independently operable switches controlled by said reciprocable device near each limit of its movement, two of said switches at said respective limits of movement controlling the motor circuit oppositely, and one or more others of said switches at each limit of movement controlling the acceleration of the motor, and means for determining which of the motor circuit-controlling and acceleration-controlling switches shall be effective.

3. In a hoist, the combination of a car, an electric motor for operating said car, a circuit interrupter for controlling said motor, and means coacting with said car at one limit of its travel for actuating said circuit interrupter, said means being unresponsive

to the dead weight of the car loaded or unloaded, but responsive to a predetermined impulse applied by said car.

4. In a skip hoist, the combination of a pair of skips, an electric motor for operating them, a reversing switch for the motor, a circuit-breaker in the motor circuit, and means for causing the opening of the circuit-breaker in case a skip falls to the bottom of the hoist, said means being inoperative if the skip travels to the bottom of the hoist at normal speed.

5. In combination, an electric motor, a device reciprocable thereby, a switch operated by said device near each limit of its movement for controlling the acceleration of the motor, and a separate switch operated by said device near each limit of its movement for controlling the deceleration of the motor.

6. In combination, an electric motor, a device reciprocable thereby, and a plurality of switches operated by said device near each limit of its movement, said switches at each limit of movement including a motor-accelerating switch and a motor-decelerating switch and the motor-accelerating switch at each end being in series with the motor-decelerating switch at the other end.

7. In combination, an electric motor, a device reciprocable thereby, a power-operated reversing switch for the motor, one or more power-operated speed-regulating switches for the motor, and a plurality of power-admitting means operated by said reciprocable device near each limit of its movement, one of said power-admitting means at each limit of movement controlling the reversing switch, one or more the speed-increasing action, and one the speed-decreasing action of said speed-regulating switches.

8. In combination, an electric motor, a device reciprocable thereby, an electrically operated reversing switch for the motor, a regulating resistance for the motor, one or more electrically operated switches for controlling said resistance and a plurality of control switches operated by said reciprocable device near each limit of movement, one of said control switches near each limit of movement controlling said reversing switch, one or more controlling the closing of the resistance switches, and a different one controlling the opening of said resistance switches.

9. In combination, an electric motor, a device reciprocable thereby, an electrically operated reversing switch for the motor, a regulating resistance for the motor, one or more electrically operated switches for controlling said resistance, a plurality of control switches operated by said reciprocable device near each limit of movement, one of said control switches near each limit of movement controlling said reversing switch, one or more controlling the closing of the resistance switches, and a different one controlling the opening of said resistance switches, and means for determining which of the control switches shall control.

10. In combination, an electric motor, a device reciprocable thereby, control means for said motor operative to effect continuous reciprocation of said device and comprising a plurality of successively operable speed-controlling devices, said control means being operable automatically in response to conditions attending the desired operation of said reciprocable device to cause successive operation of said speed-controlling devices, and auxiliary means operable at the will of an operator for causing successive operation of said speed controlling devices.

11. In combination, an electric motor, a brake operatively associated with said motor and automatically operative in response to conditions of the motor circuit, a device reciprocable by said motor, normal control means operable by said reciprocable device for effecting the desired automatic control of said motor, and emergency control means operable in joint response to predetermined abnormal operating conditions and said reciprocable device for controlling the operation of said motor, said emergency control means comprising a switch operable by said brake and effective to render said emergency control ineffective when said brake is in released condition.

12. In combination, an electric motor, a brake operatively associated with said motor and automatically operative in response to conditions of the motor circuit, a device reciprocable by said motor, normal control means operable by said reciprocable device for effecting the desired automatic control of said motor, emergency control means operative in response to predetermined abnormal operating conditions for controlling the operation of said motor, and means for rendering said emergency control ineffective during normal operation of said motor, said means comprising a switch operatively associated with said brake and operative to render said emergency control ineffective when the motor is running, and an auxiliary switch automatically operative in response to the movement and position of said reciprocable device for rendering the emergency control ineffective when the motor is inoperative and the brake is in set position.

13. In combination, an electric motor, a device reciprocable thereby, control means for said motor operative to cause the controlled operation of said motor in either direction and comprising a circuit-opening switch and a plurality of successively operable speed-controlling devices, said reciprocable device being automatically operative to cause the desired successive operation of

said speed-controlling devices, a manually operable device operative to effect the desired successive operation of said speed-controlling devices, and auxiliary means operative at the will of an operator for causing the successive operation of said speed-controlling devices and the operation of said circuit-opening switch.

14. In combination, a motor having a rotor, a reversing switch therefor, primary speed controlling means, means for controlling said speed controlling means including devices responsive to the travel of the rotor of said motor in either direction, and means dependent upon the travel of said rotor for controlling both said reversing switch and said means for controlling said speed controlling means.

15. In combination, a motor, a device reciprocable thereby, means for controlling the speed of said motor comprising a plurality of sets of switches associated respectively with the limiting positions of said device, means responsive to the position of said reciprocable device for transferring control from one set of said switches to the other and reversing the direction of operation of said motor.

16. In combination, a motor, a device reciprocable thereby, means for causing said motor to automatically reciprocate said device at desired intervals, and means dependent upon the position of said device for increasing the speed of said motor as said device moves away from a limit of its reciprocation.

17. In combination, a motor, a device reciprocable thereby, means for causing said motor to automatically reciprocate said device at desired intervals, means dependent upon the position of said device for increasing the speed of said motor as said device moves away from a limit of its reciprocation, and for decreasing the speed of said motor as said device moves toward a limit of reciprocation.

18. In combination, a motor, a device reciprocable thereby, reversing switch-means for controlling said motor, means responsive to the reciprocation of said device, a plurality of sets of switches associated respectively with the limiting positions of the reciprocable device, one switch at least of each set of said switches exercising control over said reversing switch jointly with said reciprocation-responsive means, and means responsive to the reciprocation of said device for transferring control from one set of said switches to the other.

19. In combination, a motor, a device reciprocable thereby, a reversing switch for controlling said motor, primary speed controlling means in the circuit of said motor, a plurality of sets of switches for controlling said primary speed controlling means, means for transferring control from one of said sets of switches to the other, means dependent upon the position of said device for controlling said sets of switches, and means responsive to the reciprocation of said device for controlling said reversing switch and said means for transferring control from one set of said switches to the other.

20. In combination, a motor, a device reciprocable thereby, primary speed controlling means for said motor, a plurality of sets of switches dependent upon the position of said device for controlling said primary speed controlling means, means for transferring control from one of said sets to the other, a portion of each of said sets of switches being operable to cause an increase of speed of said motor as said device moves away from a limit of reciprocation and one switch at least of each of said sets being operable to cause a portion of the other set to become inactive.

21. In combination, a motor, a device reciprocable thereby, means for controlling the speed of said motor, a plurality of sets of switches associated respectively with the limiting positions of said device, means responsive to the position of said device for controlling said sets of switches so that as said device moves away from a limit of reciprocation the speed of said motor will be increased and as said device approaches the opposite limit of reciprocation control will be taken away from said first mentioned set and transferred to another set.

22. In combination, a motor, a device reciprocable thereby, means for causing said motor to automatically reciprocate said device at desired intervals including means for automatically controlling the speed of said motor, and means whereby said speed controlling means may be controlled manually while automatic reciprocation continues.

In testimony whereof the signature of the inventor is affixed hereto.

RAY C. NEWHOUSE.