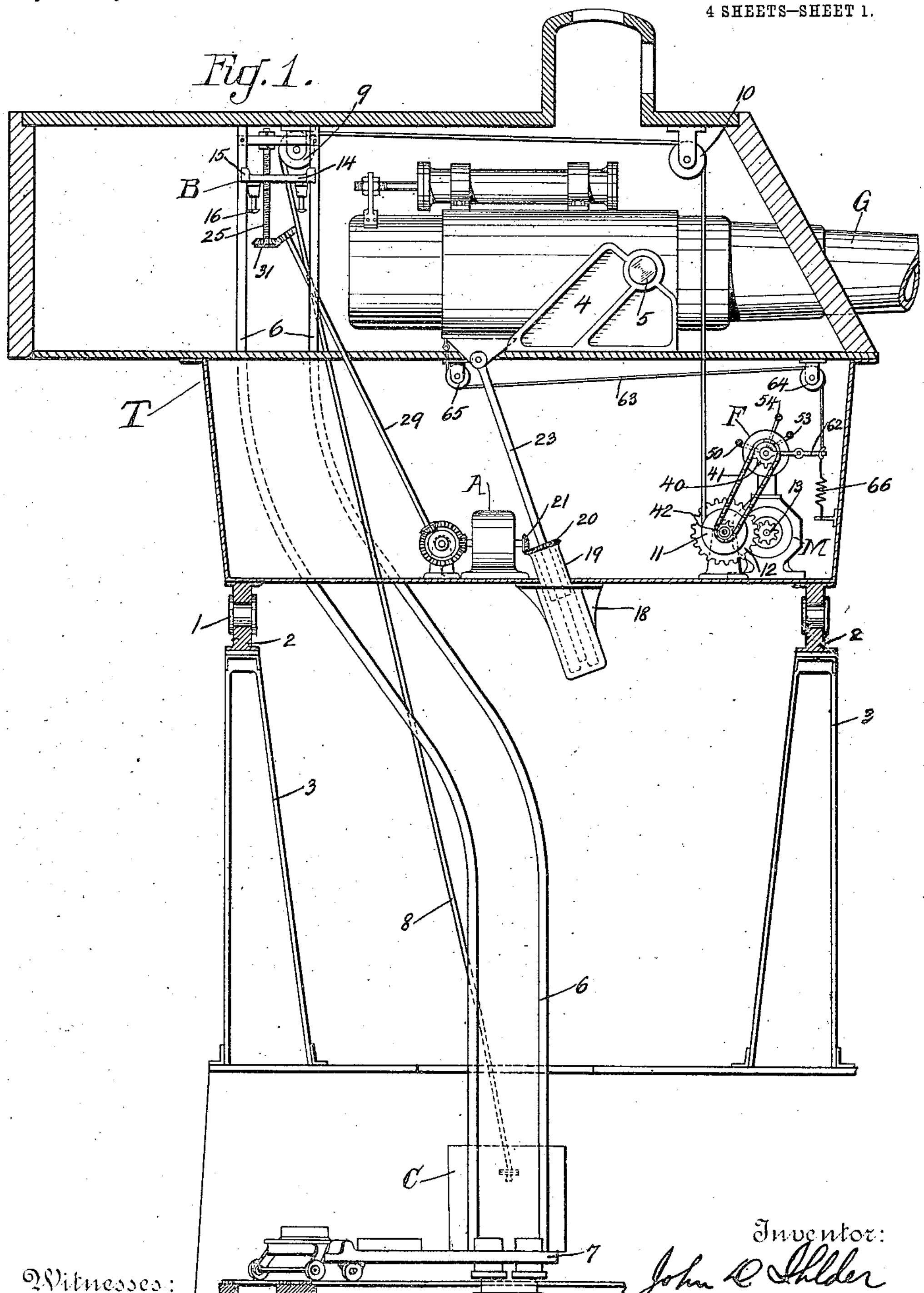
J. D. IHLDER.
SYSTEM OF ELECTRICAL CONTROL.
APPLICATION FILED JUNE 12, 1908.

1,052,587.

Patented Feb. 11, 1913.

4 SHEETS—SHEET 1.



Witnesses:
Ernest L. Gale Jr.
James G. Bethell

Inventor:
John D. Ihlder
By C. M. Nissen
Attorney

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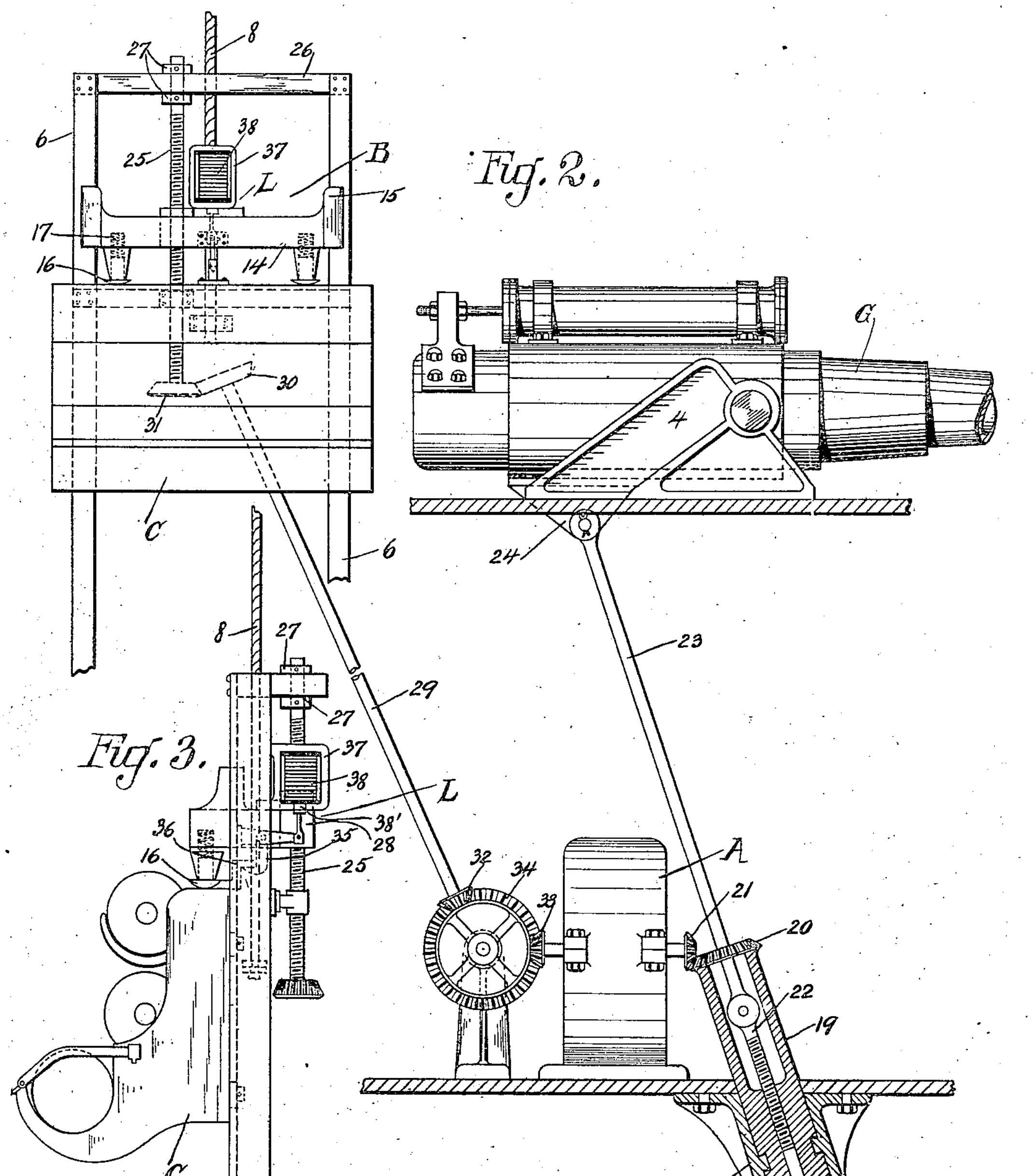

Fig. 2.

Fig. 3.

Witnesses:

Ernest L. Gale Jr

James G. Bethell

Inventor:

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By C. M. Nissen

Attorney

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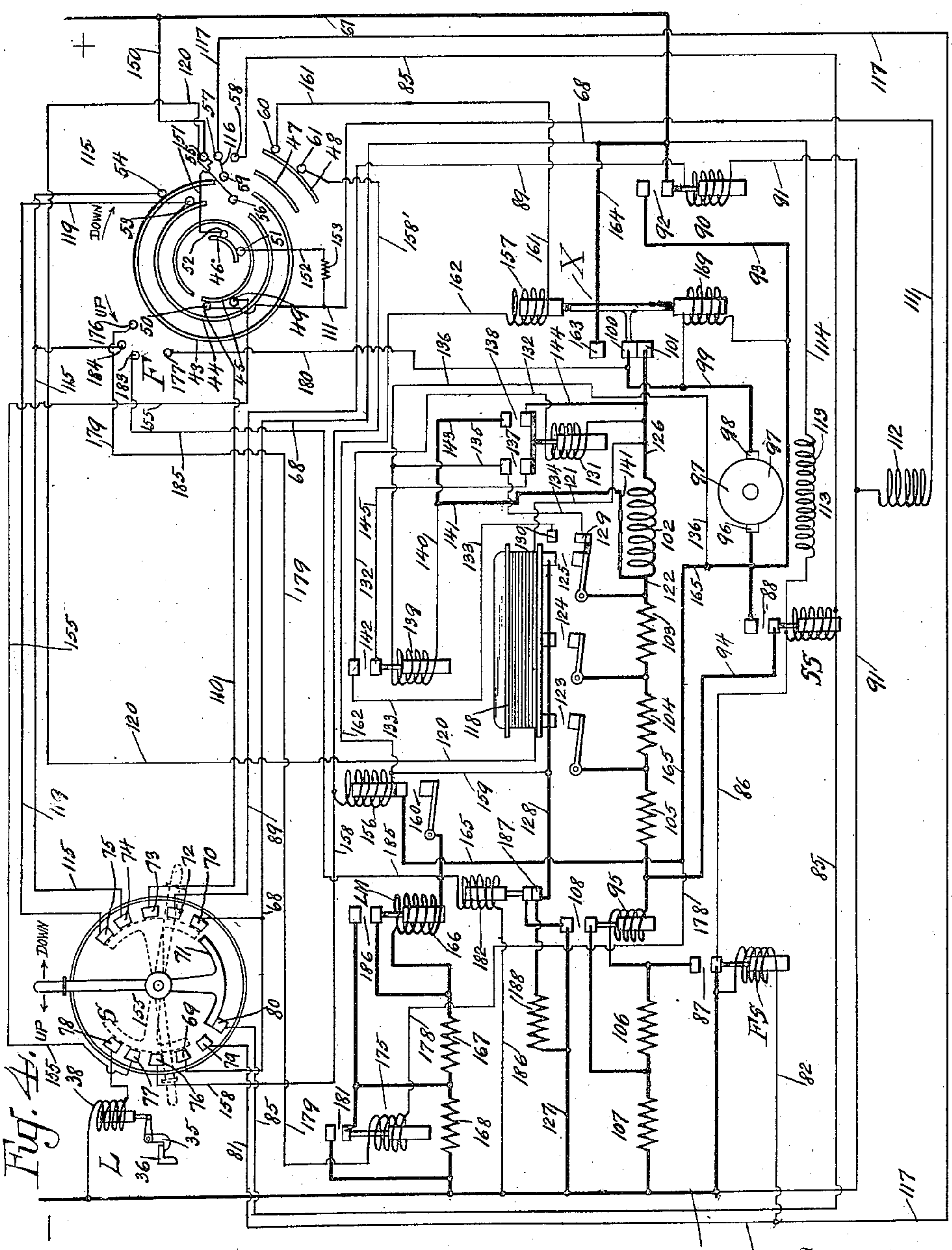

Fig. 4.

Witnesses:

Ernest L. Gale Jr.

James G. Bethell.

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John D. Ihlder

By C. M. Nissen

Attorney

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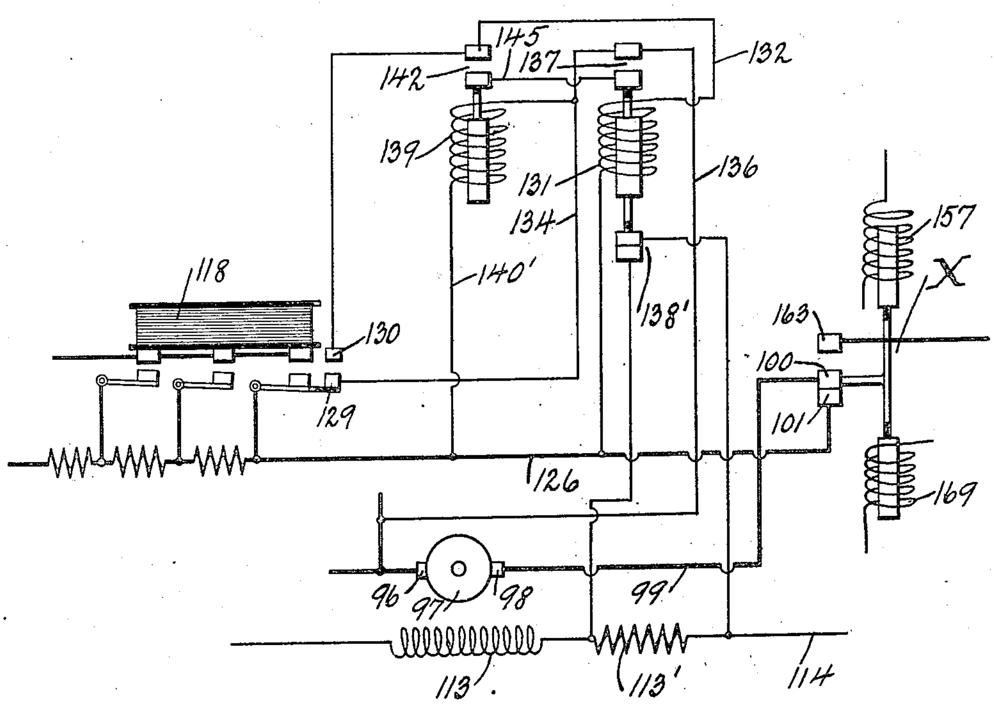
4 SHEETS—SHEET 4.

Fig. 5.



Witnesses:
J. F. Rule.
James G. Bethell.

Inventor
John D. Ihlder
By his Attorney
L. H. Campbell

UNITED STATES PATENT OFFICE.

JOHN D. IHLDER, OF NEW YORK, N. Y., ASSIGNOR TO OTIS ELEVATOR COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

SYSTEM OF ELECTRICAL CONTROL.

1,052,587. Specification of Letters Patent. Patented Feb. 11, 1913.

Application filed June 12, 1908. Serial No. 438,080.

To all whom it may concern:

Be it known that I, JOHN D. IHLDER, a citizen of the United States, residing in New York city, in the county of New York and State of New York, have invented a new and useful Improvement in Systems of Electrical Control, of which the following is a specification.

The present invention relates to hoisting mechanism and electrical operating and controlling mechanism therefor, and is more particularly adapted to ammunition hoists of that type in which the ammunition is lifted by a carrier to a position opposite the breech of the gun, and the carrier held in its elevated position by means of a reduced current supplied to the hoisting motor.

One of the objects of the invention is to provide means for reducing the current as the carrier approaches its upper limit of travel to an amount substantially proportional to or varying with the load.

Another object of the invention is the provision of improved means for limiting the speed of descent of the car or carrier.

A further object of the invention is the provision of means for overcoming any excessive starting friction of the descending load by supplying an initial current to the motor which is automatically cut off as the load commences its descent.

Still another object is to provide means for automatically slowing down the carrier during any desired portions of its travel either ascending or descending.

Other objects of the invention will appear hereinafter, the novel combinations of elements being set forth in the appended claims.

Referring to the accompanying drawings, Figure 1 is an elevational view of a gun and ammunition hoisting machanism; Fig. 2 is a view showing mechanism for simultaneously adjusting the gun elevation and the position of the buffer; Fig. 3 is a rear elevation of the buffer and ammunition carrier; Fig. 4 is a diagrammatic view of the electrical system of control; Fig. 5 shows a modification of the controlling mechanism adapted to a shunt wound motor.

The invention is herein shown in connection with a gun as used on a war vessel. The gun G is mounted in a rotating turret T supported on rollers 1 adapted to travel on a track 2 on the framework 3. The gun is mounted on its carriage 4 in the usual way by means of horizontal trunnions 5 journaled in the gun carriage. The ammunition is elevated from the hold of the ship to the gun by a car or carrier C adapted to travel on the tracks 6. The upper ends of these tracks are fixed to the turret and the lower ends are secured to a frame 7 rotatable with the turret so that the tracks retain a fixed position relative to the gun carriage. The carrier C is lifted and lowered by means of a hoisting rope or cable 8 connected at one end to the carrier and extending up and over the guide sheaves 9 and 10 and down to the winding drum 11. A gear wheel 12 connected to the winding drum meshes with the driving pinion 13 on the shaft of the hoisting motor M.

An adjustable buffer B is located near the upper end of the tracks 6 in position to form a stop for the carrier at its upper limit of travel. This buffer comprises a cross beam 14 and guides 15 slidable vertically on the rails 6. Abutments 16 normally projected by springs 17 form yielding stops for the carrier C.

The mechanism for adjusting the elevation of the gun comprises a bracket 18 bolted to the under surface of the turret floor, and having a hollow cylindrical body portion to receive a rotatable member 19. A miter gear 20 on the upper end of the member 19 meshes with a pinion 21 on the shaft of an electric motor A. A screw-threaded rod 22 works in a threaded recess in the member 19. A connecting rod 23 is connected at its lower end to the rod 22, and at its upper end to a bracket 24 on the gun. The operation of the motor A will effect an adjustment of the gun elevation in an obvious manner. This mechanism *per se* is not my invention. The following means, however, in combination with such mechanism for automatically adjusting the position of the buffer B as the gun elevation is adjusted, forms a feature of the present invention. A screw-threaded rod 25 is swiveled in a cross-beam 26 which is secured to the rails 6. The rod 25 is held against vertical movement by disks 27 secured to the rod on opposite sides of the beam 26.

An internally screw-threaded sleeve 38′ receiving the rod 25, is secured to the cross-piece 14 and forms a support therefor. A power-transmitting rod 29 supported in any convenient manner has a beveled gear 30 at its upper end meshing with a gear 31 on the lower end of the rod 25. The rod 29 is geared to the motor A by means of pinions 32 and 33 and a gear wheel 34. When the motor A is operated to adjust the gun elevation, the shaft 25 will be rotated by means of the gearing just described, and as said rod cannot move vertically the sleeve 38′ and buffer B will be moved up or down, depending on the direction of rotation of the motor armature. The gearing is so arranged and proportioned that the buffer moves up and down with the breech of the gun and to substantially the same extent, so that whatever the gun elevation may be the buffer is in position to stop the carrier C with the charge in proper position for loading.

In connection with the buffer B, I have shown an electro-magnetic locking device L adapted to lock the carrier C in its elevated position during the loading of the gun. This device comprises a catch 35 (Fig. 4) adapted to engage below a bracket 36 secured to the carrier C, the under surface of the catch being beveled to permit the same to be moved out of the way as the carrier nears its upper limit of travel, the catch then returning to normal position to hold the carrier suspended. In order to permit the carrier to descend, the catch is released by energizing the electro-magnet comprising the solenoid 38, the frame 37 and the core or plunger 38′.

An automatic floor controller F is connected for rotation to the motor M, or some movable part of the hoisting mechanism. As shown in Fig. 1, the controller F is provided with a sprocket wheel 40 geared by a chain 41 to a sprocket wheel 42 on the shaft of the hoisting drum, so that the controller will move in unison with the carrier C. As shown diagrammatically in Fig. 4 the controller carries a series of arc-shaped movable contact strips 43, 44, 45, etc., adapted to engage a series of stationary brushes 49, 50, etc. The brushes, or those controlling the motor circuits as the carrier C is lifted, may be carried by an arm 62 journaled at one end on the shaft of the controller. A rope or cord 63 is connected at one end to the arm 62 and passes over direction sheaves 64, 65 and is secured at its other end to the gun. A coil spring 66 keeps the rope 63 taut. The position of the brushes carried by the arm 62 will therefore be changed whenever the gun elevation is changed, and the arrangement is such that the relative position of the brushes and contact strips is always substantially the same for any given position of the carrier C relatively to the buffer B and breech of the gun. The specific construction of the controller F may be the same as that fully shown and described in my former Patent No. 879,387, dated February 18, 1908. If it is desired to give the controller more than one revolution, the construction disclosed in my Patent No. 710,914, dated October 7, 1902, may be used.

In Fig. 4 the controller F is shown in the position assumed when the car C is at its normal upper limit of travel. The lever of the car switch S has been brought to center and the machine is at rest with the car held by the locking device L. The power is cut off from all parts except the brake magnet. To start the car on its downward travel from this position, the car switch handle is moved to the right to bring the contact plate 71 into engagement with the stationary contacts 69, 76, 77 and 78. It is assumed that the car is not sufficiently heavy to overcome the friction of rest of all the parts, but that after being set in motion it will accelerate and continue running downward without requiring power from the source of supply.

The circuits established are as follows: from the plus line 67 through conductor 68 to car switch contact 69, plate 71 and contact 76, through conductors 158, 158′, contact 61 on controller F, plate 48, contact 60, conductor 161, coil 157 of the double magnet X, conductors 162, 159, 128, contacts 187 and conductors 127 to the minus line 84. The magnet X being thus excited its core is lifted, making connection between the contacts 100 and 163, and thereby closing a main line circuit through the motor, which circuit is from the plus line to the armature brush 98, through the armature 97, brush 96, conductor 165, switch 160, coil 166 of magnet LM, and resistances 167 and 168 to the minus line. The switch 160 is closed at this time since its magnet spool 156 is energized, being in a parallel circuit with the spool 157 of magnet X which circuit may be traced from the conductor 158 through spool 156, conductors 159, 128, contacts 187, and conductor 127 to the minus line. Current is admitted to the brake magnet 112 by way of car switch contact 77 through conductor 155, contact 49, spiral 45, contact 50, conductor 111 to the brake spool 112, and through conductor 91 to the minus line. A parallel circuit through the brake magnet may be traced from the plus line through conductor 150, contact 55, conductor 151, contact 52, spiral 46, contact 51, conductor 152, resistance 153 to conductor 111 and the brake coil 112. The purpose of this latter circuit will be pointed out later. The car switch contact 78 controls the circuit through the magnet coil 38 of the locking device L which is therefore operated to disengage the catch 35 and permit the car to descend. As the switch lever is thrown over to the right, the plate 71 momentarily engages the contact 79 and closes a circuit through the magnet FS which may cause the latter to operate, but this is merely incidental and has no effect on the operation of the motor and hoisting mechanism.

Briefly stated, the effect of moving the lever of the switch S over to the right is to release the locking device L and supply current to the armature in a direction to start the carrier downward. This current is only supplied during the initial downward movement of the carrier, however, and is for the purpose of overcoming the excessive starting friction which in some cases the weight of the carrier may not be able to overcome. The carrier now commences its downward movement and the increasing speed of the armature quickly develops sufficient counter-electro-motive force to cause the lower magnet 169, which is connected across the armature, to pull its core down against the pull of the upper magnet 157. The contact strip 48 also leaves the brush 60 when the carrier has moved downwardly a short distance and opens the circuit through the upper magnet 157, thereby limiting the distance the car can travel before the magnet is operated. The operation of the magnet 169 opens the circuit from the main line through the motor armature at the contact 163 and closes a local circuit through the armature. This latter circuit may be traced from the armature brush 98 through conductor 99, contacts 100, 101, series field coil 102, resistances 103, 104, 105, coil of magnet 95, resistances 106, 107, conductor 84, resistances 168, 167, coil 166 of the load magnet LM switch 160, conductor 165 to the armature brush 96. The car now drives the motor as a generator and the current in this local circuit produces an electro-dynamic braking effect which limits the speed of the car in its descent. The magnet 95 acts during the descent of the car to regulate the speed for different loads. That is, if the load is heavy and accelerates the motor above a predetermined limit, the magnet 95 receives sufficient current to close the switch 108 and short-circuit the resistance 107, thereby increasing the current in the local circuit and thus increasing the electro-dynamic braking action sufficiently to bring the speed down again. If the load is light, it will not tend to produce an excessive speed and the magnet will not operate to short-circuit the resistance 107, and the braking action will be correspondingly limited. If a heavy load has caused the magnet 95 to close the switch 108 and as a result the speed falls below a given limit, the magnet will be weakened and the switch will open again to reduce the braking effect. The load magnet LM operates a switch 186 in the same way to control the resistance 167, so that the speed is regulated during the descent of the carrier and kept substantially the same or within predetermined limits for different loads. As the car descends, the spiral contacts of the controller F are turned in a clockwise direction and when the car reaches a point in its travel where it is necessary or desirable to reduce the speed temporarily, as for example, where it has to pass over a sharp curve in the tracks or through a hatchway port, the spiral 47 makes connection between the contacts 177 and 176. This introduces a magnet coil 175 into a circuit across the armature as follows, from the armature brush 96, through conductors 165, 178, magnet coil 175, conductor 179, contact 176, spiral 47, contact 177, and conductors 180 and 99 to the brush 98. The magnet coil 175, if the speed of the armature is sufficiently high depending on the load, closes the switch 181 and short-circuits the resistance 168 which is at this time in the local circuit of the motor armature. The electrodynamic brake action is thus increased and slows down the carrier until the obstruction has been passed, when the spiral 47 leaves the brush 177 and opens the circuit through the magnet coil 175 to reinsert the resistance 168 and permit the motor to run up to full speed again.

During the descent of the carrier, the controller F makes somewhat less than a complete revolution. The first step in slowing down the motor as the carrier approaches its lowermost position takes place when the contact strip 47 of the floor controller reaches the position where it bridges the contacts 55 and 57. This closes a circuit from the positive main through conductor 150, brush 55, strip 47, brush 57, conductors 117, 82, coil of magnet FS, and conductor 84 to the negative main. The magnet FS now closes the switch 87 and short-circuits the resistances 106 and 107, increasing the electro-dynamic braking effect and slowing down the motor. The next step in the control of the motor occurs when the strip 47 reaches the brush 58, the strip 47 still rotating clockwise. This establishes a circuit from the positive main through conductor 150, brush 55, contact strip 47, brush 58, conductor 85, coil of magnet SS, and conductors 86 and 84 to the negative main. The magnet SS closes the switch 88 and short-circuits the load magnet LM, resistances 167, 168 and the magnet 95, leaving only the resistances 103, 104, 105, and the series field coil 102, in circuit with the motor armature. The electro-dynamic braking effect is now very powerful and slows down the carrier so that it comes quietly to rest in its lowered position. This removes the driving power for the motor, and the dynamic braking action quickly brings the motor and hoisting mechanism also to rest. In case the motor does not stop immediately, a slight further movement separates the spiral 45 and contact 49 of the controller F and interrupts the circuit of the brake magnet 112, so that the brake assists in stopping the motor. Generally the dynamic brake action will be sufficient to effect a prompt stop without the mechanical brake being applied. The car switch handle may then be brought to the stop position.

To lift the car, the handle of the car switch S is turned to the left, causing the contact plate 71 to make connection between the contacts 70, 72, 73, 74 and 75. This establishes the following circuits: from the plus line through conductor 68, contact 70, plate 71, contact 72, conductor 89, main line magnet spool 90, and conductor 91 to the minus line. The main line magnet closes the switch 92, establishing a motor circuit from the plus line through switch 92, conductor 93 to armature brush 96, through the armature 97, brush 98, conductor 99, contacts 100, 101, conductor 126, series field winding 102, resistances 103, 104, 105, spool 95, and resistances 106, 107 to the minus line. Another circuit is made from the plus line through conductor 68, contact 70, plate 71, contact 73, conductor 110, contact 50, conductor 111, brake spool 112 and conductor 91 to the minus line, energizing the spool and lifting the brake. A connection is also made through the previously traced conductors to plate 71, contact 74, conductor 115, contact 54, spiral 43, contact 59, conductors 116, 117, 82, through the winding of the magnet FS and to the minus line. This energizes the magnet FS and closes the switch 87. A further circuit is made at the car switch which may be traced from the plate 71 through contact 75, conductor 119, contact 53, spiral 44, contact 56, conductor 120, accelerating magnet spool 118, conductor 121 to the junction 126, which energizes the accelerating magnet spool according to the potential of the motor armature. The magnet FS, having closed the switch 87, thereby short-circuiting the resistances 106 and 107, has reduced the starting resistance to the amount contained in the series field 102, resistances 103, 104, 105 and the spool 95. These resistances are so proportioned that the current admitted by them will start the maximum load.

As the speed of the armature increases and the accelerating magnet gradually increases in power, it first closes the switch 123, short-circuiting the resistance 105; and as the speed further increases the switch 124 is closed to short-circuit the resistance 104; and finally the switch 125 is closed to short-circuit the resistance 103. The closing of the switch 125 also brings the auxiliary contacts 129, 130 together and thereby establishes a circuit for the spool 131, which operates to close the switches 137 and 138, short-circuiting the series field 102. The magnetization of the motor depends now on the shunt field winding 113 only, the latter being connected between the plus and minus lines by the conductors 114 and 86. The motor now reaches maximum speed, the starting resistance being all short-circuited. The armature circuit at this time is as follows: from the plus line through contacts 92, conductor 93, armature brush 96, armature 97, brush 98, contacts 100, 101, conductor 144, contacts 138, conductors 143, 141, 122, switch 125, conductor 128, contacts 187 and conductor 127 to the minus line. During the upward travel of the car, the spirals of the controller F move in an anti-clockwise direction. When the car reaches the hatchway or position for which a slower speed is desired, the spiral 48 makes connection between the contacts 184 and 183, energizing the spool 182, which opens the normally closed switch 187 and introduces the resistance 188 in the armature circuit, thereby reducing the speed of the motor. After the car has passed such position, the spiral 48 breaks connection between the contacts 184 and 183, deënergizing the spool 182, closing the switch 187, and permitting the motor to again attain full speed. As the car approaches the upper limit of its travel the spiral 44 breaks connection between the contacts 53 and 56, interrupting the circuit of the accelerating magnet 118, causing the switches 123, 124 and 125 to open, introducing the resistances 103, 104, 105 and also the spool 95 into the armature circuit, and thereby reducing the speed of the armature. The switch 87 is closed at this time and the resistances 106 and 107 therefore short-circuited. The current through the magnet 95 which has just been excited by the operation of the accelerating magnet, is proportional to the load being lifted by the motor, and this magnet is so designed that with a heavy load it will close the switch 108, but with a light load the switch 108 will remain open.

The second step in slowing down the motor takes place when the controller has rotated a short distance farther and the contact strip 43 runs off the brush 59 and opens the circuit through the magnet FS. This effects the opening of switch 87 and introduces the resistance 106 into the armature circuit, and if the load is light so that the magnet 95 has not operated, the resistance 107 is also connected in the armature circuit, but if the load is heavy and the magnet 95 has closed the switch 108 the resistance 107 will remain short-circuited. The current through the motor armature is thus further reduced an amount depending on the load, less resistance being introduced when the load is heavy. It is thus seen that the magnet 95 and resistance controlled thereby form a means for varying the current in the motor in accordance with the load as the latter is being brought to rest at its upper limit of travel. Although the magnet 95 provides for only one variation in the current, it is obvious that the number of magnets and resistances may be increased to secure any degree of refinement of control desired. The speed of the motor is now reduced so that the carrier C is moving slowly as it is brought up against the buffer B and comes to rest without any undue jar or strain on any of the parts. The hook or catch 35 carried by the buffer will be engaged by the carrier as the latter is being brought to rest and hold the same until the hook is released by its magnet.

In order to insure the brake being off during the time the carrier is opposite the gun, the following means may be provided. A contact strip 46 on the floor controller is so located as to engage the brush 52 when the carrier reaches the lowest position of the breach of the gun. This closes a circuit through the brake magnet, which may be traced from the positive main through conductor 150, conductor 151, brush 52, contact strip 46, brush 51, conductor 152, resistance 153, conductor 111, brake magnet coil 112, and conductors 91, 84 to the negative main. This circuit is entirely independent of the manual switch S and is maintained until the carrier has descended below the gun. The operator is thereby prevented from opening the brake circuit and applying the brake to the motor when the carrier is moved while locked to the buffer. Without this provision the brake might be applied when the carrier was locked to the buffer and the breech of the gun then moved, carrying with it the buffer and carrier C which would be forced down against the holding power of the brake. Or, the carrier might be raised when the brake was applied, thereby producing slack in the hoisting cable so that the carrier would drop when the brake was released. In either case, the cable might be broken or other injurious results follow.

In some cases it is not only necessary to provide sufficient torque to hold the car, but a surplus torque must be provided to enable the motor to follow up the movement of the gun. In order to give the motor this additional torque with the least increase of current I make use of the magnet 131 which has short-circuited the series field, this magnet being connected to the terminals of the motor armature through the circuit which has been traced. When the connection was made during the acceleration, the motor had nearly reached full potential. This magnet is designed to hold the switches 137, 138 closed until the motor has nearly come to rest, when it will open said switches, introducing the series field into the circuit. The strength of the series field is preferably so proportioned that it is sufficient to overcome the extra friction of rest.

To prevent magnet 131 becoming deënergized when contacts 129 and 130 open, and thereby separating contacts 137 and 138, I use magnet 139 to keep the spool 131 energized, as long as the motor armature is generating a moderate counter-electromotive force. The circuit for spool 139 can be traced from brush 98, through conductor 99, contacts 100, 101, conductor 126, series field 102, conductor 141, conductor 140, spool 139, conductor 136 to brush 96. The switch 142 for spool 139 is closed as soon as the armature makes proper potential, and after contacts 129 and 130 have energized spool 131, causing it to close the switch 137, it will be seen that the separating of contacts 129 and 130 does not deënergize spool 131, its circuit remaining established from conductor 126 through spool 131, conductor 132, contacts 142, conductor 145, contacts 137, conductors 135 and 136, conductor 165 to armature brush 96. The magnets 131 and 139 will only become deënergized when the armature potential drops below a predetermined point.

I have shown in Fig. 4 a compound motor and while the compound field winding has advantages over the shunt field winding in hoisting motors, a motor with a shunt field winding may be used if desired as illustrated in Fig. 5. In this case the series winding 102 is omitted and a resistance 113′ is placed in circuit with the shunt field winding 113. This resistance is short circuited by the contacts 138′ which are arranged to be separated when the magnet 131 is energized. The circuit for the spool 139 may be traced from the brush 98 through conductor 99, contacts 100, 101, conductors 126, 140′, spool 139, conductor 136 to brush 96. The magnet 139 closes the contacts 142 and maintains a holding circuit for the magnet coil 131 as before pointed out. The operation is substantially like that described in connection with Fig. 4, except that the magnet 131 when energized separates the contacts 138′ to introduce the resistance 131′ in the field circuit instead of the contacts being closed to short-circuit a series coil as in Fig. 4. In either case slowing down of the motor so that the magnet 131 drops its core, effects an increase in the strength of the motor field so that the torque is sufficient to enable the motor to follow up the movement of the gun.

In my Patent 879,387, above referred to, I have disclosed means for stopping the carrier automatically at different positions, varying with the position of the breech of the gun. The same device used there can of course be employed in this case in connection with controller F. Also, though I show controller F in the form of spirals, I do not limit myself to this construction. Any other suitable form, such as switches opened by cams, or equivalent construction, can be used, if desired.

It is understood that the position and length of the spirals and the location of the brushes is to be determined according to the travel of the car, and the movement provided for the spirals. The contacts and contact plate on the car switch also are to be located to suit the desired movement of the car switch handle. The spacing may be irregular, and the movement of the handle does not necessarily have to be to the center position for stopping. The position of the contacts is shown on the wiring diagram symmetrical, for clearness sake.

Slow speed can be produced by the operator at any time during the run by moving the handle of switch S from extreme position toward the stop position, opening on the up motion the accelerating magnet contacts, while with such movement of the switch S during the down motion the contacts of magnet FS are closed. A stop can be made by the operator at any time by bringing the switch handle to stop position for either up or down, thereby cutting off the power and applying the brake.

I wish not to be limited to the exact construction disclosed, as various changes in the details of construction and arrangement of parts may be made without departing from the spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination with an electric motor, of resistance in the motor circuit, a device for closing a short circuit across said resistance while the motor is running at normal speed and opening said short circuit to reduce the speed, and means for reducing said resistance to an amount dependent on the current strength while said short circuit is open.

2. The combination with a car and its motor, of means for automatically reducing the current through the motor to an amount varying with the load as the car approaches its upper limit of travel and holding the car at its upper limit by means of a reduced current.

3. The combination with a car or carrier, of an electric motor for lifting the car, and automatic controlling means for reducing the speed of the car as it approaches its upper limit of travel to an extent varying with the load on the car, and to maintain the motor energized to hold the car in its elevated position.

4. The combination with a load-carrying device, of an electric motor for lifting said device, means for reducing the current as said device approaches its upper limit of travel and holding said device in its elevated position by such reduced current, and means for increasing the field strength of the motor while said device is so held.

5. The combination with a car and its motor, of means for automatically reducing the speed of the car as it approaches its upper limit and permitting it to be held at its upper limit by the torque of the motor, and means for increasing the field strength of the motor while the car is in such position.

6. In hoisting mechanism, the combination with an electric motor comprising a series field winding, of a car, power-transmitting mechanism between the car and motor, starting resistance, means for introducing said resistance in the motor circuit and short-circuiting the series field winding as the car approaches its upper limit of travel, and means for automatically introducing the series field winding into the motor circuit while the car is being brought to rest in its elevated position.

7. The combination with an electric motor comprising a series field winding, of starting resistance in the motor circuit, an accelerating magnet operable to short-circuit said resistance, means controlled by said magnet for effecting the closing of a short circuit across the series field winding, and means independent of the accelerating magnet for maintaining the series field winding short-circuited.

8. The combination with an electric motor comprising a series field winding, of an electro-responsive device controlling a short circuit across the series field winding, means for effecting the operation of said device to short circuit the field winding when the speed of the motor reaches a predetermined limit, and means for retaining the field winding short-circuited until the speed of the motor is reduced to a point materially below said limit.

9. The combination with an electric motor comprising a series field winding, of starting resistance, an accelerating magnet, an electro-magnet, a switch in the circuit of the electro-magnet operated by the accelerating magnet, a short circuit across the series field winding comprising a switch operated by said electro-magnet, and a holding circuit for said electro-magnet.

10. The combination with an electric motor, of starting resistance therefor, an accelerating magnet controlling said resistance, additional resistance in a local circuit for the motor, and an electro-magnet having its winding in a circuit in series with the motor, and operable to short-circuit said additional resistance only when the speed of the motor is excessive.

11. The combination with an electric motor, of starting resistance therefor, means for controlling said resistance, additional resistance, means for closing a local circuit including the motor armature and said resistances, an electro-magnet having its winding in said local circuit, and means operated by said magnet for controlling said additional resistance.

12. The combination with a car, of a motor for lifting the car, means for supplying current to the motor in a direction to start the car downward from its elevated position, and means for automatically cutting off the supply of current when the car has started downward.

13. The combination with a motor, of a device operated by the motor in one direction and operative to drive the motor as a generator in the opposite direction, means for supplying current to the motor to start it in said last-named direction, and means for cutting off the supply of current when the motor has started and permitting it to be run as a generator.

14. The combination with a car, of an electric motor, driving connections between the car and motor, means for supplying current to the motor in a direction to lift the car, means for reversing the direction of the current through the motor when the car is in its elevated position, and means for automatically cutting off the current supply and establishing a local circuit for the motor when the car has developed a predetermined speed in its initial downward travel and maintaining said local circuit during the remaining downward travel of the car.

15. The combination with a car, of an electric motor, power-transmitting connections between the car and motor, means for supplying current to the motor to lift the car, and means for supplying current to the motor in direction and quantity to overcome the starting friction when the car is in its elevated position and start the car downward and then permitting it to be lowered by gravity.

16. The combination with a car, of an electric motor, power-transmitting connections between the car and motor, means for supplying current to the motor in a direction to lift the car, mechanism for reversing the current through the motor and starting the car downward from its elevated position, and means for automatically cutting off the current supply when the car has reached a given point a short distance below its upper limit of travel.

17. The combination with a car and a lifting motor, of means for supplying current to the motor in a direction to lift the car, a device for reversing the current while the car is elevated and starting the car downward, and means for cutting off said current supply and closing a local circuit through the motor when the car has started downward.

18. The combination with a car and a motor, of means for supplying current to the motor and lifting the car, a reversing switch in the motor circuit, mechanism for operating said switch when the car is in its elevated position, and means for cutting off the supply of current to the motor when the car has started downward.

19. The combination with a car, of an electric motor, an electro-magnetic reversing switch normally closed in a direction to supply current to the motor for lifting the car, a floor controller, and circuit connections between the magnet winding of the reversing switch and the floor controller for reversing said switch only when the car is at its upper limit of travel and during its initial downward movement.

20. The combination with a car, of an electric motor for lifting the car, a switch in the motor circuit, a switch-operating electro-magnet, a floor controller, circuit connections between the floor controller and the winding of said magnet for closing the magnet circuit only while the car is near its upper limit of travel.

21. The combination with an electric motor and hoisting mechanism, of a reversing switch, an electro-magnet for operating said switch having differential windings, the current in one of said windings being dependent on the speed of the motor armature, a floor controller, and circuit connections between the floor controller and the other of said windings.

22. The combination with an electric motor, of a switch, circuit connections for establishing a line circuit through the motor armature when the switch is in one position and for opening the line circuit and establishing a local circuit through the motor armature when the switch is in another position, a differentially wound electro-magnet for operating the switch, and a floor controller automatically controlling one of the circuits of the magnet windings.

23. The combination with a hoisting motor, of a load-carrying device, means for supplying current to the motor in a direction to lift said device, mechanism operable when the car is at its upper limit of travel to supply current in a direction to start the car downward, means for cutting off the current supply when the motor has developed a given speed in its downward travel, and additional means for cutting off the current supply when the car has moved downwardly a given distance independently of the speed.

24. The combination with an electric hoisting motor, of a car, means for operating the motor, a floor controller and elec-

tro-responsive means controlled thereby for automatically varying the speed of the car at an intermediate point in its travel and again bringing it back to normal speed during the operation of the motor.

25. The combination of an electric motor, a car operated thereby, electrically operated means for automatically reducing the speed of the car and again bringing it back to normal speed at predetermined intermediate points in its travel.

26. The combination with a car, of an electric hoisting motor, and an automatically operable electro-responsive device electrically controlled and operated to effect a temporary reduction in the speed of the car and again bring it back to normal.

27. The combination with a car, of an electric hoisting motor, and electro-responsive means to effect a change in the current strength in a circuit of the motor during an intermediate period in the travel of the car and thereby produce a temporary change in the speed of the car.

28. The combination with a car, of a hoisting motor, a resistance in a circuit of the motor, a normally closed electro-magnetic switch in a short circuit across said resistance, and automatic means for energizing the switch magnet and introducing said resistance in the motor circuit for a limited period in the travel of the car.

29. The combination with a car, of an electric motor, a floor controller, and means controlled thereby for effecting a temporary reduction in the speed of the car.

30. The combination with a car, of an electric motor, a floor controller, an electromagnetic device controlled thereby operative to automatically effect a temporary slowing down of the car at an intermediate point in its travel and circuit connections between said device and the floor controller.

31. The combination with a car, of an electric hoisting motor, circuits and connections for supplying current to the motor to lift the car, means for establishing an electro-dynamic brake circuit through the motor armature during the descent of the car, a resistance in said circuit, and means for automatically short-circuiting said resistance during an intermediate period in the descent of the car.

32. The combination with a car, of an electric motor, a resistance in the motor circuit, a normally open switch in a short circuit across said resistance, an operating electromagnet for said switch, and means operable automatically at a predetermined point in the travel of the car to excite said magnet and close the switch during a limited period in the travel of the car and then deënergize said magnet and reopen the switch and permit the continued travel of the car at normal speed.

33. The combination with a car, of a hoisting motor, means for effecting automatically a reduction in the speed of the car throughout a predetermined period in its upward travel, and additional means for automatically reducing the speed of the car at a corresponding period in its downward travel.

34. The combination with a car, of a hoisting motor, means for operating the motor, mechanism for automatically reducing the speed as the car approaches its limit of travel, and independent means for effecting a temporary reduction in the speed while the car is at an intermediate point.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN D. IHLDER.

Witnesses:

WALTER C. STRANG,
JAMES G. BETHELL.