No. 815,826. PATENTED MAR. 20, 1906.

G. H. HILL.

# TRAIN CONTROL SYSTEM.

APPLICATION FILED AUG. 20, 1904.

3 SHEETS—SHEET 1.

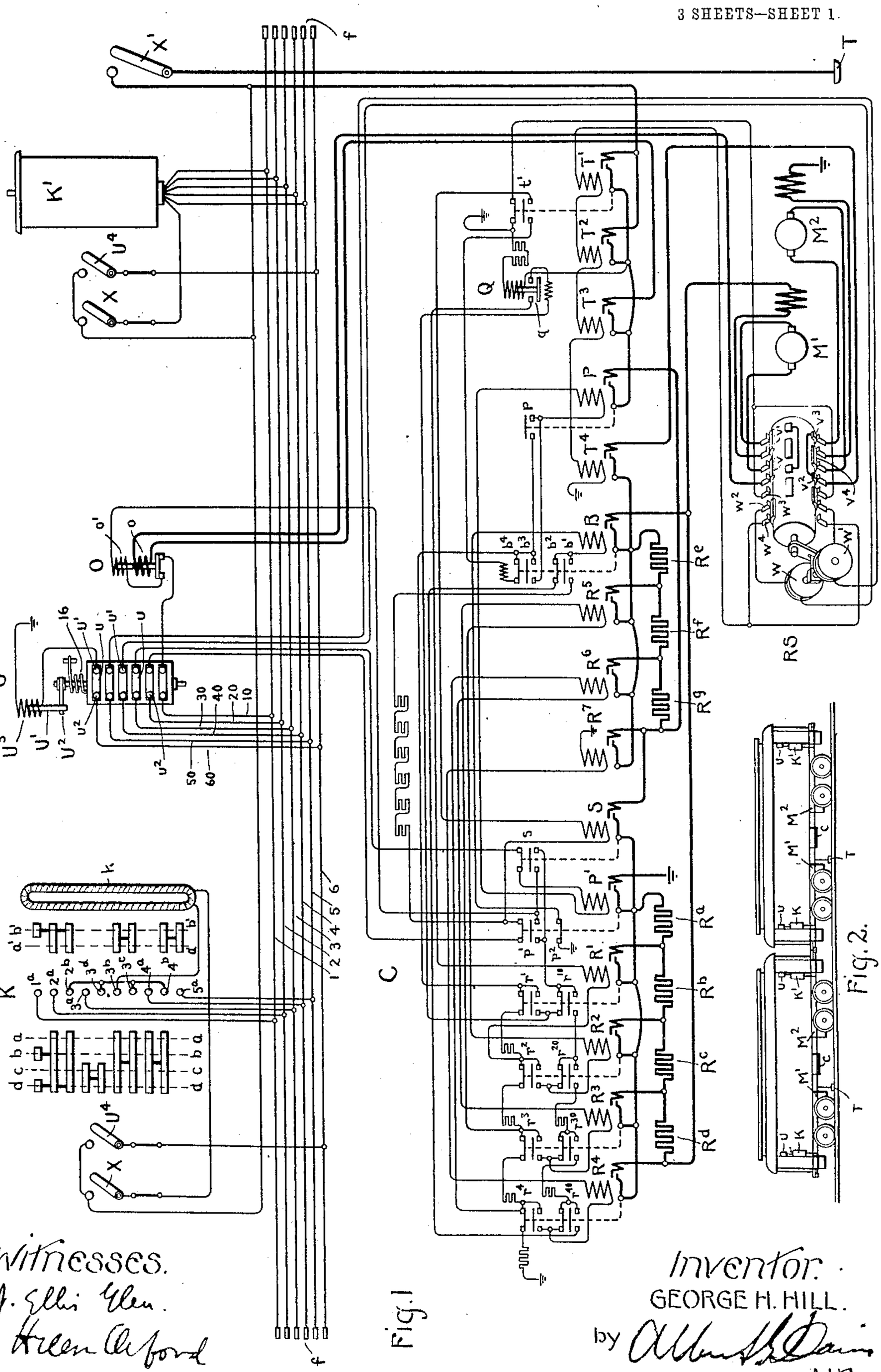



Fig. 1




Fig. 2.

Witnesses.
J. Ellis Glen.
Green Alford

Inventor.
GEORGE H. HILL.
by Albert G. Davis
Atty.

No. 815,826. PATENTED MAR. 20, 1906.

G. H. HILL.

TRAIN CONTROL SYSTEM.

APPLICATION FILED AUG. 20, 1904.

3 SHEETS—SHEET 2.

Fig. 3.

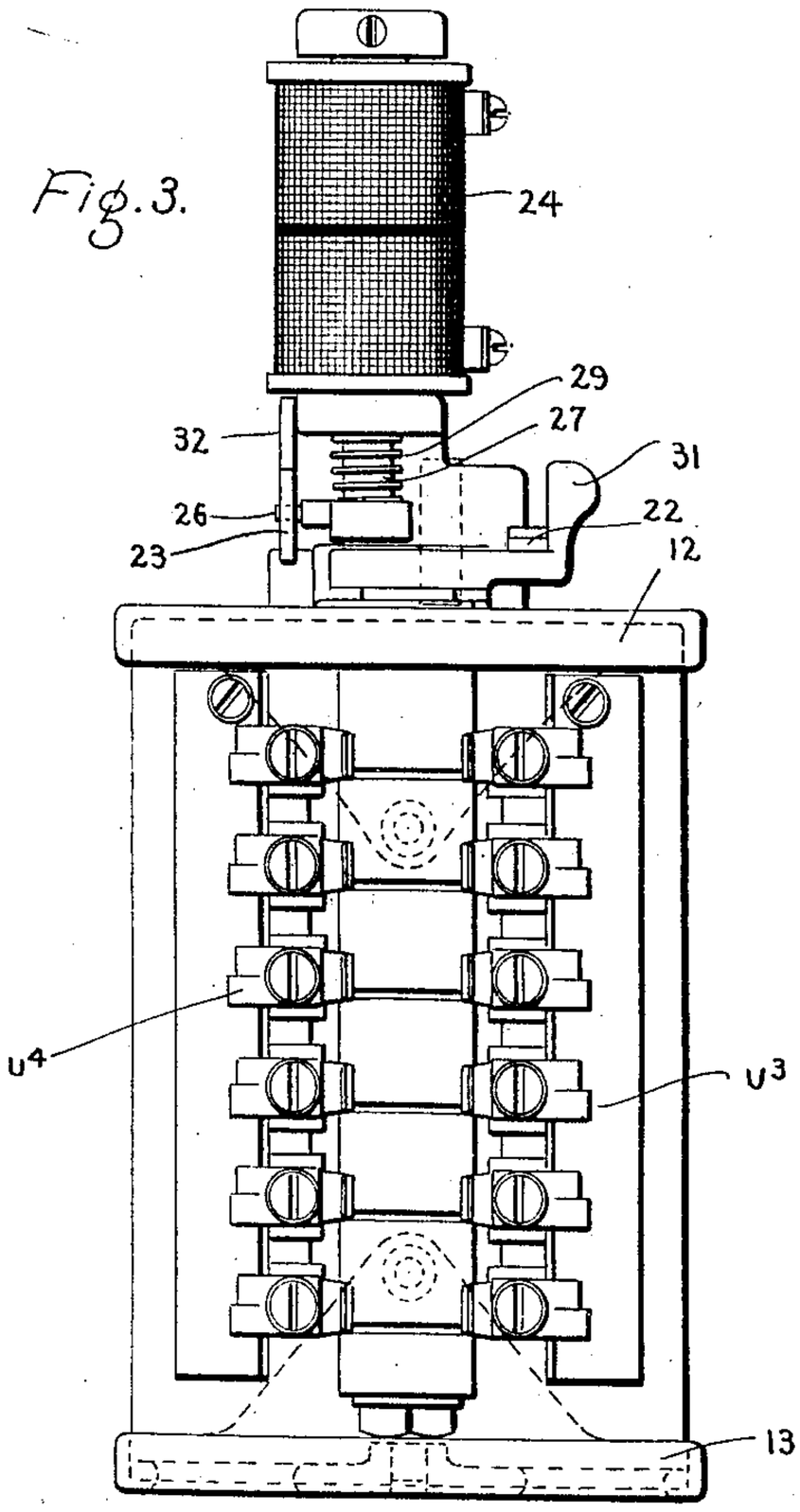



Fig. 4.

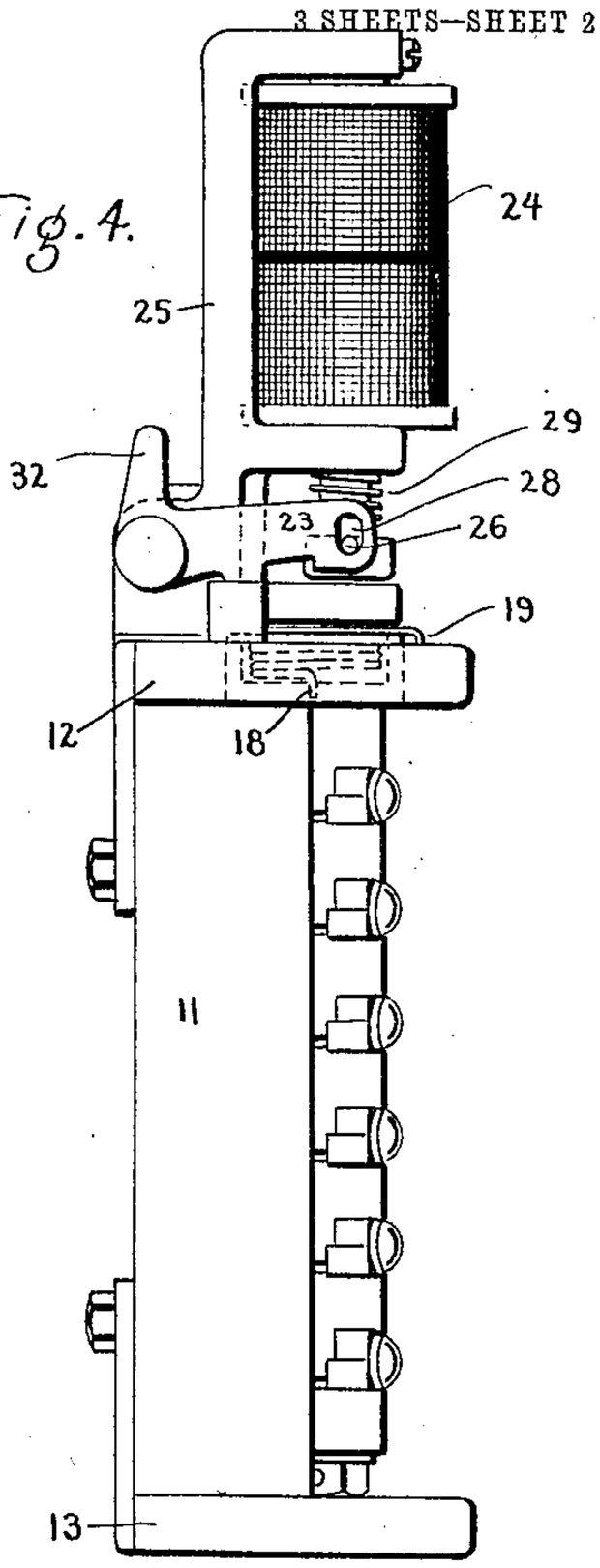



Fig. 5.

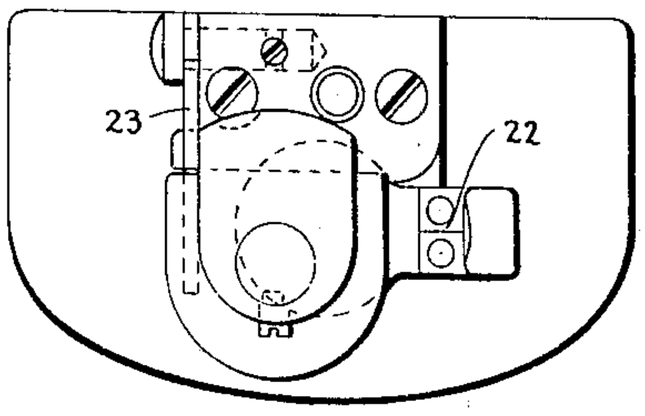



Fig. 7.

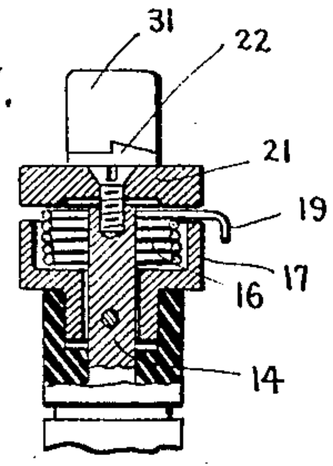



Fig. 6

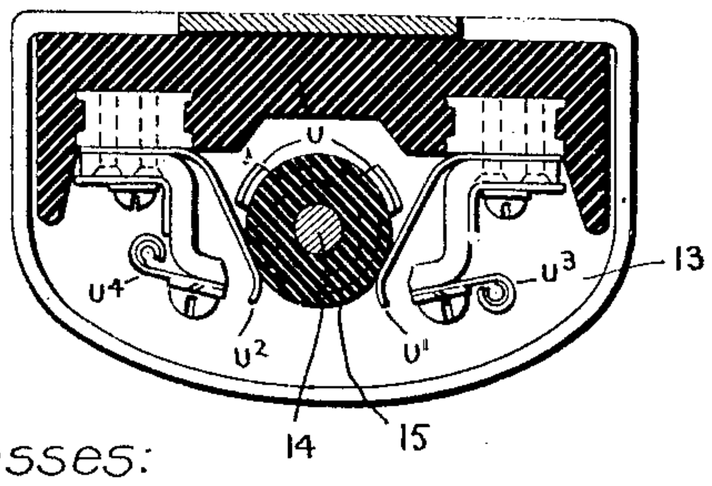



Fig. 8.


Witnesses:

Marcus L. Byng.

Helen M. Ford

Inventor:
George H. Hill.
by Albert G. Davis
Atty.

No. 815,826. PATENTED MAR. 20, 1906.

G. H. HILL.

TRAIN CONTROL SYSTEM.

APPLICATION FILED AUG. 20, 1904.

3 SHEETS—SHEET 3.

Fig. 10.

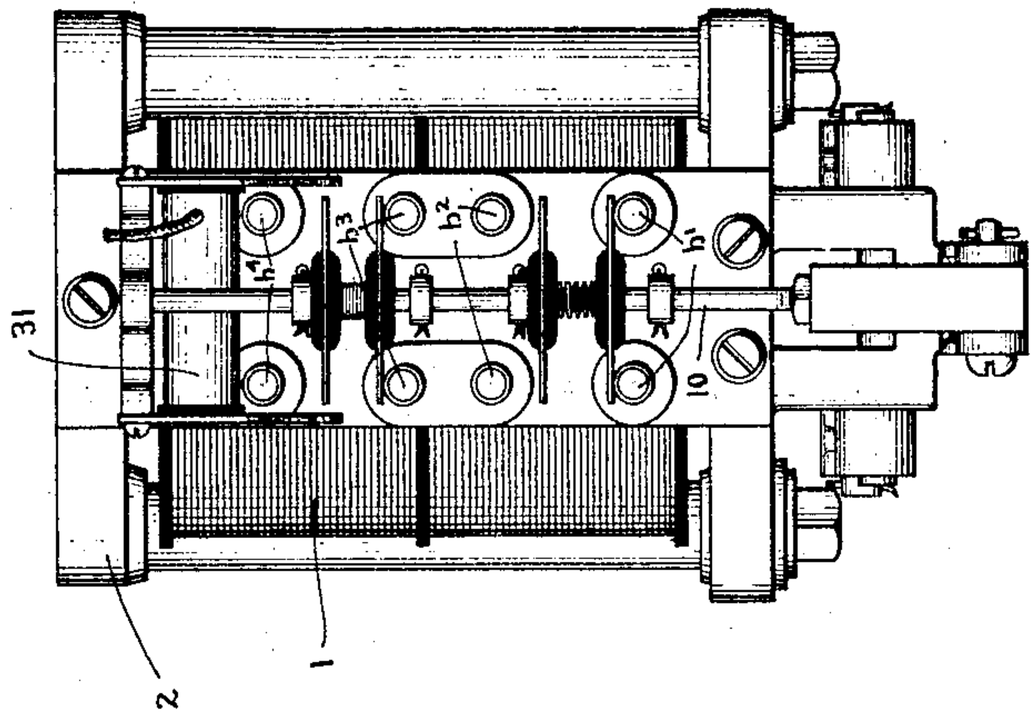
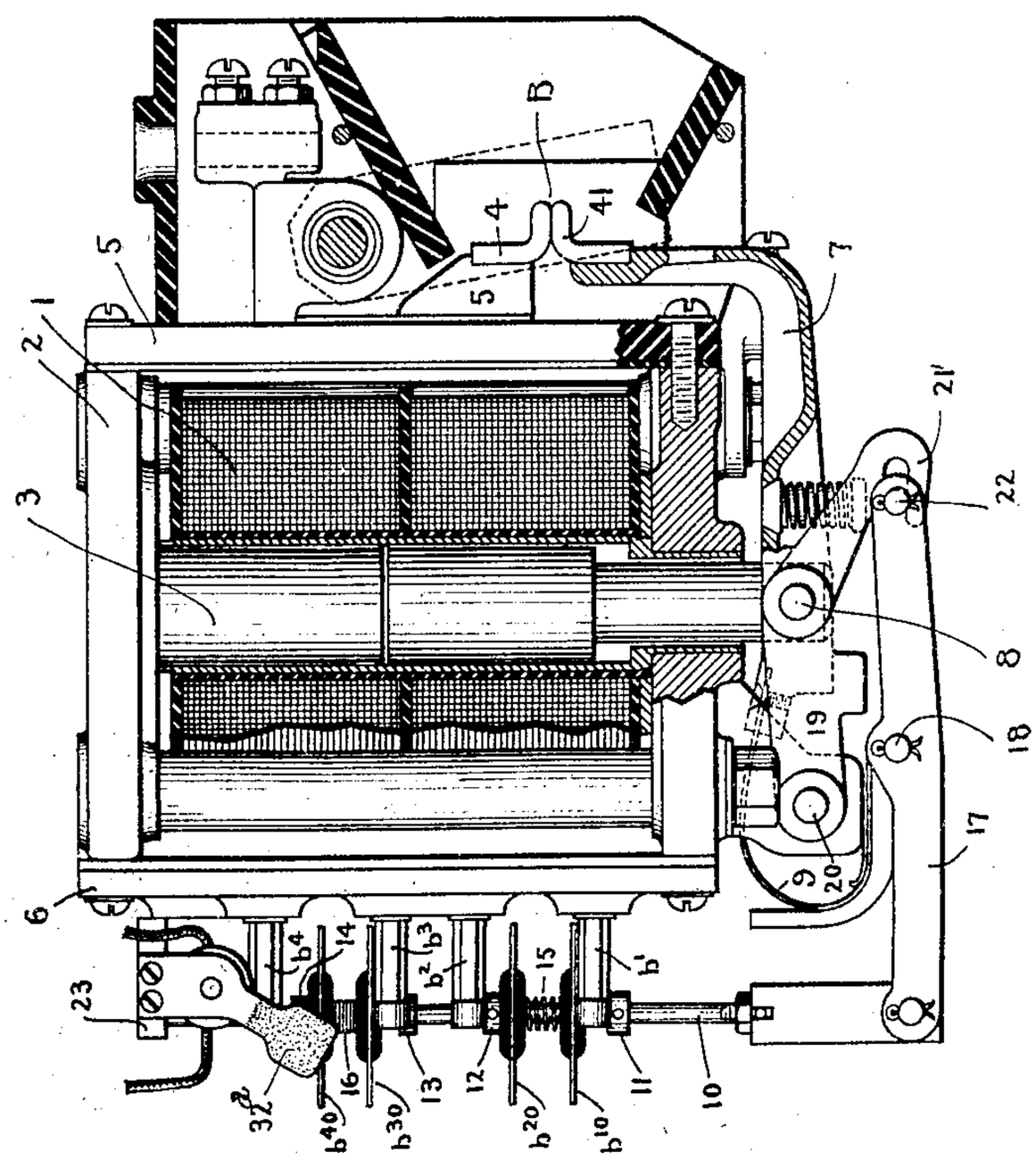



Fig. 9.




Witnesses:

George H. Tilden.

Helen Arfond

Inventor:

George H Hill,

by Albert G. Davis

Att'y.

# UNITED STATES PATENT OFFICE.

GEORGE H. HILL, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## TRAIN-CONTROL SYSTEM.

No. 815,826. Specification of Letters Patent. Patented March 20, 1906.

Application filed August 20, 1904. Serial No. 221,475.

*To all whom it may concern:*

Be it known that I, GEORGE H. HILL, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Train-Control Systems, of which the following is a specification.

The present invention relates to systems of control, and more particularly to systems wherein it is desired to control the operation of the motors of a car or train from any one of several points upon the car or train.

In Patent No. 762,409, granted to me on June 14, 1904, there is disclosed a system of motor control applicable to a train of cars having independent motors and motor-circuits, the control-current being in such case obtained from the source of supply for the particular car upon which the master-controller is located. The resistance adapted for insertion in the motor-circuit is divided into a number of sections each governed by a switch or contact, and the arrangement of circuits is such that when the master-controller is moved to its second series or second parallel position the resistance-governing contacts are operated in automatic succession subject to the throttling effect of the current in the motor-circuit of the particular car to cut out the resistance-section. If during the progression of the resistance-contacts the motor-current passes a predetermined safe maximum, the actuating-circuit for the contacts is opened, preventing any further elimination of resistance until the motor-current drops within safe bounds; but the resistance-contacts which have been already closed are not affected. If, however, there happens to be no current flowing through the motor-circuit and the control-circuit is energized, the entire resistance will be cut out progressively, exactly the same as if the motors were taking their normal current. Such an arrangement has been found to be objectionable under some conditions of operation. For example, in a system in which the motors on each of the separate cars of a train are supplied with current through collector-shoes on that car it is evident that if after the resistance-contacts on the several cars have been actuated in the usual manner to cut out all resistance the collector-shoe or trolley on any one or more of the cars breaks connection with the third rail or with the trolley-wire, as may frequently happen at cross-overs, or if the current to the motors fails from any cause the resistance may remain cut out, and when connection is again made full line potential will be impressed on the motors with no resistance in circuit, rendering the equipment liable to serious damage. A further instance in which damage has resulted by reason of the resistance-contacts being energized with no current flowing through the motors is where a train of cars is run from a siding or barn to the third-rail or trolley tracks, current being supplied by a cable hooked to the trolley or collector-shoe of one car. It is seen that the cable supplies current to the motors of one car and to the control-circuits of all the cars, and when the master-controller is turned to start the motors on the car to which the cable is connected and to cause the automatic progression of the resistance-contacts the resistance will be cut out of the local motor-circuits of all the other cars of the train, so that when their current-collecting devices engage the trolley or third rail, as the case may be, the previously-inactive motors are at once subjected to full line potential.

One of the objects of the present invention is to prevent the occurrence of damage in the manner described by rendering the means for cutting resistance out of a motor-circuit inoperative except when the motor-circuit is energized.

It happens at times in systems of train-control that by reason of local short circuits or other defects on an individual car of the train the return of the master-controller to its off position does not affect the control-circuit of the defective car sufficiently to interrupt the motor-circuit of that car and bring all contacts to their off positions. This of course places the train beyond the control of the motorman and may cause a serious accident by reason of the failure of the train to stop.

A further object of the present invention is to lessen the danger of causing the motorman to lose control by reason of local defects by enabling the motorman to break the control-circuits simultaneously at each car.

In a system of the separately-actuated contact type interlocks must be provided to prevent the progression of the contacts in improper order. It is usual to connect tc

number of the main contacts auxiliary contacts or switches, movable therewith and through which the energizing-circuits for some of the contacts pass.

In one of its aspects the present invention contemplates a novel contactor construction embodying in a single simple and compact structure a main contact and interlocking contacts.

Further objects of the present invention will appear in connection with the following description thereof.

The present invention is illustrated in the accompanying drawings, in which—

Figure 1 represents diagrammatically a motor and control equipment arranged in accordance with the present invention and adapted to form one unit of a train system. Fig. 2 shows a train of two cars equipped in accordance with the present invention. Figs. 3, 4, and 5 are respectively front elevation, side elevation, and plan of the cut-out switch. Fig. 6 is a cross-section taken through a set of contacts on the cut-out switch. Figs. 7 and 8 are views showing details of the cut-out switch. Fig. 9 is a cross-section of my improved main and interlocking contact device; and Fig. 10 is a front elevation thereof, showing the interlocking contacts.

Similar reference characters will be used throughout the drawings and specification to indicate like parts.

Referring to Fig. 1, M′ and M² represent the two motors of a car equipment. C indicates a motor-controller of the separately-actuated contact type, including line-contacts T′, T², T³, and T⁴; resistance-contacts R′ to R⁷, controlling resistances Rᵃ to Rᵍ; a contact S, which connects the motors in series; contacts P and P′, which make the parallel connections for the motors; contact B, which serves to complete a bridge connection about the series contact and the resistances before the series contact is broken in changing from series to parallel, and the throttling and checking relay O, which limits the rate of automatic progression of the resistance-contacts. RS is the reversing-switch for determining the direction in which current passes through the motor-armatures. K K′ are master-controllers at opposite ends of the car, the controller K being shown in developed form. T is the trolley or other source of current-supply. X and X′ are switches arranged in the control and main circuits. 1, 2, 3, 4, and 5 are train-control wires connecting the master-controllers in parallel to the local control-circuits of the several cars of the train, these wires having suitable couplings *f* at their respective ends, whereby connection between cars is made. The parts and arrangement of parts just described may have any desired or usual form, since they themselves form no part of the present invention except as will be hereinafter pointed out.

One of the features of the present invention resides in the relay Q, which is controlled by current in the motor-circuit and which in turn controls the actuating and maintaining circuits of the resistance-controlling contacts, the arrangement being such that when no current flows in the motor-circuit the resistance-controlling circuits are interrupted at their relay; but when the motor-circuit is energized current will flow through the coil of the relay, causing it to complete the actuating and maintaining circuits of the resistance-contacts. It is thought that the operation of this relay will be more fully understood in connection with a description of the entire system as outlined above.

Assuming that the main switch X′ and the switch X adjacent controller K are closed and that the controller K is moved so as to bring its contacts into engagement with the row of fixed contacts 1ᵃ to 5ᵃ along the dotted line *a a*, current will flow from T through switches X′ X, blow-out coil *k*, fixed contact 3ᵇ and the movable contacts of the controller to contacts 3ᶜ and 2ᵇ, and from thence through the movable contacts of the controller to contacts 2ᵃ and 4ᵃ. From contact 4ᵃ a circuit may be traced through train-wire 4, wire 40, and cut-out switch U, to be hereinafter described, to coil *w* of the reversing-switch, and if the reversing-switch is in a position other than its forward position current will pass from the magnet *w*, through finger $w^2$, finger $w^3$, upper contact of interlock *t′*, to ground. Electromagnet *w* is thereupon energized, throwing the switch to the position shown, whereupon the exciting-circuit of the magnet is broken at finger $w^3$ and a new circuit is established through finger $w^4$ and the actuating-coils of contacts T′, T², T³, and T⁴, to ground, thereby closing contacts T′ to T⁴. A second circuit may be traced from contact 2ᵃ of the master-controller through train-wire 2, wire 20, the cut-out switch U, the upper contact of interlock *p′*, the actuating-coil of contact S, lower contacts of interlock *t′*, which are now closed, through contacts $b^4$, upper contacts of interlock *r′*, upper contacts of interlock $r^2$, upper contacts of interlock $r^3$, upper contacts of interlock $r^4$, to ground, thereby energizing coil of contact S and completing the motor-circuit as follows: from trolley T, through switch X′, contacts T′ and T², contact T³, throttling-coil *o* of relay O, contact *v* of the reversing-switch, armature of motor M′, contact *v′* of the reversing-switch, field of motor M′, resistance-sections Rᵈ Rᶜ Rᵇ Rᵃ, contact S, resistance-sections Rᵍ Rᶠ Rᵉ, contact T⁴, contact $v^2$ and $v^3$ of the reversing-switch, armature of motor M², contact $v^4$ of the reversing-switch, field of motor M², to ground. The motors are therefore

connected across the line in series and in series with all resistance.

Upon moving the controller to its second position—namely, to that in which line *b b* coincides with the line of fixed contacts—a further circuit is completed through contact $1^a$, train-wire 1, wire 10, cut-out switch U to the contacts controlled by the relay O, thence through checking-coil *o'*, the lower contact of interlock *s*, the upper contact of interlock $r^{10}$, contact *q*, actuating-coil of contact *r'*, upper contacts of interlocks $r^2$ $r^3$ $r^4$, to ground. From the circuit connections above traced it will be apparent that if no current is flowing through the motor-circuit and the control-circuits are energized from a separate source of current-supply main contacts T' to $T^4$ and contact S will be closed and that if relay Q were not interposed the resistance-sections would be automatically and progressively cut out of circuit in the manner described in my patent above referred to. The energizing-circuit for the resistance-contacts, however, passes through contact *q* of the relay Q, so that it is impossible to operate the resistance-controlling contacts unless the contact *q* is closed. As illustrated in the drawings, the actuating-coil of relay Q is connected to the motor-circuit at a point between the line-contacts T' and $T^2$ and to the ground. As soon, therefore, as line-contacts T' and $T^2$ are closed current is free to flow from trolley through the line-contacts directly to the coil of relay Q to the ground, energizing the coil and closing contact *q;* but if the trolley on the car in question is receiving no current the relay will not be energized, and therefore the energizing-circuit for the resistance-contacts will remain broken, thereby preventing the cutting out of resistance from the motor-circuit when the motor-circuit is inactive. The further operation of the system on any car on which the trolley is energized is as follows: The completion of the circuit last traced through the actuating-coil of the contact R' causes this contact to be actuated, cutting out resistance-section $R^a$. The current in passing through coil *o'* energizes it and breaks the actuating-circuit of the coil, which operates contact R'. A second circuit has, however, been established before the complete closing of contact R'—namely, the circuit passing through the actuating-coil of contact S is broken at the upper contact of interlock *r'* and is reëstablished through the lower contacts of this same interlock, contact *q*, through the actuating-coil of contact R', upper contacts of interlocks $r^2$ $r^3$ $r^4$, to ground. This latter circuit is the maintaining-circuit for contact R' and also for the remaining resistance-contacts. This circuit, it will be seen, also passes through contacts *q* of relay Q, so that not only is it impossible to actuate the resistance-contacts when no current is flowing in the motor-circuit, but it is also impossible to maintain in closed position the resistance-contacts which have been previously operated, thereby providing an effective safeguard against cutting out any or all resistance from the motor-circuit except when the motors are actually being accelerated.

The relay O is actuated with each of the resistance-controlling contacts and in case the current in the motor-circuit rises above a predetermined maximum is maintained in its open-circuit position until the current drops to its normal value, as explained in my prior application, Serial No. 175,176, filed September 30, 1903. When relay O again closes, a circuit is established as before through the lower contact of interlock *s;* but now instead of passing through the upper contact of interlock $r^{10}$ the current passes through the lower contact of the interlock, then through the upper contact of interlock $r^{20}$, actuating-coil of contact $R^2$, actuating-coil of contact $R^5$, upper contacts of interlocks $r^3$ $r^4$, to ground. Contacts $R^2$ and $R^5$ are thus closed, cutting out additional resistance-sections $R^b$ and $R^e$. As in the case of contact R' closing of contact $R^2$ breaks the actuating-circuit at the upper contacts of interlock $r^{20}$ and establishes a maintaining-circuit at the lower contact of interlock $r^2$, this being the maintaining-circuit for contact R', which now instead of passing through interlocks to the ground passes through actuating-coil of contact $R^2$, actuating-coil of contact $R^5$, upper contact of interlock $r^3$, upper contact of interlock $r^4$, to ground, thereby maintaining contacts $R^2$ and $R^5$ closed. In this same manner (subject to the checking action of coil *o'* and the throttling action of coil *o*) resistance-sections $R^c$ and $R^f$ and $R^d$ and $R^g$ are progressively cut out.

It will be seen that when the contact $R^4$ is closed an actuating-circuit similar to the actuating-circuits for the resistance-contacts is established at the lower contacts of interlock $r^{40}$, through interlock $b^2$, actuating-coil of contact B, interlock $p^2$, to ground, thereby closing contact B. As we have seen, the energizing-circuit for the series contact S and the maintaining-circuit for the resistance-contacts passes through interlock $b^4$, and therefore upon the closing of contact B the coils of the series and resistance-contacts will be deënergized, permitting these contacts to open. The prior closing of contact B has, however, established a complete circuit between the motors and around the resistance-sections, so that the motor-current is not interrupted nor is the resistance reinserted during this operation.

Upon moving the controller to its third position—namely, that in which the line *c c* registers with the line of fixed contacts—a further circuit may be traced through contact $3^a$ to train-wire 3, wire 30, cut-out switch U, up-

per contacts of interlock *s*, actuating-coil of contact P′, actuating-coil of contact P, contact $b^3$, upper contacts of interlocks $r'$ $r^2$ $r^3$ $r^4$, to ground. Contacts P and P′ are therefore closed, connecting the motors in parallel. The closing of contact $p'$ breaks the circuit of the bridging-coil at contact $p^2$, thereby causing contact B to open and removing the bridge about the resistance. The opening of contact B breaks the actuating-circuit for the parallel contacts at $b^3$; but previously—namely, upon the closing of contact B—a shunt is established about the contact $b^3$ by means of the auxiliary contact *p*. The motor-circuit when the controller is in its third position is as follows: trolley T, switch X′, line-contacts T′ and $T^2$, contact $T^3$, throttle-coil *o*, contact *v* of reversing-switch, armature of motor M′, contact *v*′, field of motor M′, resistance-sections $R^d$ to $R^a$, contact P′, to ground. A further circuit is established from contacts T′ and $T^2$ to contact P, resistance-sections $R^g$ to $R^e$, contact $T^4$, reverser-contacts $v^2$ and $v^3$, armature of motor $M^2$, contact $v^4$, field of motor $M^2$, to ground.

On moving controller K to its final position—namely, that in which the line *d d* coincides with the line of fixed contacts—the actuating-circuit for the resistance-contacts will again be established at contact $1^a$ and automatic progression of the resistance-contacts takes place as before, contact R′ being closed first and then contacts $R^2$ and $R^5$, $R^3$ and $R^6$, $R^4$ and $R^7$, as before, until finally the motors remain connected in parallel with no resistance in circuit. During this latter progression of the resistance-contacts the circuits, as before, pass through the contact *q* of the relay Q, which must be energized before the resistance-contacts can be closed or held closed.

For reverse movements of the car or train the controller is provided with but two running positions *a*′ and *b*′. In order to reverse, the controller is first moved so that the line *a*′ *a*′ coincides with the fixed contacts. Instead of contact $4^a$ being energized as before contact $5^a$ will be first energized, and a circuit will pass from this contact to train-wire 5, wire 50, to cut-out switch U, to magnet *w*′ of the reversing-switch, throwing the reversing-switch in the opposite direction and reversing the direction in which the current passes through the armature of the motors. Otherwise the circuits in the first and also in the second running position for reverse movement are the same as the corresponding circuits during the forward movement of the train.

Another feature of the present invention resides in the cut-out U, which is arranged between the motor-controller and reversing-switch and the train-wires. This switch consists of a cylinder provided with a series of fixed contacts *u*, adapted to engage with corresponding members of two series of fixed contacts *u*′ $u^2$. The parts are so arranged that when the contacts *u* are in engagement with the contacts *u*′ and $u^2$, as illustrated in Fig. 1, the controller connections between the train-wires and the controllers C and RS are completed; but upon moving the cylinder through a predetermined angle the contacts are disengaged from each other and the local control-circuits are disconnected from the train-wires and the master-controller. A spring 16 is placed under tension when the cut-out cylinder is in the position illustrated; but the cylinder is held against rotation by means of a stop U′, which engages an arm $U^2$, projecting from the cylinder-shaft. This stop forms part of or is actuated by the core of an electromagnet $U^3$, which when energized releases the cylinder and permits the spring 16 to return it to its off position. In order that the cut-out switches of all the cars may be actuated simultaneously, I have provided an additional train-wire 6, which is connected to the upper contact $u^2$ of the cut-out switch by means of the wire 60. The corresponding contact *u*′ is connected to one terminal of the coil of the electromagnet $U^3$, the other terminal of which is grounded.

It is apparent that when wire 6 is energized, whether intentionally or by reason of the grounding of the control-wires or from other cause, the electromagnet $U^3$ will be energized, causing the several cut-out switches to be thrown and isolating the control-circuits of each car. Manually-operated switches $U^4$ are placed near the master-controllers and serve to connect the train-wire to the trolley. The motorman may at any time, therefore, cut out the control-circuits of all the cars of the train by simply closing the local switch $U^4$. Any suitable means may be provided for returning the switches to their operative positions, or they may be returned manually.

A preferred form of cut-out switch U is illustrated in detail in Figs. 3 to 8. It consists of a slab of insulation 11, having secured thereto end plates 12 and 13, which form bearings for the shaft 14 of cylinder 15. On the cylinder 15 are mounted the contacts *u*, which are adapted to engage with the fixed contacts *u*′ and $u^2$, and in order to provide suitable insulation between the series of contacts the cylinder 15 may be made of insulating material within which the contacts *u* are embedded. Suitable insulation is provided for the fixed contacts by mounting them upon the slab 11. $u^4$ and $u^3$ are terminals for receiving, respectively, the end of wires 10, 20, 30, 40, 50, and 60 and the connections to the local control-circuits and the tripping-magnet. The parts are illustrated in their off position in Figs. 3 to 7, namely, with the contacts broken. A spring 16, housed in a cap 17, fastened to or forming part of the shaft 14, is secured at one end to said cap, as shown in dotted lines at 18 in Fig.

4, and at its other end engages with end plate 12 at 19. When the cylinder is turned from its off position, the spring 16 is placed under tension, and when free to do so returns the cylinder to the off position. Secured to the upper end of shaft 14 is an arm 21, having a shoulder 22 near its outer end, said shoulder extending radially along the arm. A catch 23 is pivoted upon the end plate 12 in such position that when the arm 21 is turned until the catch 23 drops behind the shoulder 22 the switch is in its circuit-closing position and is so held against the tension of the spring by means of the catch. The electromagnet 24, whose circuit is closed through the upper set of contacts, is mounted within a suitable bracket 25 adjacent the catch 23 and has a pin 26 extending from its core 27 through an elongated slot 28 in the catch. Upon energizing the coil of magnet 24 the catch is tripped, releasing the cylinder and permitting the spring to throw it quickly to its off position, interrupting the control-circuits and the tripping-magnet circuit. A spring 29 surrounds the core of the magnet, preventing the catch from being jarred out of position. A thumb-lever 31 on the arm 21 enables the operator to return the cut-out cylinder to its operative position after it has been tripped. The catch 23 is provided with an arm 32, whereby it may be tripped manually in order to cut out a single car without affecting the others.

In Figs. 9 and 10 I have shown in detail a main contact and its interlocks, the particular contact represented being the bridging contact B. As we have seen, the circuit of the actuating-coil of the series contact is broken at $b^4$ when the bridging contact is closed. Since the object of the bridging contact is to prevent the interruption of the motor-circuits during the change in the motor connections from series to parallel, it is imperative that the series contact be not opened until the bridging contact has been fully closed. Also the actuating-circuit of contact B is broken at $b^2$ when the contact is closed, and it is necessary that the actuating-circuit of the bridging contact shall not be broken before contact is completed in order that the weaker maintaining-current need only operate to maintain the contact in its closed position. Furthermore, the maintaining-circuit must be completed at $b'$ before the actuating-circuit is broken at $b^2$. The mechanism illustrated provides in a simple and compact construction, easily inspected and repaired, means for accomplishing the above results. This same construction serves equally well for the other main contacts having interlocking contacts subject to such changes as will be obvious from the diagrammatic contact arrangements shown in Fig. 1. 1 is the coil of the electromagnet, suitably supported within a frame 2 and provided with a core 3. The fixed member 4 of the contact B is mounted upon an insulating-support 5, secured to the frame at one side of the electromagnet. On the opposite side of the magnet and mounted on a similar support 6 are the fixed contacts $b'$, $b^2$, $b^3$, and $b^4$, projecting laterally from the support. The movable member 41 of contact B is carried by one end of an arm 7, pivoted to the core 3 at 8 and supported at its other end by a curved leaf-spring 9. As the core moves upwardly or downwardly contact B is respectively closed or opened. The movable contact members $b^{10}$, $b^{20}$, $b^{30}$, and $b^{40}$ consist of disks of copper or other good conducting material provided with hubs of insulating material molded thereon. These disks are assembled upon a rod 10, which passes loosely through the hubs of the disks. Collars 11, 12, 13, and 14 on this shaft serve as stops for limiting the movement of the disks away from each other. A coiled spring 15 surrounds the shaft 10 and bears against the hub of disks $b^{10}$ and $b^{20}$, respectively, normally holding them against the stops 11 and 12, but permitting them to move toward each other and enabling them to move slightly out of parallelism to each other, as occasion may require. The lower end of rod or shaft 10 is secured to one end of a lever 17, pivoted at 18 by means of a double hinge-joint, and the other end thereof passes through a guide-bearing in a bracket 23. A second lever 19, pivotally secured to the core 3 at 8 and to the frame 2 at 20, is provided with a hook 21, engaging with a pin carried by lever 17. Consequently the movements of the core are transmitted to shaft 10, but reversed in direction. In the positions of the parts illustrated the contact B is closed, and similarly contact $b'$ in the maintaining-circuit of coil 1 and contact $b^3$ in the actuating-circuit of the parallel contacts are also closed, while contacts $b^2$ and $b^4$ in the actuating-circuits of coil 1 and the series coil, respectively, are open. The circuit of the series coil, and which is broken at contacts $b^4$, operates on full potential, and in order to disrupt any arcs which may be formed at these contacts I arrange a blow-out coil adjacent thereto and provide deflecting-plates $32^a$, whereby any incipient arc is blown outwardly and away from adjacent contactors.

The operation of the switch is as follows: Assume contact B open and contacts $b^3$ and $b^4$ closed. The actuating-circuit of coil 1 passing through contact $b^2$ energizes this coil and causes the core 3 to be drawn up. Contact B is thereby closed, but somewhat before the core reaches the limit of its movement, due to the manner in which arm 7 is supported. Also, by reason of the springs 15 and 16, the opening of contacts $b^4$ and $b^2$ is delayed until contact B is closed and until the contacts $b'$ and $b^3$ are likewise closed; but the

final movement of the core brings the collars 12 and 14 into engagement with disks $b^{20}$ and $b^{40}$ and moves them away from their respective fixed contacts, at the same time compressing the springs 15 and 16, as illustrated. This operation permits the actuating-circuit of contact B to remain effective until after contact B is completely made and the maintaining-circuit therefor established through contact $b'$. Furthermore, the circuit of the series coils is not broken at $b^4$ until after contact B is closed. Upon deënergizing coil 1, by reason of energizing the parallel contacts, and thereby breaking the maintaining-circuit of coil 1, breaking of contact at $b^3$ is similarly delayed until contact B is fully opened, giving sufficient time for the parallel contacts to become closed and establish their maintaining-circuit before the actuating-circuit therefor is broken at $b^3$.

While I have described specific embodiments of the several features of my invention in detail in order to clearly explain the principles and modes of operation of the various features, I do not desire to limit the present invention to the particular details illustrated further than is indicated in the appended claims, for in the broader aspects the present invention may be embodied in various forms.

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

1. In a system of train control, a train wire or wires, a control-circuit on each of a plurality of cars normally connected to said train wire or wires, and means controlled from a single point upon the train for simultaneously breaking the connection between said train wire or wires and said circuits.

2. In a system of train control, a train wire or wires, a control-circuit on each of a plurality of cars, a master-controller for energizing said train wire or wires and said circuits, and means for simultaneously interrupting the connections between said train wire or wires and said circuits.

3. In a system of train control, a train wire or wires, a control-circuit on each of a plurality of cars, a master-controller for connecting said train wire or wires and said circuits to a source of current-supply, and means controlled from a single point on the train for simultaneously interrupting the connections between said train wire or wires and said circuits.

4. In a system of train control, a train wire or wires, a control-circuit on each of a plurality of cars normally connected to said train-wire, a master-controller for energizing said train wire or wires and said circuits, and means controlled from a single point on the train for disconnecting said circuits from said train wire or wires.

5. In a system of motor control, a plurality of motors or groups of motors, a control-circuit for each of said motors, or groups of motors, a master-controller, electrical connections between said master-controller and each of said control-circuits, and means independent of the master-controller for simultaneously interrupting the connections between said master-controller and said control-circuits.

6. In a system of train control, a train wire or wires, a control-circuit on each of a plurality of cars, a master-controller, a switch between each control-circuit and said train wire or wires, and means for simultaneously opening all of said switches.

7. In a system of train control, a train wire or wires, a control-circuit upon each of a plurality of cars, a master-controller, an electromagnetic switch between each of said control-circuits and said train wire or wires, and means located at a single point on the train for energizing said switches.

8. In a system of train control, a train wire or wires, a control-circuit upon each of a plurality of cars and connected to said train wire or wires, a master-controller for energizing and deënergizing said train wire or wires and said control-circuits, and additional means for simultaneously deënergizing said control-circuits.

9. In a system of train control, a train wire or wires, a control-circuit upon each of a plurality of cars and connected to said wire or wires, a master-controller for energizing and deënergizing said control-circuits, and additional means controlled from a single point to the train for deënergizing said control-circuits.

10. In a system of control, a plurality of motors or groups of motors, motor-controlling devices for each of said motors or groups of motors, a master controlling device, and means for rendering said master controlling device inoperative as to said motor-controlling devices whenever the corresponding motors or groups of motors are deënergized.

11. In a system of control, a plurality of motors or groups of motors, independent circuits for said motors, local controlling devices for said motors or groups of motors, a source of current-supply, a master-controller for connecting said controlling devices to said source of current-supply, and means for rendering said controlling devices inoperative whenever the corresponding motor-circuits are deënergized.

12. In a system of motor control, a plurality of motors or groups of motors and circuits therefor, a speed-controlling device for each of said motors or groups of motors, a master-controller, controlling-circuits for said speed-controlling devices connected in parallel to said master-controller, and means for rendering said controlling-circuits inop-

erative whenever the corresponding motor-circuit is interrupted.

13. In a system of motor control, a source of current-supply, a motor-circuit connected thereto, a speed-controlling device for said motor, a control-circuit for said speed-controlling device, and means for rendering said control-circuit inoperative whenever said motor-circuit is deënergized.

14. In a system of motor control, a plurality of motors or groups of motors, separate speed-controlling devices therefor, separate control-circuits for said speed-controlling devices, a master-controller, and means for interrupting said control-circuits whenever the corresponding motor-circuits are interrupted.

15. In a system of control, a plurality of motors or groups of motors, a speed-controlling device for each motor or group of motors, actuating-circuits for said speed-controlling devices, a source of current-supply, a master-controller for connecting said actuating-circuits to said source of current-supply, and means for interrupting said actuating-circuits whenever the corresponding motors or groups of motors are deënergized.

16. In a system of control, a plurality of motors or groups of motors, a speed-controlling device for each motor or group of motors, maintaining-circuits for said speed-controlling devices, a source of current-supply, a master-controller for connecting said maintaining-circuits to said source of current-supply, and means for interrupting said maintaining-circuits whenever the corresponding motors or groups of motors are deënergized.

17. In a system of control, a plurality of motors or groups of motors, a speed-controlling device for each motor or group of motors, actuating and maintaining circuits for said speed-controlling devices, a source of current-supply, a master-controller for connecting said actuating and maintaining circuits to said source of current-supply, and means for interrupting said actuating and maintaining circuits whenever the corresponding motors or groups of motors are deënergized.

18. In a system of control, a plurality of motors or groups of motors, speed-controlling devices for each of said motors or groups of motors, normally open switches governing said speed-controlling devices, actuating-circuits for said switches, a master-controller for connecting said actuating-circuits to a source of current-supply, and a switch in each of said actuating-circuits arranged to be closed by current in the corresponding motor or group of motors.

19. In a system of control, a plurality of motors or groups of motors, speed-controlling devices for each of said motors or groups of motors, normally open switches governing said speed-controlling devices, maintaining-circuits for said switches, a master-controller for connecting said maintaining-circuits to a source of current-supply, and a switch in each of said actuating-circuits arranged to be closed by current in the corresponding motor or group of motors.

20. In a system of motor control, a plurality of motors or groups of motors, and circuits therefor, a resistance for one of said motors or groups of motors, a controlling-circuit for said resistance, and means for rendering said controlling-circuit inoperative whenever the corresponding motor-circuit is interrupted.

21. In a system of motor control, a source of current-supply, a motor-circuit connected thereto, a resistance for said motor, a control-circuit for said resistance, and means for rendering said control-circuit inoperative whenever said motor-circuit is deënergized.

22. In a system of motor control, a plurality of motors or groups of motors, separate resistances therefor, separate control-circuits for eliminating said resistance from the respective motor-circuits, a master-controller, and means for interrupting the control-circuits when the corresponding motor-circuits are interrupted.

23. In a system of motor control, a plurality of motors or groups of motors, a resistance for each motor or groups of motors, a control-circuit for each of said resistances, separate circuit connections between the source of current-supply and each motor or groups of motors, and means for interrupting the said control-circuits when the corresponding circuit connections to the source of current-supply are interrupted.

24. In a system of motor control, a motor-circuit, a source of current-supply, a resistance for said motor-circuit, a control-circuit for said resistance, and means for rendering said control-circuit inoperative whenever the current in the motor-circuit is interrupted.

25. In a system of motor control, a plurality of motors or groups of motors, a separate connection to the source of current-supply for each motor or groups of motors, resistances for said motors, independent control-circuits for each of said resistances, a master-controller for controlling the supply of current to said control-circuits, and means operative upon the interruption of current to any one of said motors or groups of motors for rendering the corresponding control-circuit inoperative.

26. In a system of motor control, a motor-circuit, a series of resistance-sections together with a series of contacts for introducing the resistance-sections in and eliminating them from the motor-circuit, a control-circuit including means for causing automatic progression of said resistance-governing contacts,

and means for rendering said control-circuits inoperative when no current is flowing in the motor-circuit.

27. In a system of motor control, a motor-circuit, a resistance, a control-circuit for cutting said resistance out of the motor-circuit, a source of current-supply, and means for interrupting the control-circuit when said source of current-supply is deënergized.

28. In a system of motor control, a motor or groups of motors on each of a plurality of cars, resistances for each motor or groups of motors, a motor-controller on each car including controlling-circuits for connecting the motors of that car to the corresponding current-collecting device and for varying the amount of resistance in the motor-circuit, a normally open switch in each resistance-controlling circuit for rendering it inoperative, and means controlled by the respective motor-currents for closing said switches.

29. In a system of train control, a motor or groups of motors on each of a plurality of cars, resistances for said motors, local control-circuits on each car including circuits for connecting the motor or motors of each car to the corresponding current-collecting device and control-circuits for said resistances, train-lines connecting the several control-circuits, a master-controller for controlling the supply of current to said train-lines, and means controlled by the motor-currents for rendering corresponding resistance-control circuits operative.

30. An electromagnetic switch, comprising an electromagnet, fixed contact members arranged on opposite sides and between the ends thereof, coöperating movable contact members, and operative connections between said movable contact members and the core of the electromagnet, one of said connections including a resilient section, whereby the opening of one of said contacts is delayed.

31. An electromagnetic switch comprising an electromagnet, fixed contacts arranged on opposite sides and between the ends thereof, coöperating movable contact members on one side of the electromagnet arranged in pairs, and operative connections between said movable contact members and the core of the electromagnet including resilient spacing devices within each pair of movable contact members.

32. A contact member comprising a rod, a plurality of contacts arranged in pairs loosely mounted thereon, and insulated therefrom, stops for limiting the separating movement of the contacts of each pair, and a spring between the contacts of each pair for holding them against said stops.

33. A contact member comprising a rod, a pair of metallic disks provided with hubs of insulating material, said rod passing loosely through the hub of the disks, stops on the rod for limiting the movement of the disks away from each other, and a spring between the hubs of the disks, whereby the disks are normally held in parallelism against said stops but are enabled to move out of parallelism and toward each other.

34. An electromagnetic switch comprising an electromagnet, fixed main and auxiliary contact members, a movable contact member carried by the core of the electromagnet, a rod upon which are yieldingly mounted a series of contacts arranged in pairs and adapted to coöperate with said fixed auxiliary contact members, a pivotally-supported lever connected to the core of the electromagnet, and an operative connection between said lever and said rod.

35. An electromagnetic switch comprising an electromagnet, a main contact member operatively connected to the core thereof, an auxiliary contact member comprising a rod, a plurality of contacts arranged in pairs loosely mounted thereon and insulated therefrom, together with means for yieldingly positioning the contacts upon said rod, an operative connection between said rod and the core of the electromagnet, and fixed main and auxiliary contact members.

36. An electromagnetic switch comprising an electromagnet, a main contact member operatively connected therewith, an auxiliary contact member comprising a rod, a plurality of contacts yieldingly mounted thereon and insulated therefrom, a lever pivoted to said electromagnet, an operative connection between said lever and said rod, and fixed main and auxiliary contact members.

37. An electromagnetic switch, comprising an electromagnet, a movable main contact yieldingly supported and pivoted to said electromagnet, an auxiliary movable contact member comprising a rod, a series of contacts yieldingly mounted thereon and insulated therefrom, a pivoted lever pivotally connected to said electromagnet, an operative connection between said lever and said rod, and fixed main and movable contact members.

38. An electromagnetic switch comprising an electromagnet, a movable main contact member operatively related thereto, a movable auxiliary contact member comprising a rod, a series of contacts yieldingly mounted thereon and insulated therefrom, an operative connection between said rod and said electromagnet, and fixed main and auxiliary contact members, the arrangement of the parts being such that the opening of some of auxiliary contacts is delayed until after the main contact has been opened.

39. An electromagnetic switch comprising an electromagnet, a movable main contact member operatively related thereto, an auxiliary movable contact member comprising a rod, a series of contacts yieldingly mounted

thereon and insulated therefrom, an operative connection between said rod and electromagnet, and fixed main and auxiliary contact members, the arrangement of parts being such that certain of said auxiliary contacts are closed previously to the opening of certain other contacts.

In witness whereof I have hereunto set my hand this 19th day of August, 1904.

GEORGE H. HILL.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.