No. 762,509. PATENTED JUNE 14, 1904.

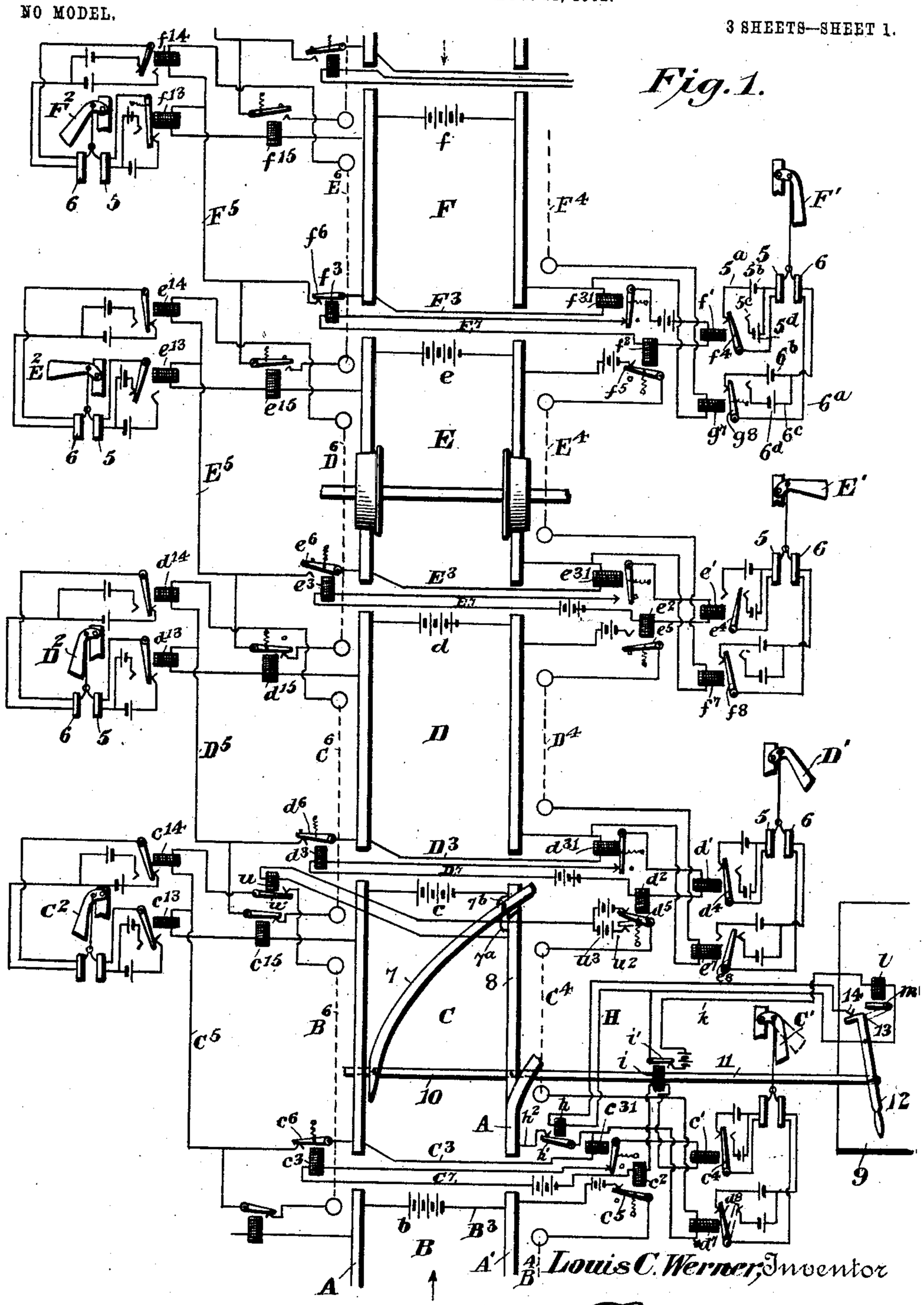
L. C. WERNER.

ELECTRIC BLOCK SIGNAL SYSTEM.

APPLICATION FILED AUG. 14, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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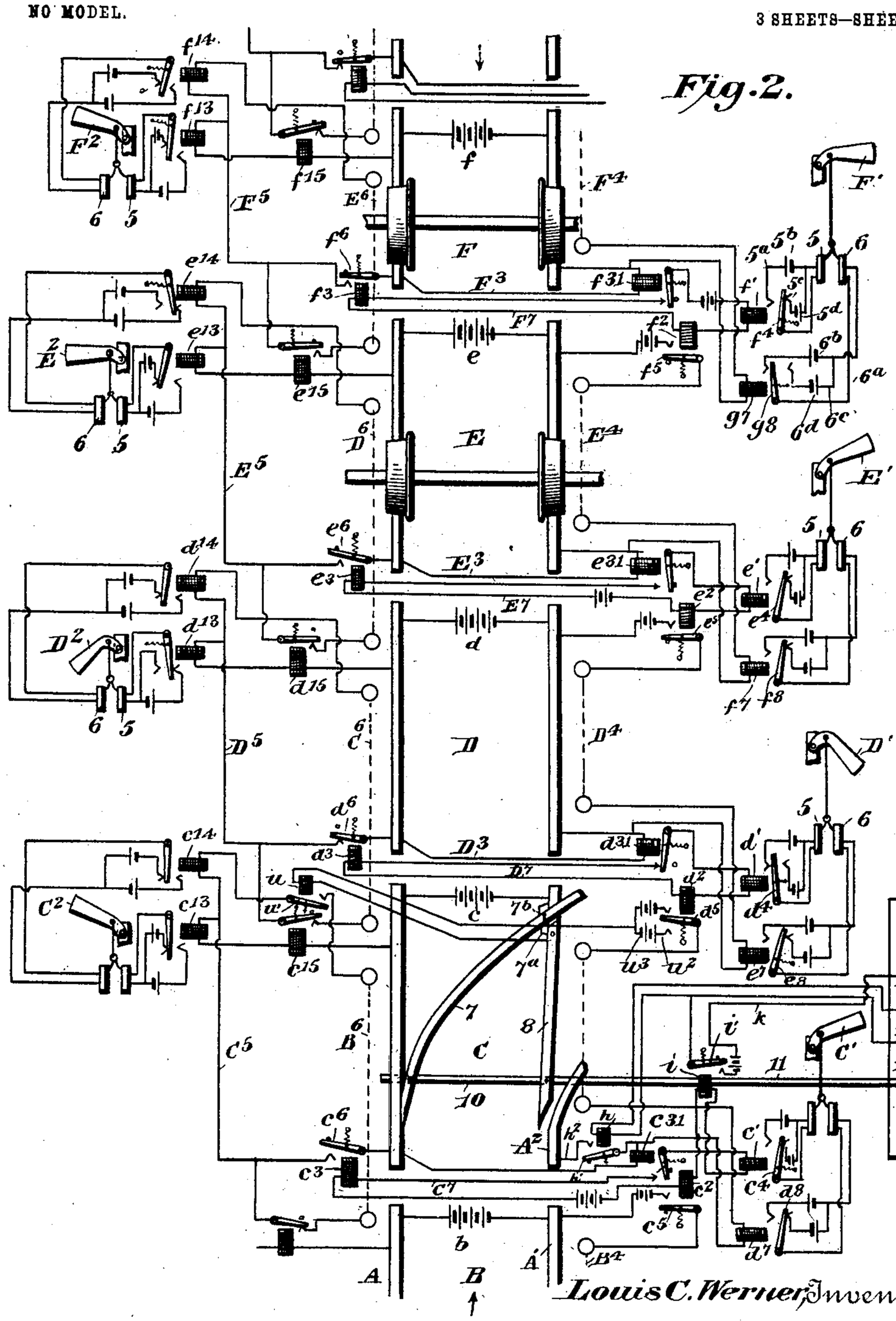
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

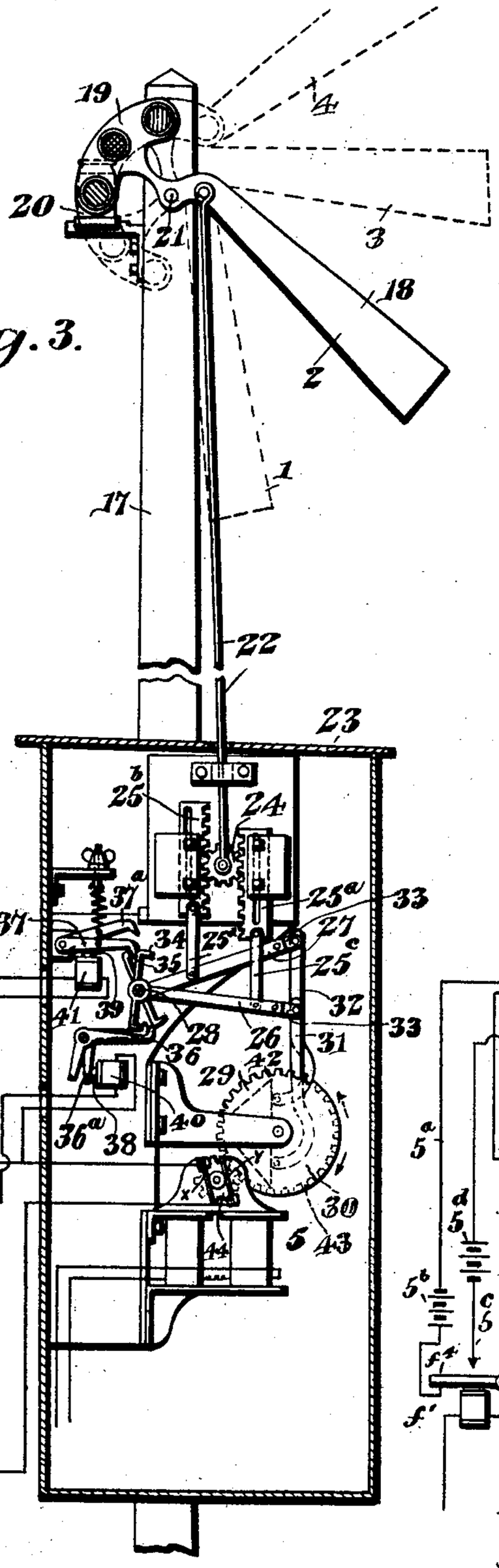
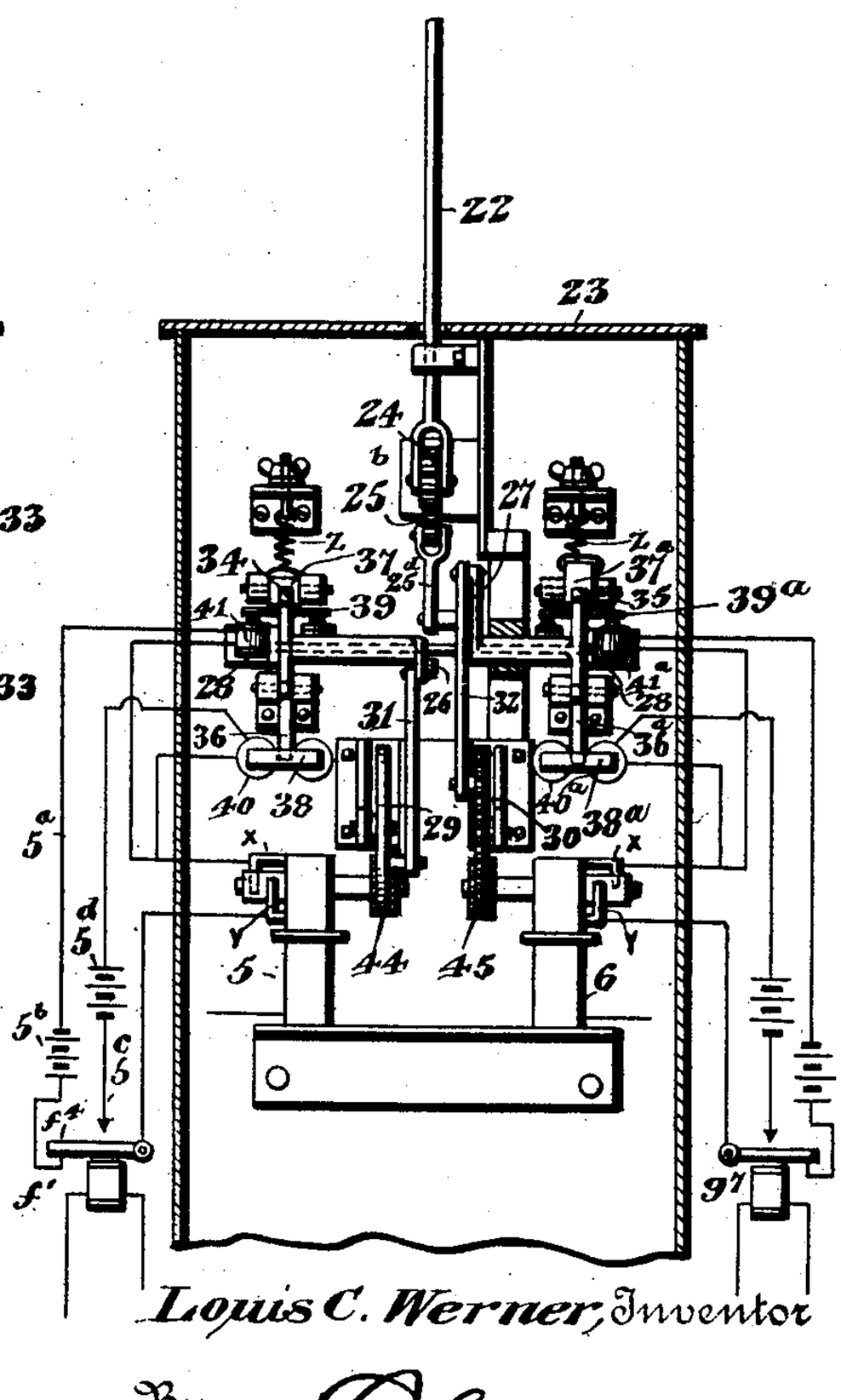


Fig. 4.



Witnesses
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No. 762,509. Patented June 14, 1904.

UNITED STATES PATENT OFFICE.

LOUIS CHARLES WERNER, OF DRYDEN, NEW YORK.

ELECTRIC BLOCK-SIGNAL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 762,509, dated June 14, 1904.

Original application filed December 12, 1901, Serial No. 85,595. Divided and this application filed August 14, 1902. Serial No. 119,669. (No model.)

To all whom it may concern:

Be it known that I, LOUIS CHARLES WERNER, a citizen of the United States, residing at Dryden, in the county of Tompkins and State of New York, have invented a new and useful Electric Block-Signal System, of which the following is a specification.

My present invention relates to a novel block-signal system for railways having one or more main tracks, but is particularly applicable for single-track railways, and is designed with special reference to the automatic display of signals at opposite sides of a single track over which trains are passed in both directions.

The object of the invention is to provide for the automatic display of four signals whenever a block is occupied by a train, two of these signals being located at the opposite ends of the block and at the opposite sides of the track and the other two signals being located one block removed from the block thus occupied and at opposite sides of the track. The effect of this arrangement is to apprise the engineer approaching from either direction of the presence of a train upon a block beyond that which he is about to enter.

A further object of the invention is to provide for the changing of certain of these signals and for the display of certain additional signals when a second train passes into the block adjacent to the one already occupied, and a still further object contemplates the display of extreme-danger signals at any block in which either a switch or drawbridge is located when the switch or drawbridge is open, and in this connection I have also devised special apparatus for automatically locking the switch in the closed position when the block is occupied in order to absolutely preclude the possibility of derailment either by the accidental or designed actuation of the switch-operating mechanism while the train is in the block.

Subordinate to these general objects are many others which will hereinafter more fully appear and to the accomplishment of which the system is arranged and the apparatus constructed in the manner to be fully described, illustrated in the accompanying drawings, and succinctly defined in the appended claims.

In said drawings, Figure 1 is a diagrammatic view illustrating my system with certain of the semaphores positioned by the presence of a train in a block, and Fig. 2 is a similar view showing the semaphores positioned by the presence of trains in adjacent blocks and also showing the semaphores opposite a switch-block moved to the position of "extreme danger" by the opening of the switch. Fig. 3 is a sectional elevation of one of the signals or semaphores and its operating mechanism, the electrical connections being shown in diagram and certain positions of the semaphore-arm being indicated in dotted lines. Fig. 4 is another view of the operating mechanism shown in Fig. 3, but viewed from another direction.

A and A′ indicate the rails of a single-track railway divided into blocks B C D E F, &c., the rail-sections included in each block being electrically disconnected from the rails of the adjoining blocks, as by open joints or insulation, as is well understood in the art. Each block is equipped with a pair of semaphores C′ and C^2, D′ and D^2, E′ and E^2, or F′ and F^2, located at the opposite ends of the block and at the opposite sides of the track. By reference to Fig. 1 of the drawings it will be seen that this arrangement locates the semaphores C′, D′, E′, and F′ at the right-hand side of the near ends of the blocks, considered with respect to a train moving in the direction of the arrow in said figure, and locates the semaphores C^2, D^2, E^2, and F^2 at the left-hand side of the far ends of the blocks, the former series of signals being designed for the guidance of engineers approaching in the direction of the arrow and having the right of way and the semaphores of the second series—that is to say, those at the left-hand side of the track—being designed for the guidance of engineers approaching in the opposite direction. (Indicated by the dotted arrow in Fig. 1.)

At the far end of each block is located a track-battery *b*, *c*, *d*, *e*, or *f*, having its opposite poles in electrical connection with the far ends

of the rails of the adjacent block and furnishing the electrical energy of the normally closed track-circuits B^3, C^3, D^3, E^3, and F^3, each including the rails of a block and a relay c^{31}, d^{31}, e^{31}, or f^{31}, together with suitable wiring. Associated with each track-circuit is a local circuit C^7, D^7, E^7, or F^7, controlled by the relay in the track-circuit, the local circuit F^7, for instance, being controlled by the relay f^{31} in the track-circuit F^3. In each local circuit are located three relays, those associated with the several blocks being designated by the characters c' c^2 c^3, d' d^2 d^3, e' e^2 e^3, f' f^2 f^3, the armatures of which are designated by c^4 c^5 c^6, d^4 d^5 d^6, e^4 e^5 e^6, f^4 f^5 f^6. The armature of each relay c^2, d^2, e^2, or f^2 constitutes a make-and-break device for a ground-circuit B^4, C^4, D^4, or E^4, (the relay for the circuit F^4 not shown,) utilizing the right-hand rail of the adjacent block as a conductor. The ground-circuits C^4, D^4, E^4, and F^4 each include a relay d^7, e^7, f^7, or g^7, whose armatures are designated by d^8, e^8, f^8, or g^8.

It should be noted that the relay of each ground-circuit is paired with a relay located adjacent to a semaphore at the near end of the block preceding the local circuit containing the relay which controls the ground-circuit. For example, the relay e^7 is paired with the relay d' at the semaphore D'. This semaphore is located at the near end of the block D; but the relay e^7 is included in the ground-circuit D^4, controlled by the relay e^2 in the local circuit E^7 of the block E. Thus the short-circuiting of the track-battery e by the presence of a train upon the block E cuts out the relay e^{31}, opens the local circuit E^7, and likewise cuts out the relays e', e^2, and e^3. The cutting out of the magnet or relay e^2 releases the armature e^5 and opens the ground-circuit D^4, consequently cutting out the relay e^7. It will thus be noted that the presence of a train on any block—for instance, E—will cut out a relay—for instance, e'—located at the semaphore situated at the near end of the occupied block and will also deënergize a relay—for instance, e^7—located adjacent to the semaphore D' at the near end of the block D, preceding the block E, occupied by the train. This discussion of the electrical relation of the several magnets at the right-hand side of the track brings us now to the consideration of the relation of these pairs of magnets with respect to the semaphore or other signal adjacent to which they are located.

Each semaphore is capable of being moved to four different positions. The completely-depressed position (semaphore C', Fig. 1) indicates that the track is "clear," the second position (semaphore D') admonishes "caution," the third position (semaphore E') indicates "danger," and the fourth or completely-elevated position (semaphore C^2, Fig. 2) indicates "extreme danger." Each semaphore is operated by a pair of motors (primary and secondary) 5 and 6, one of which is arranged to move the semaphore the distance of two positions and the other of which is of sufficient capacity to move it one position. Under normal conditions the motors will retain the semaphore at "clear." Each motor is provided with a motor-circuit 5^a or 6^a, in which is located a battery 5^b or 6^b. These two circuits controlling the motors of the adjacent semaphore are normally closed by the armatures of the paired relays—as, for instance, the relays f' and g^7—which are designed to control the motor-circuits of the semaphore. When the two motor-circuits are thus closed by the attraction of the armatures f^4 and g^8 by reason of the location of the relays f' and g^7 in closed circuits, the batteries 5^b and 6^b will generate sufficient energy to operate both motors in one direction until the semaphore is drawn down to "clear," where, as before stated, it is normally held.

The relay—for instance, f'—controlling the motor-circuit 5^a of the more powerful or primary motor 5 is located in the local circuit—for instance, F^7—of the adjacent block F, while the relay—for instance, g^7—controlling the motor-circuit 6^a of the less powerful or secondary motor 6 is located in the ground-circuit of the next succeeding block. Each of the motor-circuits 5^a and 6^a is provided with a shunt-terminal 5^c or 6^c, in which is located a reversely-disposed battery 5^d or 6^d. This arrangement is adopted so that when the armatures of the paired semaphore-relays are released by the opening of the circuits in which said relays are included said armatures will contact with the shunt-terminals to close the circuits through the reversed batteries, thus effecting the reversal of the motors and semaphores. By this means the semaphore-arms are operated positively in both directions, although it is evident that so far as the broader aspect of my invention is concerned the arm may be permitted to gravitate to one position and the motors employed for moving it positively in the opposite direction. In this event the shunt-terminals and reversed batteries would be omitted; but the illustrated arrangement is preferable, as it insures the proper operation of the signals under all conditions.

We have now seen that the local circuit of each block is controlled by a relay in the track-circuit of said block and that said local circuit in turn controls the primary relay of the adjacent semaphore and also the relay which controls a ground-circuit in which is included the secondary relay of the next preceding semaphore. We have also seen how each semaphore is operated by a pair of primary and secondary motors of different capacities included in motor-circuits controlled by primary and secondary relays, the primary relay being included in the local circuit of the adjacent block and the secondary relay being

located in a ground-circuit controlled from the next succeeding block. We are therefore in a position to consider the effect which the occupation of a block will have upon the semaphores at the right-hand side of the track. Suppose, for instance, that a train moving in either direction passes into the block E, as indicated in Fig. 1. The rail-sections of this block constitute conductors of the track-circuit E^3, including the track-battery e. The current passing from the battery will be short-circuited through the wheels and axles of the train, cutting out the relay e^{31} and permitting the armature thereof to swing back, and thus open the local circuit E^7. The opening of the local circuit E^7 will cut out the primary relay e' of the semaphore E', reversing the primary motor of the semaphore, which will thus be moved two positions to "danger." The opening of the local circuit will also cut out the relay e^2, the armature e^5 of which will swing back to open the ground-circuit D^4, thus cutting out the secondary relay e^7 of the semaphore D'. The secondary motor of the semaphore E' will thus be reversed and said semaphore will be moved one position to "caution." Thus the right-hand semaphore of the occupied block will be at "danger" and the right-hand semaphore of the block preceding the one occupied will be at "caution," and as trains moving in the direction of the full-line arrow in Fig. 1 are supposed to have the right of way a train following the one in the block E will move into the block D, but will be apprised by the "caution" signal of the presence of a train in the succeeding block and will be prepared to stop in case the next signal still remains at "danger" by reason of the failure of the train ahead to leave the occupied block E. Suppose, however, that while the train is in the block E another train moves into the next succeeding block F. (See Fig. 2.) The effect of this will be to short-circuit the track-battery f, cut out the relay f^{31}, and open the local circuit F^7. The effect of this will be to cut out the primary relay of the semaphore F', thus moving the latter to "danger," and to also cut out the relay f^2, opening the ground-circuit E^4 and cutting out the secondary relay f^7 of the semaphore E. The presence of the train in the block E has already effected the elevation of the semaphore E' two positions to "danger," and now the cutting out of the secondary relay f^7 by the passage of a train into the block F will move the semaphore E' one additional position to "extreme danger." When, therefore, two adjacent blocks—for instance, the blocks E and F—are occupied, as shown in Fig. 2, the semaphore F' of the block F will be at "danger," the semaphore E' of the block E will be at "extreme danger," and the semaphore D' of the block D will be at "caution." Thus an engineer approaching the block D in the direction of the full-line arrow will be cautioned. Having the right of way, however, he will pass into the block D, but upon approaching the block E will be apprised by the semaphore E' of the extreme danger occasioned by the occupation of the two succeeding blocks. As soon as this unusual condition is overcome by the passage of the train out of the block F the track-circuit F^3 will be closed, thus closing the local circuit F^7 and the ground-circuit E^4. The secondary relay f^7 will again attract its armature, reversing the secondary motor of the semaphore E' and restoring said semaphore to "danger," apprising the engineer approaching the block E that the extreme or unusual danger is past, but that the block ahead—to wit, the block E—is still occupied. Of course when the train moves out of the block E into the block F the primary relay e' will immediately reverse the current through the primary motor; but the cutting out of the secondary relay f^7 by the opening of the local circuit F^7 will position the semaphore E' at "caution," so that the engineer approaching the block E will be apprised that said block has been cleared, but that the train ahead is in the next block F.

Proceeding now to the consideration of the semaphores and connections at the left-hand side of the track, it will be noted that the armatures of the relays c^3, d^3, e^3, and f^3 in the local circuits constitute make-and-break devices for the primary controlling-circuits C^5, D^5, E^5, and F^5, which latter include the primary relays c^{13}, d^{13}, e^{13}, and f^{13}, respectively, of the semaphores C^2, D^2, E^2, and F^2. These primary controlling-circuits C^5 D^5, &c., also include relays c^{15}, d^{15}, e^{15}, and f^{15}, controlling the secondary controlling-circuits B^6, C^6, D^6, and E^6, which, respectively, include the secondary relays c^{14}, d^{14}, e^{14}, and f^{14} of the semaphores at the left of the track.

Now by referring to Fig. 1 it will be seen that the occupation of the block E and the consequent opening of the local circuit E^7 will cut out the relay e^3, opening the primary controlling-circuit E^5 and cutting out the primary relay e^{13} of the semaphore E^2, located at the far end of the block E, at the left-hand side thereof, said semaphore being moved two positions to "danger" in an obvious manner. The opening of the primary controlling-circuit E^5 in the manner stated will also cut out the relay e^{15}, opening the secondary controlling-circuit E^6 to cut out the secondary relay f^{14}, thus effecting the shifting of the semaphore F^2 at the left-hand side of the far end of the block F to "caution." Thus it will appear that the presence of a train in the block E will cause the two semaphores E' and E^2 at the opposite ends of the occupied block to move to "danger" and will also cause the preceding semaphore at the right of the track, and the succeeding semaphore at the left of the track to move to "caution." Therefore an engineer approaching from either direction will be cautioned before entering the block next to that

in which the train is located and if, having the right of way, he enters the block next to that occupied he will be apprised by the danger-signal of the continued presence of the train in the next block. (See Fig. 1.)

The arrangement of the system at a block in which a switch is located—as, for instance, the block C—is somewhat different from that thus far described. The switch-rails 7 and 8 are connected to each other by a bond-wire 7^a and are in electrical connection with a fixed section of the right-hand rail by means of a bond-wire 7^b. The switch-rail 7 is normally out of contact with the left-hand rail A of the block C, and as the switch-rail 8 is normally in contact with the rail A′ of the block the track-circuit C^3 and the ground-circuit C^4 will be normally closed through the switch-rail 8. In other words, the rail 8 constitutes a movable track-section included in the track-circuit C^3 and also in the ground-circuit C^4 and arranged to open said circuits when moved to one position—to wit, the position shown in Fig. 2. When the block C is occupied by a train, the semaphores at the opposite sides thereof will be moved to "danger" and the next preceding and succeeding semaphores at the right and left hand sides of the track, respectively, will be moved to "caution" in the manner heretofore explained, precisely the same as in the case of the occupation of any other block. It will be noted, however, that as the wire h^2, the fixed sections of the right-hand rail A′ of the block C, and the switch-rail 8 all constitute common conductors included in both the track-circuit C^3 and the ground-circuit C^4 both of these circuits will be opened whenever the switch-rail 8 is shifted to the position indicated in Fig. 2, or, in other words, both the track-circuit and the ground-circuit will be opened by the opening of the switch. Therefore both of the relays c' and d^7 of the semaphore C′ will be cut out, and the semaphore at the right of the block in which the switch is located will thus be thrown to "extreme danger" whenever the switch is opened.

It is desirable that both semaphores of the block C be thrown to "extreme danger" when the switch is opened, and as the opening of the track-circuit will only effect the opening of the primary controlling-circuit at the left-hand side of the block (throwing the semaphore C^2 to "danger") it is obvious that some special provision must be made for opening the secondary controlling-circuit B^6 at the left of the track upon the opening of the switch. This I accomplish by including in the ground-circuit C^4 a relay u, the armature u' of which is included in and controls the secondary controlling-circuit B^6. It is now evident that the relays d^7 and u are both included in the ground-circuit C^4 and that said ground-circuit is designed ordinarily to be controlled by the relay d^2 in the local circuit of the block D, because, as heretofore explained, it is intended that the secondary relay d^7 shall be cut out to send the semaphore C′ to "caution" whenever a train is in the block D. This ordinary operation must not effect the cutting out of the relay u, which is only intended to open the secondary controlling-circuit B^6 when the switch is opened and on no other occasion. In other words, the arrangement must be such that under ordinary circumstances the cutting out of the relay d^2 will cut out the relay d^7 without cutting out the relay u, while under extraordinary conditions—that is to say, when the switch is open—both of the relays d^7 and u must be cut out in order that the semaphores C′ and C^2 will be moved to the position of "extreme danger." To this end the magnet of the relay d^7 is polarized and the ground-circuit C^4 is provided with a shunt-terminal u^2, in which is placed a reversed battery u^3. When the armature d^5 is attracted toward its magnet, it will contact with the primary terminal of the circuit C^4, closing the circuit and causing the magnets of both relays d^7 and u to attract their armatures. (See Fig. 1.) When, however, a train occupies the block D, the opening of the controlling-circuit D^7 cuts out the relay d^2, and the armature d^5 thereof moves away from the primary terminal and into contact with the shunt-terminal of the ground-circuit C^4. The effect of this will be to reverse the direction of the current in the circuit C^4, and while this reversal will not affect the relay u it will cut out the polarized magnet of the relay d^7 to release the armature d^8, and thus move the semaphore C′ to "caution." Suppose, however, that with the armature d^5 in either position the switch is opened. (See Fig. 2.) Both the track-circuit C^3 and the ground-circuit C^4 will be opened. The opening of the track-circuit will open the local circuit C^7, which will in turn cut out the relays c', c^3, and c^{13}, moving the semaphores C′ and C^2 at the opposite sides of the switch to "danger." At the same time the opening of the ground-circuit C^4 will cut out the relays d^7, u, and c^{14}, which in an obvious manner will cause the two semaphores C′ and C^2 to be moved to "extreme danger," where they will remain to apprise engineers approaching from either direction of the extreme danger occasioned by the presence of an open switch in the block C.

It will be obvious from the above description in connection with the switch and the signals associated with the block in which it is located that the signals at the opposite ends of a block containing a drawbridge would operate in precisely the same manner. One of the movable rail-sections carried by the bridge would correspond in function with the switch-rail 8, and upon the opening of the drawbridge circuits corresponding to the track-circuit C^3 and ground-circuit C^4 would be opened to send

the semaphores to "extreme danger" just as the semaphores at opposite sides of the block C are operated by the movement of the switch-rail 8. The same arrangement would be made at a block including a crossing of two roads.

In connection with the system as thus far described I prefer to employ a novel arrangement of switch operating and locking mechanism controlled by an operator located in a switch house or station 9. The tie-rod 10, to which the free ends of the switch-rails are secured, is connected to one end of a connecting-rod 11, extended into the switch-house 9 and connected to a switch-operating lever 12. At one end of this lever 12 is formed a contact-heel 13, normally in electrical connection with a contact-spring 14, constituting one terminal of a relay-circuit H, including a relay h, and having its other terminal constituted by the lever 12. The armature h' of the relay h is included in and constitutes a make-and-break device for the wire h^2, constituting, as stated, a common return-wire for both the track-circuit C^3 and the ground-circuit C^4, so that when the relay-magnet h is demagnetized the release of the armature h' will open the track-circuit C^3 and the ground-circuit C^4, thus absolutely insuring the display of the proper signal irrespective of the electrical connection or disconnection of the switch-rail 8 and the block-rail A'. Therefore when the switch-lever is moved to the position shown in Fig. 2 the switch-rail will be thrown and both the track-circuit and the ground-circuit opened by reason of the movement of the heel 13 out of contact with the spring 14 and the consequent breaking of the circuit H and the release of the armature h'. Consequently if by any possibility electrical connection should be maintained between the switch-rail 8 and the block-rail A' after the throwing of the switch such connection would not interfere with the displaying of the proper signals, because both the ground-circuit and the track-circuit would be entirely broken by the armature h'. In addition to this safeguard the automatic locking of the switch-lever in its normal position whenever a train enters the block C is contemplated in order that the throwing of the switch during the occupation of the block may be absolutely prevented. This is accomplished by including a relay-magnet i in the local circuit C^7, the armature i' of said magnet i constituting a make-and-break device for a switch-locking circuit k, including a magnet l, whose armature m is arranged to be projected into the path of the heel 13 of the switch-lever 12 when the armature m is demagnetized. (See dotted lines in Fig. 1.) Thus when a train enters the block C the opening of the local circuit C^7, besides effecting the proper movement of the signals in the manner stated, will demagnetize the magnet i, releasing the armature i', opening the circuit k, demagnetizing the magnet l, and causing the armature m to be moved into the path of movement of the lever 12. The lever will consequently be locked against movement, and it will be absolutely impossible to throw the switch until the train has left the block, at which time the armature m will be drawn back in an obvious manner to release the switch-lever.

In describing my signal system I have not undertaken to explain the manner in which each semaphore is connected to its motors, for the reason that the semaphore-operating mechanism proper has been made the subject of a separate application, of which this is a division. It may be stated briefly, however, that the motors 5 and 6 of each semaphore operate independently of each other and are capable of moving the semaphore in either direction irrespective of the position which the semaphore may occupy at the beginning of its movement. For instance, if the semaphore is moved by the weaker motor to "caution" the stronger motor being then brought into operation may move the semaphore two additional positions to "extreme danger." If the stronger motor is operated first, it will move the semaphore to "danger," from which it may be moved subsequently by the weaker motor to "extreme danger." A number of combinations may thus be effected by the operation of the motors in any desired order and in either direction.

The mechanism for operating and locking each of the several semaphores is illustrated in Figs. 3 and 4 and comprises a support or post 17, adjacent to the upper end of which is pivoted a semaphore-arm 18, formed, as usual, with a counterweight 19 of arcuate form and having openings fitted with disks of glass arranged for presentation before a signal-lantern 20 and colored in a manner to signify the position of the semaphore-arm at night, white signifying "clear." The counterweight 19 is entirely withdrawn from before the lantern when the arm is at "clear," permitting the display of the white light of the signal-lantern. When the semaphore-arm is moved to "caution," the counterweight 19 is swung down to present a green glass before the light, a pink glass displayed when the arm is at "danger," and a red glass when the arm is moved to the position of "extreme danger."

At one side of the pintle 21, upon which the arm is mounted, said arm is connected to the upper end of a connecting-rod 22, having its lower end extended into a casing 23 and provided with a pinion 24 at its lower extremity. At opposite sides of the pinion are suitably guided a pair of vertically-disposed racks 25^a and 25^b, meshing with the pinion and pivotally connected at their lower ends to links 25^c and 25^d, having their lower ends secured to oscillatory arms or levers 26 and 27 at different distances from the common axis of the latter, said arms or levers being mounted

upon a common shaft 28, supported within the casing by suitable brackets. It should be noted that the connection of the rack 25^a with the lever 26 is at least twice as far from the shaft 28 as is the connection between the rack 25^b and the lever 27. Therefore a given oscillation of the lever 26 will move the rod 22 twice as far as a similar oscillation of the lever 27. It is by reason of this peculiar arrangement of the connections that the motor 5 (heretofore designated the "primary" motor and connected to the lever 26 in a manner to be explained) has twice the capacity of the motor 6, referred to as the "secondary" motor and arranged to oscillate the lever 27. At a point below the levers are mounted a pair of motor-disks 29 and 30, connected to the levers 26 and 27, respectively, by means of intermediate links 31 and 32, pivoted at their upper ends to the outer ends of the levers and eccentrically connected at their lower ends to the disks. The throw of the levers is adjustable by means of adjustable extensions 33, which serve to lengthen or shorten the levers and to thus determine the distances from the fulcrums thereof of their connections with the links 31 and 32. Each of the levers 26 and 27 is of a general T form in order to provide each of them with a locking-head 34 or 35, each arranged to coöperate with a pair of pivoted detents 36 and 37 and 36^a and 37^a, disposed to engage the opposite ends of the locking-head in front and rear thereof. These detents, which of course constitute elements of the semaphore-locking mechanism, are connected to and operated by the armatures 38 and 39 and 38^a and 39^a of magnets 40 and 41 and 40^a and 41^a.

It will now be evident that the rotation of either of the disks in the direction of the full-line arrow in Fig. 3, assuming the connecting-rod to beat its highest position, will draw the rod down, and thus effect corresponding movement of the semaphore-arm, the latter being moved down two positions by a complete downward oscillation of the lever 26, one position by a complete downward oscillation of the lever 27, and three positions—that is to say, from "extreme danger" to "clear"—by the downward movement of both levers. In like manner the release of the lever 26 will permit the semaphore-arm to move up two positions, the release of the lever 27 will permit it to move up one position, and the complete upward movement of both levers will restore the semaphore-arm from "clear" to "extreme danger." As stated, the downward movement of the levers is secured by the rotation of the disks in the direction of the full-line arrow in Fig. 3, and the opposite oscillation of the levers is of course effected by the reversal of the disks in the direction of the dotted arrow in Fig. 3. It now remains to be seen how these disks are rotated and how the detents are actuated to lock the levers in their depressed or normal positions. The disks 29 and 30 are provided with peripheral teeth 42 and 43, extending part way around the disks and meshing, respectively, with the pinions 44 and 45, constituting the power-transmitting elements of the motors 5 and 6. The character of these motors is not essential, since any mechanism adapted for either electrical actuation or control and capable of operating the disks may be employed. For purposes of illustration, however, I have shown somewhat diagrammatically a pair of electromotors, upon the armature-shafts of which the pinions 44 and 45 are mounted. It has been explained that at each semaphore is grouped a pair of relays, one of which controls the operation of the primary motor 5 and the other the operation of the secondary motor 6. In Figs. 3 and 4 these relays are shown and designated by the characters f' and g^7; but I shall only describe in detail the relation of the primary relay f' with respect to the motor 5 and the locking mechanism of the lever 26, as this arrangement is identical with the arrangement of the other relay g^7, the motor 6, and the locking mechanism of the lever 27, the only difference in the two sets of devices being different capacities of the two motors with respect to the movement of the semaphore-arm under the impulse thereof. The armature f^4 of the primary relay f' when attracted by the latter closes a motor-circuit 5^a, including the battery 5^b, the magnet 41, and the brushes $x\,y$ of the motor 5. When this motor-circuit is closed, the motor will be driven to rotate the disk 29 in the direction of the full-line arrow in Fig. 3 to draw down the lever 26 to its lowermost position, where it is normally held. When such position has been reached, the magnet 41, having been energized to attract its armature 39, will draw down the detent 37 into locking engagement with the upper end of the locking-head 34 of the lever 26. The locking of the lever 26 will serve to retain the latter irrespective of any movement which may be imparted by the other motor to the lever 27.

The motor-circuit 5^a is provided with a shunt-terminal 5^c, containing a reversed battery 5^d and including the magnet 40. If now the armature f^4 is released by the demagnetization of the relay f', said armature will open the motor-circuit 5^a and will close the circuit through the shunt-terminal 5^c. The battery 5^b and the magnet 41 will thus be cut out of the motor-circuit, and under the impulse of the reversed battery 5^d the motor will be driven in a reverse direction to rotate the disk 29 in the direction of the dotted arrow for the purpose of raising the lever 26 to permit the upward movement of the semaphore-arm. This movement of the parts will not be interfered with by the movement of the detent 37, because as soon as the motor-circuit 5^a is opened the magnet 41 will be demagnetized

and the detent 37 will be drawn out of its locking position by its spring *s*. Simultaneous with the reversal of the motor the magnet 40 will be energized, attracting its armature 38 and swinging the detent 36 upward. The detent, however, will strike against the locking-head 34 and will not interfere with the movement of the lever. As soon, however, as the lever has reached its uppermost position the detent 36 will move to its locking position behind the lower end of the locking-head and will lock the lever 26 in its elevated position in a manner similar to the locking of said lever in its depressed position by the detent 37. In the position of the parts shown in Fig. 3 the lever 26 is drawn down and the lever 27 is thrown up. As the latter lever is only capable of moving the semaphore-arm 18 the distance of one position, the effect of its movement will be to present said arm at "caution." Suppose, however, the lever 27 should be drawn down and the lever 26 thrown up. The result of this position of the parts would be to place the semaphore-arm at "danger"—that is to say, at the second position. If now both levers are thrown up, it is evident that the semaphore-arm will be moved three steps from the normal position—to wit, to "extreme danger." If both levers 26 and 27 are drawn down, the semaphore-arm will obviously be drawn back three positions to "clear."

It is thought that from the foregoing the arrangement of the system and its operation and use will be clearly apparent; but while the present embodiment of the invention is thought at this time to be preferable I wish to reserve to myself the right to effect such changes, modifications, and variations of the illustrated structure as may be fairly embraced within the scope of the protection prayed.

What I claim is—

1. The combination with a pair of blocks; of a signal, a pair of motors one of which moves the signal a greater distance than the other, connections between the signal and the motors, and track-circuits associated with the blocks and each controlling one of the motors.

2. The combination with a pair of blocks; a signal, a pair of motors one of which moves the signal a greater distance than the other, connections between the signal and the motors, separate motor-circuits for the motors, relays controlling the motor-circuits, and track-circuits associated with the respective blocks and each controlling one of the relays.

3. The combination with a pair of blocks; of a signal, a pair of reversible motors one of which moves the signal a greater distance than the other, connections between the signal and the motors, separate motor-circuits for the motors, a separate relay for reversing the current through each motor-circuit, and track-circuits associated with the respective blocks and each controlling one of the relays.

4. The combination with a plurality of blocks and a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other, and motor-controlling means associated with different blocks.

5. The combination with a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other, and separate track-circuits controlling the motors.

6. The combination with a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other, separate motor-circuits, relays controlling the same, and separate track-circuits controlling the relays.

7. The combination with a plurality of blocks and a signal; of a pair of reversible motors, differential connections whereby one motor will move the signal a greater distance than the other, separate motor-circuits, relays controlling the direction of the current in the motor-circuits, and track-circuits associated with the blocks and controlling the relays.

8. In a block-signal system for railways, the combination with a plurality of blocks, of a signal device, a pair of motors therefor, a motor-circuit for each motor, a pair of reversed generators for operating each motor in different directions, a relay associated with each motor-circuit and having its armature arranged to pass the current through either of the generators, a track-circuit associated with one block and controlling one of said relays, and a track-circuit associated with another block and controlling the other relay.

9. In a block-signal system for railways, the combination with a block, of an adjacent signal device, a second signal device remote from the block, separate motors for the signal devices, separate motor-circuits for said motors, a local circuit including a relay controlling one of the motor-circuits, a line-circuit including a relay controlling the other motor-circuit, a relay in the local circuit and controlling the line-circuit, and a track-circuit associated with one of the blocks and including a relay controlling the local circuit.

10. In a block-signal system for railways, the combination with a block, of a signal device, operating mechanism including a motor, a second remote signal device, operating mechanism for the second signal device of less capacity of movement than the operating mechanism for the first-named device and including a second motor, separate motor-circuits for the motors, a local circuit including a relay controlling the motor-circuit of the first-named motor, a line-circuit including a relay controlling the motor-circuit of the second signal device, a relay included in the local circuit and controlling the line-circuit, and a track-circuit associated with the block and including a relay controlling the local circuit.

11. In a block-signal system for railways,

the combination with a plurality of blocks, of a plurality of signal devices, of said signal devices having independent operating mechanisms of different capacities of movement, and a track-circuit associated with each block and each controlling the primary motor of one signal device and the secondary motor of another signal device.

12. In a block-signal system for railways, the combination with a plurality of blocks, of a plurality of signal devices, each of said signal devices having a primary and a secondary motor for separately operating the same, a separate motor-circuit for each motor of each signal device, primary and secondary relays controlling the circuits of the primary and secondary motors of each device, a track-circuit associated with each block, a local circuit controlled by each track-circuit and including one of the primary relays, and a line-circuit controlled by the local circuit and including the secondary relay of a remote signal device.

13. In a block-signal system for railways, the combination with a block, signal devices arranged at opposite sides thereof, and other signal devices arranged at remote points, of a primary and a secondary motor for operating each signal device separately, and a track-circuit associated with the block, said track-circuit controlling the primary motors of the adjacent signal devices and the secondary motors of the remote signal devices.

14. In a block-signal system for railways, the combination with a block, of signal devices arranged at opposite sides of the block, other signal devices located at remote points, independent primary and secondary motors for operating each signal device, separate motor-circuits for each motor, primary and secondary relays controlling the circuits of the primary and secondary motors of each signal device, and a track-circuit associated with the block and controlling the primary relays of the adjacent signal devices and the secondary relays of the remote signal devices.

15. In a block-signal system for railways, the combination with a block, of a signal device located at one side of the block, a second signal device located at the same side of another block, motors and motor-circuits for each signal device, a local circuit including a relay controlling the motor-circuit of the first device, a line-circuit including a relay controlling the motor-circuit of the second signal device, a relay in the local circuit and controlling the line-circuit, a third signal device at the opposite side of the first-named block, a motor and motor-circuit for the third signal device, a primary controlling-circuit including a relay controlling the motor-circuit of the third device, a relay located in the local circuit and controlling the primary controlling-circuit, a fourth signal device located at a block beyond the third signal device and provided with a motor and motor-circuit, a secondary controlling-circuit including a relay controlling the motor-circuit of the fourth signal device, a relay included in the primary controlling-circuit and controlling the secondary controlling-circuit, and a track-circuit associated with the first-named block and including a relay controlling the local circuit.

16. In a block-signal system for railways, the combination with a block, a switch therein, and a signal device, of means for automatically moving the signal device to danger when a train enters the block, and means for automatically moving said device to extreme danger upon the opening of the switch.

17. In a block-signal system for railways, the combination with a block, a switch therein, and a four-position signal device, of a second block, means for automatically moving the signal device to "caution" when a train enters the second block, means for automatically moving said device to "danger" when the train enters the first-named block, and means for moving the signal device to "extreme danger" upon the opening of the switch.

18. In a block-signal system for railways, the combination with a block, a switch therein, and a signal device, of a primary and a secondary motor for said signal device, means for automatically starting the primary motor when a train enters the block, and means for automatically starting both motors when the switch is opened.

19. In a block-signal system for railways, the combination with a four-position signal device, and primary and secondary motors for independently operating the same, of an adjacent block having a switch therein, a remote block, and means for automatically starting the secondary motor when a train enters the remote block, for automatically starting the primary motor when the train enters the adjacent block and for automatically starting both motors when the switch is opened, whereby the signal device will be moved to "caution" by a train in the remote block, to "danger" by a train in the adjacent block and to "extreme danger" by the opening of the switch.

20. In a block-signal system for railways, the combination with a block, signal devices at opposite sides of the block, and primary and secondary motors for separately or jointly operating each signal device, of a track-circuit controlling both primary motors, another circuit controlling both secondary motors, and a switch-rail constituting a make-and-break device for both circuits, whereby the opening of the switch will effect the opening of both the track-circuit and the independent circuit to start both motors of each signal device.

21. In a block-signal system for railways, the combination with a block having a switch therein, of signal devices at opposite sides of the block, motors for said devices, a circuit including relays each of which controls the

motor of one signal device, one of said relays being polarized, reversed batteries in the circuit, means for closing the circuit through either generator, whereby the polarized relay may be cut out without affecting the other relay, for the purpose of operating only one of the signals, and a make-and-break device in the circuit for simultaneously cutting out both relays to effect the operation of both signals.

22. In a block-signal system for railways, the combination with a block, of signal devices at opposite sides thereof, motors for said devices, a circuit including a pair of relays controlling said motors, one of said relays being polarized, reversed generators, a relay having its armature disposed to close the circuit through either generator, whereby the polarized relay may be cut out without affecting the relay controlling the other signal device, and a switch-rail constituting a make-and-break device for the circuit, whereby both relays therein will be cut out when the switch is opened.

23. In a block-signal system for railways, the combination with a block, a switch therein, and switch-operating mechanism, of a signal device, primary and secondary motors for independently operating the signal device, separate circuits normally controlling said motors, a single relay controlling both of said circuits, and a third circuit including said relay and normally closed by an element of the switch-operating mechanism.

24. In a block-signal system for railways, the combination with a block, a switch therein, and a switch-lever for operating the switch, of a signal device, primary and secondary motors for separately operating the signal device, a track-circuit controlling the primary motor, a second circuit controlling the secondary motor, a relay controlling both of said circuits, and a third circuit including said relay and normally closed by the switch-lever but arranged to be opened when said lever is moved to open the switch.

25. In a block-signal system for railways, the combination with a plurality of blocks, of a signal device, reversible primary and secondary motors for independently moving the signal device to different positions, means for automatically starting the secondary motor when a train enters one block, and means for automatically starting the primary motor when the train enters another block.

26. In a block-signal system for railways, the combination with a block, of signal devices arranged at opposite sides of the block, other signaling devices located at remote points, independent, reversible, primary and secondary motors for independently operating each signal device in either direction, separate motor-circuits for each motor, primary and secondary relays controlling the circuits of the primary and secondary motors of each signal device, and a track-circuit associated with the block and controlling the primary relays of the adjacent signal devices and the secondary relays of the remote signal devices.

27. In a block-signal system for railways, the combination with a block, a switch therein, and a signal device, of means for automatically moving the signal device to "danger" when a train enters the block and means for automatically moving said device to "extreme danger" upon the opening of the switch.

28. In a block-signal system for railways, the combination with a block, a switch therein, and a four-position signal device, of a primary motor for moving the signal device the distance of two positions, a secondary motor for moving said signal device the distance of one position, means for automatically starting the primary motor to move the signal device from safety to danger when a train enters the block, and means for automatically starting both motors to move the signal device to "extreme danger" when the switch is opened.

29. In a block-signal system for railways, the combination with a block having a switch therein, of signal devices at opposite sides of the block, motors for said devices, a circuit including relays, each of which controls the motor of one signal device, one of said relays being polarized, means for reversing the current through the relays, whereby the polarized relay may be cut out without affecting the other relay, for the purpose of operating one only of the signals, and a make-and-break device in the circuit for simultaneously cutting out both relays to effect the operation of both signals.

30. In a block-signal system for railways, the combination with a block, of a signal, primary and secondary operating mechanisms of different capacities of movement for said signal, means associated with the block for controlling the primary operating mechanism, and means associated with another block for controlling the secondary operating mechanism.

31. In a block-signal system for railways, the combination with a block, and a signal associated therewith, of primary and secondary operating mechanisms of different capacities of movement for moving the signal different distances, a track-circuit associated with the block and controlling the operation of the primary operating mechanism, a second block, and a track-circuit associated therewith and controlling the operation of the secondary operating mechanism of the signal.

32. In a block-signal system for railways, the combination with a plurality of blocks and a signal, of two independent operating mechanisms for each signal, one for moving the signal from "safety" to "danger," or from "caution" to "extreme danger," and another for moving said signal from "safety" to "caution," or from "danger" to "extreme dan-

ger," separate circuits controlling said operating mechanisms, and means associated with different blocks for controlling said circuits, whereby the signal may be operated from either block independently of the operating mechanisms associated with any other block.

33. In a block-signal system for railways, the combination with a block, of signal devices at opposite sides of the block, other signal devices located at remote points, independent primary and secondary operating mechanisms of different capacities associated with each of the several signals, a track-circuit associated with the block, and means controlled by the track-circuit for starting the primary operating mechanism of the adjacent signal devices and the secondary operating mechanism of the remote signal devices when a train enters the block.

34. In a block-signal system, the combination with a block, and a four-position signal, of means for moving the signal to "caution," separate means for moving said signal to "danger," and means for effecting the movement of the signal to "extreme danger."

35. In a block-signal system, the combination with a plurality of blocks, and a four-position signal, of means for moving the signal to "caution" when a train enters one block, means for moving said signal to "danger" when the train enters another block, and means for effecting the movement of the signal to "extreme danger."

36. In a block-signal system, the combination with a block, and a four-position signal, of means for moving the signal from "safety" to "caution" when a train approaches the block, means for moving the signal from "caution" to "danger" when a train enters the block, and means for effecting the movement of the signal to "extreme danger."

37. In a block-signal system, the combination with a block, of a four-position signal associated therewith, means for moving the signal from "safety" to "caution" when a train approaches the block, means for moving said signal to "danger" upon the entrance of each train in the block, a second block, and means for moving the signal to "extreme danger" when a train enters the second block during the occupation of the first-named block.

38. In a block-signal system, the combination with a block, of a four-position signal associated therewith, a pair of independent operating mechanisms for the signal, means controlling the operation of said mechanisms to effect the movement of the signal from "safety" to "caution," or from "safety" to "danger" by the separate operation of one or the other of said operating mechanisms, or to effect the movement of the signal from "safety" to "extreme danger" by the combined action of said operating mechanisms.

39. In a block-signal system, the combination with a block, a four-position signal associated therewith, and separate operating mechanisms for said signal, of a second block, and means controlled by train movements for starting one of the operating mechanisms to move the signal from "safety" to "caution" when a train enters the second block, for starting the other operating mechanism to move the signal to "danger" when a train enters the first block from the second, and for starting one of the operating mechanisms to move the signal to "extreme danger" when a train enters the second block during the occupation of the first-named block.

40. The combination with a pair of blocks; of a signal, a pair of motors one of which moves the signal a greater distance than the other, connections between the signal and motors, track-circuits associated with the blocks and each controlling one of the motors, and a separate circuit controlling both motors.

41. The combination with a pair of blocks and a switching apparatus; of a signal, a pair of motors one of which moves the signal a greater distance than the other, connections between the signal and the motors, separate motor-circuits for the motors, relays controlling the motor-circuits, track-circuits associated with the respective blocks and each controlling one of the relays, and a local circuit associated with the switching apparatus and controlling both relays.

42. The combination with a pair of blocks; of a signal, a pair of reversible motors one of which moves the signal a greater distance than the other, connections between the signal and the motors, means associated with each block for controlling one of the motors, and separate means for controlling both of the motors.

43. The combination with a plurality of blocks and a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other motor, controlling means associated with different blocks, switching apparatus, and means associated with the switching apparatus to control both motors.

44. The combination with a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other, separate track-circuits controlling the respective motors, and means controlling both motors.

45. The combination with a signal; of a pair of motors, differential connections whereby one motor will move the signal a greater distance than the other, separate motor-circuits, relays controlling the same either separately or conjointly, and circuits controlling the relays.

46. The combination with a plurality of blocks, a switch, and a signal; of a pair of reversible motors, differential connections whereby one motor will move the signal a

greater distance than the other, separate motor-circuits, relays controlling the direction of the current in the motor-circuits, and circuits associated with the blocks and switch respectively to effect the separate or conjoint control of the motor-circuits.

47. In a block-signal system, the combination with a block; of a four-position signal device, means for moving the signal device to "danger" when a train enters the block, and separate means for moving the signal device to "extreme danger."

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

LOUIS CHARLES WERNER.

Witnesses:
JAMES WILLARD COLE,
GEORGIA E. COLE.