(No Model.) 8 Sheets—Sheet 1.

G. L. THOMAS.

RAILWAY SIGNAL SYSTEM.

No. 539,154. Patented May 14, 1895.

Fig. 1.

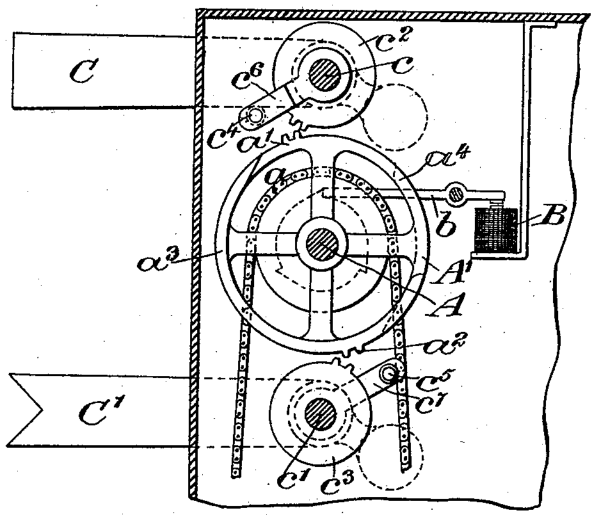

Fig. 2.

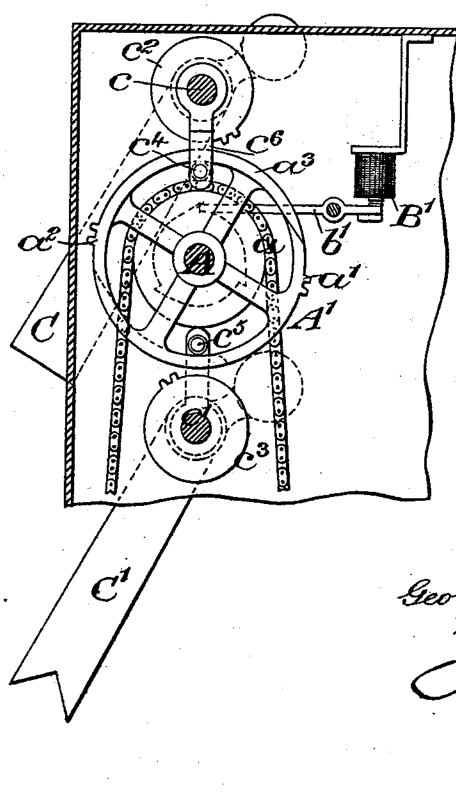

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Fig. 3.

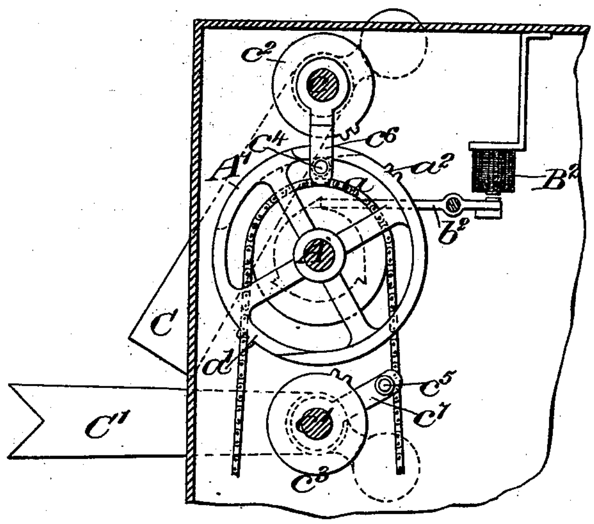

Fig. 4.

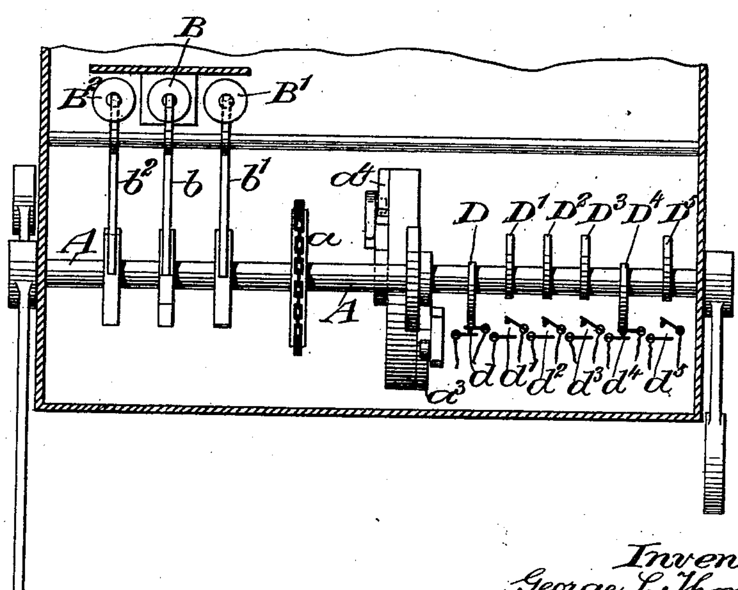

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Fig. 5.

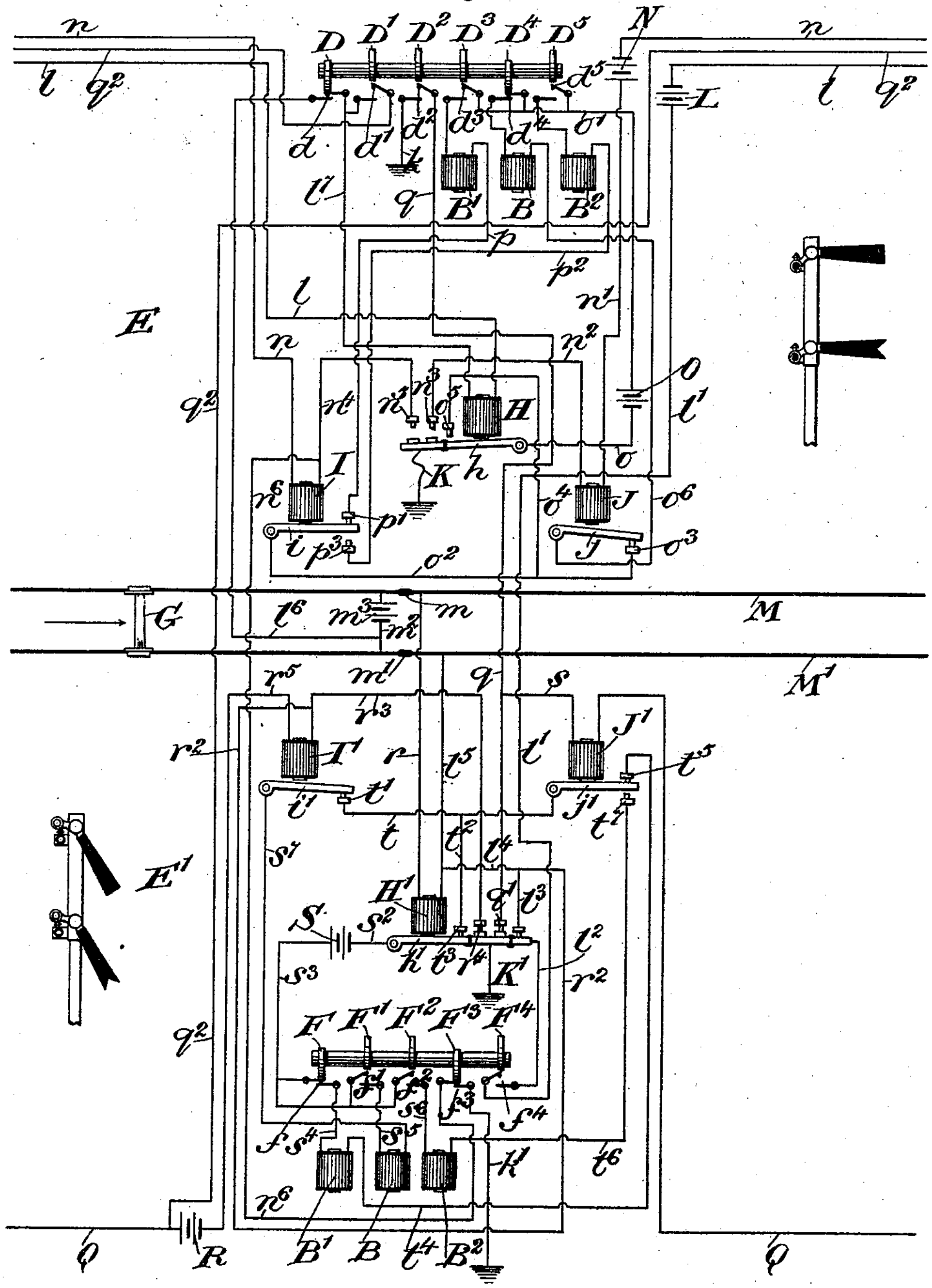

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Fig. 6.

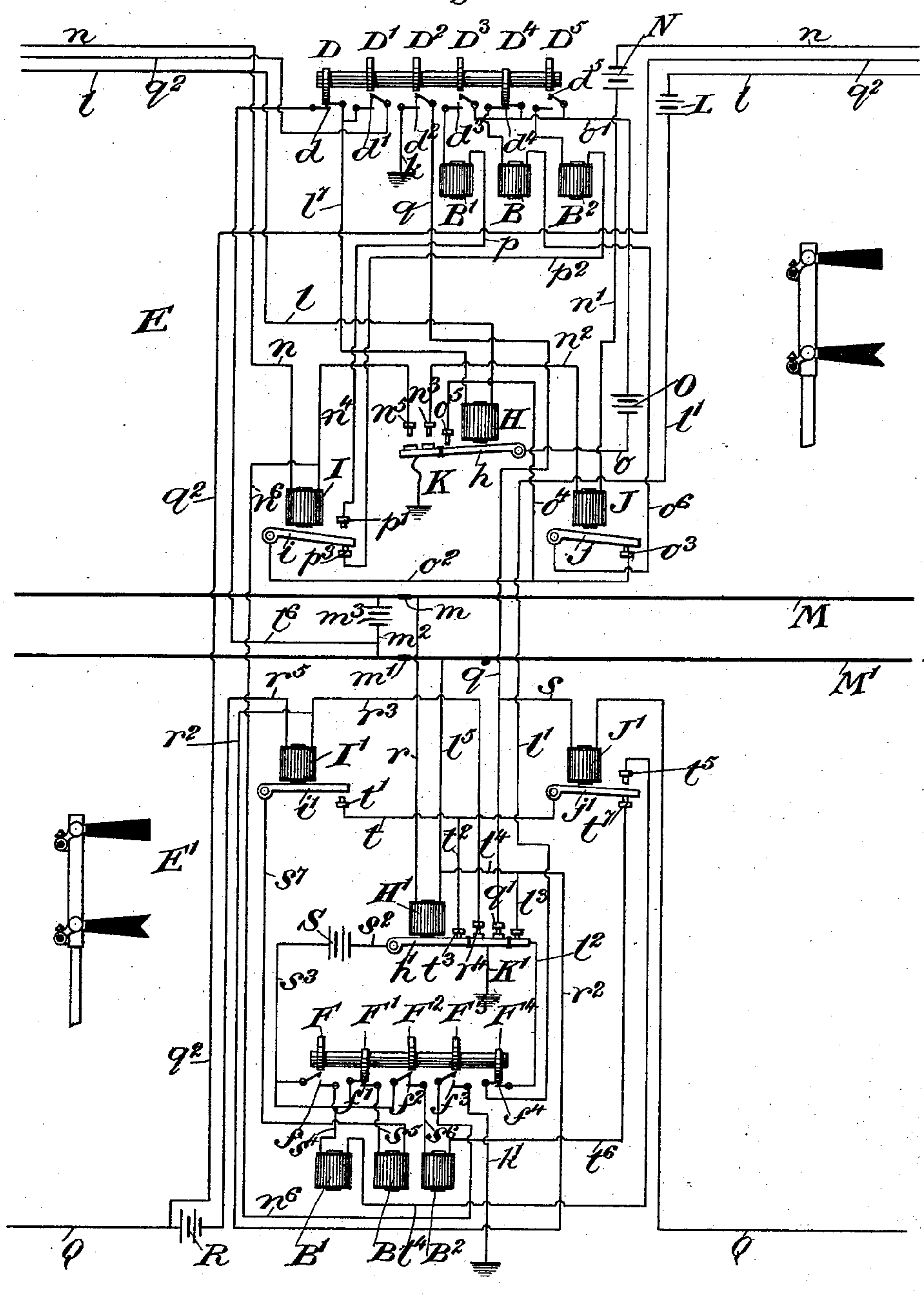

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Fig. 7.

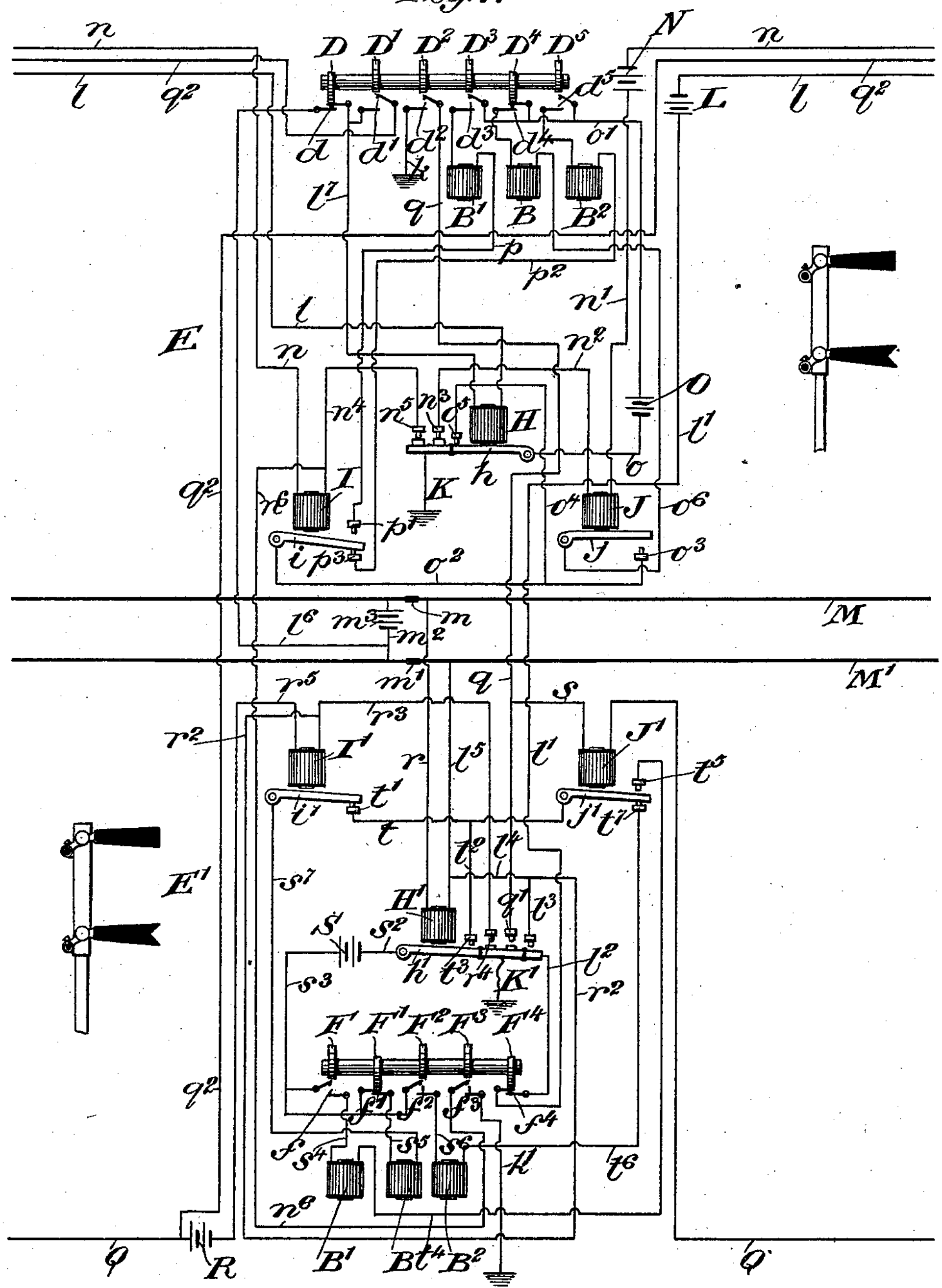

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Fig. 8.

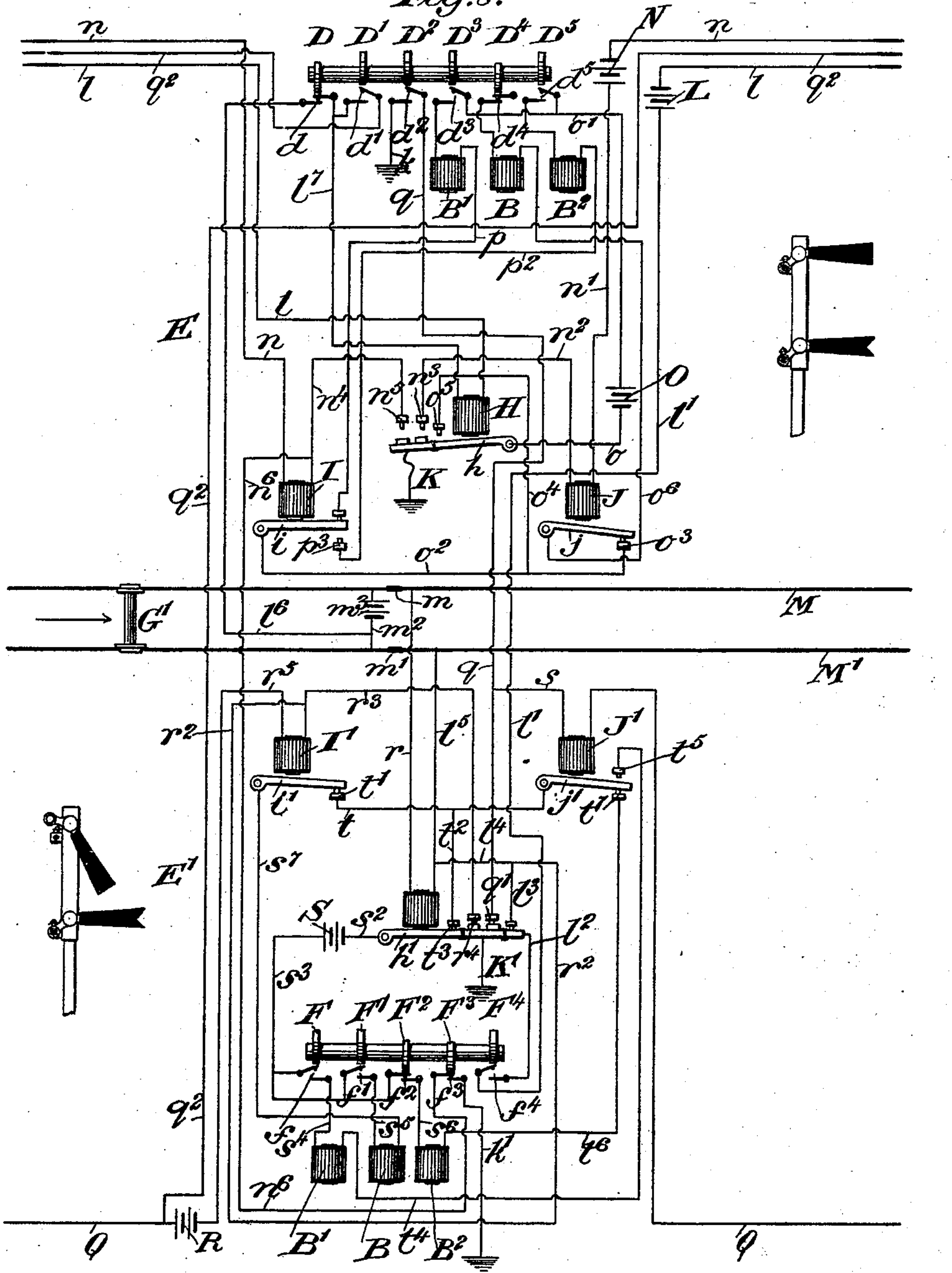

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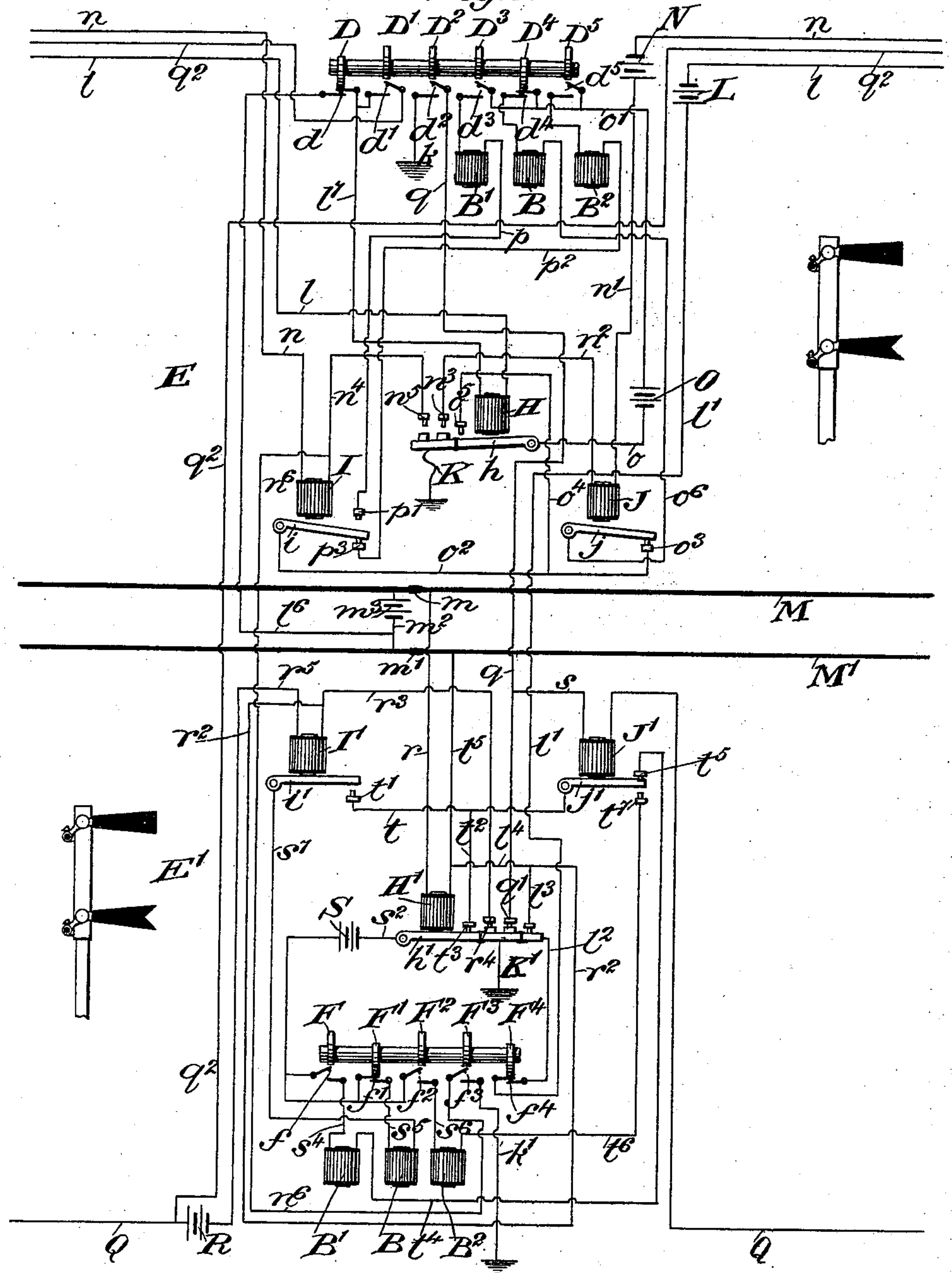
Fig. 9.



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G. L. THOMAS.

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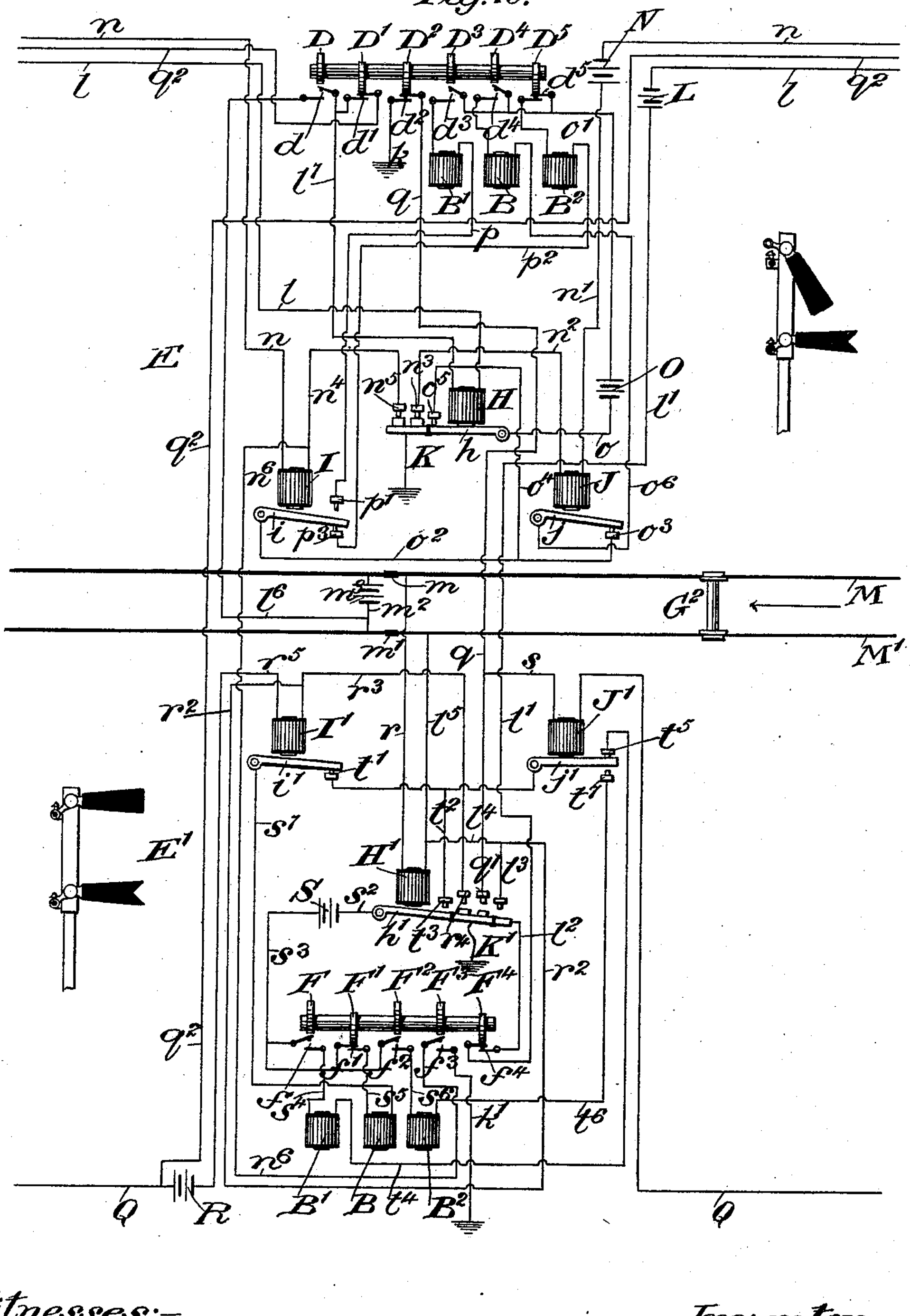
Fig. 10.



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UNITED STATES PATENT OFFICE.

GEORGE L. THOMAS, OF BROOKLYN, ASSIGNOR TO THE HASELL PERFECTED RAILWAY SIGNAL COMPANY, OF NEW YORK, N. Y.

RAILWAY SIGNAL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 539,154, dated May 14, 1895.

Application filed January 26, 1895. Serial No. 536,310. (No model.)

To all whom it may concern:

Be it known that I, GEORGE L. THOMAS, of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Railway Signal Systems, of which the following is a specification.

My invention relates to an improvement in railway signal systems in which series of signals arranged along a track are under the control of a train moving along the track to guard against both head and rear collisions and also against accident resulting from a broken or displaced rail.

In my present system the signals are normally at danger and are released and locked against releasing by electric circuits under the control of the train in such a manner that, if the way be clear, the train in passing a signal on its right will set the next succeeding signal on its right to safety, the signal which it is just passing to danger, will lock the preceding signal on its right, so that it cannot be set to safety until the train shall have passed the next succeeding signal on its right and will lock the next two successive signals on its left, so that they cannot be turned to safety by a train approaching in the opposite direction. It follows therefore that, if there be a train within two blocks of a given train in advance of it, moving in either the same or in the opposite direction, the said given train cannot obtain a "clear" signal to advance, nor can a following train within two blocks of the given train obtain a "clear" signal.

I have furthermore shown, in the present application, the signal apparatus as consisting of a plurality of semaphore arms located one above another and operated by a rotary spindle under the control of electromagnets and provided with circuit making and breaking devices, the electromagnets and their armatures for controlling the rotary movement of the spindle in steps at intervals of a third revolution being quite similar to that shown and described in connection with the signal system patented by Thomas and Seward, No. 508,356, dated November 7, 1893.

In the accompanying drawings, Figure 1 is a view in side elevation of the signal apparatus, showing the arms in the position to denote danger. Fig. 2 is a similar view showing the arms in a position to denote safety. Fig. 3 is a similar view showing the arms in a position to denote caution or distance. Fig. 4 is a top plan view of the apparatus, representing the parts in the position shown in Fig. 1, showing the circuit making and breaking devices on the rotary spindle; and Figs. 5, 6, 7, 8, 9, and 10 represent diagrammatical views of a set of signal posts or towers with the electric connections for releasing the signals, the several sets of signal posts or towers being assumed for purposes of explaining the system as being located successively along a track.

The rotary spindle for actuating the signals is denoted by A, its actuating wheel by a, the releasing magnets by B, B′, B^2 and their armatures b, b', b^2 respectively.

The semaphore arms are denoted by C, C′ and are mounted upon suitable pivots c, c' so as to be rocked from a horizontal position, shown in Fig. 1, to a depressed position, shown in Fig. 2. Each of the signal blades C, C′ is provided with a counterbalance of any well known or approved form sufficient to return the arm to the horizontal or danger position under the influence of gravity whenever the arm is left free to swing. The arm C has fixed to rotate therewith a mutilated pinion c^2 and the arm C′ has fixed to rotate therewith a similar mutilated pinion c^3.

A master wheel A′ is fixed on the spindle A to rotate therewith and is provided with mutilated gear; in the present instance a short gear of two teeth a' at a point on its periphery and at a diametrically opposite point of its periphery a short gear of two teeth a^2. The relation of the master wheel A′ to the mutilated gear pinions c^2 and c^3 is such that the gears a' and a^2 on the master wheel will engage the gear on the pinions c^2 and c^3 as the wheel A′ is revolved. The wheel A′ is further provided with laterally projecting mutilated rims a^3, a^4 upon opposite sides of the wheel A′ and adapted to receive under them antifriction rollers c^4, c^5 on arms c^6 and c^7 fixed to rotate with the mutilated pinions c^2, c^3 and their semaphore blades, for the purpose of retaining the said semaphore blades a predetermined time in their depressed positions during the revolution of the spindle A. The arrangement here shown is such that when the spindle A is released and permitted to move one-third of a revolution from the position shown in Fig. 1, the master wheel A′ will simultaneously engage both of the mutilated gear pinions c^2 and c^3 and will rock the two semaphore blades C, C′ into their depressed position (shown in Fig. 2) where they will be held by the engagement of the retaining arms with the retaining rims on the master wheel. When the spindle A is rotated the next one-third revolution, it will not engage either of the mutilated gear pinions, or if it does engage the pinion c^3, the latter will not be held in its depressed position but its retaining arm will have passed out of engagement with the guard rim a^4 and it will be free to resume its horizontal position under counterbalance weight while the arm C will still be retained in its depressed position, thereby throwing the two arms in the relative position shown in Fig. 3. During the final one-third revolution of the spindle A, the guard arm of the semaphore blade C will have passed out of engagement with the retaining rim a^3 on the master wheel A′, thereby permitting the blade C to resume its horizontal position while the lower blade C′ will have remained undisturbed, thereby leaving the signal in the position shown in Fig. 1.

For purposes of making and breaking the several circuits at the proper intervals to produce the required releasing and locking of the signal operating mechanism, I have provided the spindle A with a series of eccentric disks; represented in Fig. 4 by D, D′, D^2, D^3, D^4 and D^5; in position to close the several pairs of contact pieces; represented by d, d', d^2, d^3, d^4 and d^5 respectively. The effect of the closing or opening of the several contact pieces will be understood from the explanation of the circuits to be hereinafter recited.

The signal towers composing each set are represented respectively by E and E′, those on the left hand side of the track (assuming the train to be moving from the left toward the right as the drawings are read) being denoted by E, those on the right hand side being denoted by E′. The electrical apparatuses in the towers constituting a set are interconnected. The circuit closing disks and contact pieces, represented in plan in Fig. 4, are those which appear in each of the towers E. The disks for closing the circuits in the towers E′ are represented respectively by F, F′, F^2, F^3 and F^4 and the corresponding contact pieces by f, f', f^2, f^3 and f^4. In other respects the signal actuating mechanism of the towers E′ is quite similar to that of the towers E.

For purposes of explanation, I have assumed a train as occupying the position of the truck G in Fig. 5 and moving in the direction of the arrow also in the position represented by the truck G′, Fig. 8, and moving in the direction of the arrow and also in the position shown by the truck G^2, Fig. 10, and moving in the direction of the arrow. As the different sets of towers E, E′ are identical in all their essential features, it will only be necessary to explain in detail the set represented in Fig. 5 and then assume a similar arrangement in each of the succeeding sets.

Referring to the tower E, there is, in addition to the electromagnets B, B′, B^2, the circuit closers, contact pieces and signal actuating mechanism; a main relay H, having an armature h, an auxiliary relay I, having an armature i, and an auxiliary relay J, having an armature j. The armature h is at all times in electric communication with the earth by a wire K.

The companion tower E′ is provided with a main relay H′, having an armature h', an auxiliary relay I′, having an armature i' and an auxiliary relay J′, having an armature j'.

The track rails are denoted respectively by M and M′. The rails are interrupted at each set of towers by insulations m and m' and are electrically connected with each other to the left of such insulations by a wire m^2, having interposed therein a battery m^3.

One pole of the relay H is connected by a wire l extending from the relay through a battery L at a preceding tower E, thence across the track by a wire l' to one of the contact pieces f^4 of the tower E′, thence by a wire l^2 to the armature h' of the main relay H′ of that tower, thence by a wire l^3 and a branch wire l^4 to a wire l^5 leading from one of the poles of the relay H′ to the rail M′, thence along said rail to the next succeeding set of towers and thence by a wire l^6 to one of the contact pieces d of the tower E, thence by a wire l^7 to the opposite pole of said relay H from which the tracing of the circuit began.

One pole of the auxiliary relay I is connected by a wire n through a battery N at a preceding tower E and wire n' with one of the poles of the auxiliary relay J, the circuit continuing from the opposite pole of said auxiliary relay J through a wire n^2 to a contact piece n^3 in position to contact with the armature h when the latter is closed, the circuit continuing thence through the wire K to ground. The opposite pole of the auxiliary relay I is connected by a wire n^4 with a contact piece n^5 in position to engage the armature h of the relay H of that tower when the said armature is closed, the circuit continuing thence through the wire K of that tower to ground and thence completing the circuit through the poles of the relay I by means of the ground connections. The wire n^4 from one of the poles of the auxiliary relay I is also connected by a wire n^6 which crosses the track with one of the contact pieces f^3 of the companion tower E′, the circuit continuing thence through the other contact piece f^3 and wire k' to ground.

One pole of the auxiliary relay J is connected by the wire n^2 with the contact piece n^3 in position to engage the armature h of the relay H of that tower when the latter is closed, as has already been stated, and the other pole of said auxiliary relay J is connected through the wire n', battery N, wire n, auxiliary relay I of the next succeeding tower E, and wire n^4 of that tower and contact piece n^5 which—when the armature h of the main relay H of that tower is closed—connects with ground through the wire K.

The armature h, as has already been stated, has a constant ground connection K and also a constant connection through the wire o, battery O and wire o' with one of the contact pieces at each of the contacts d^5, d^4, d^3 of that tower.

The armature i of the auxiliary relay I has a constant connection through a wire o^2 with a contact piece o^3 in position to engage the armature j of the auxiliary relay J when the said armature is open and also by a branch wire o^4 with a contact piece o^5 in position to engage the armature h when the latter is closed.

The armature j has a constant connection through a wire o^6 with one of the poles of the electromagnet B. The opposite pole of said magnet B is connected with one of the contact pieces d^4, the other of said contact pieces d^4 being connected with the wire o', as has already been stated.

One of the poles of the electromagnet B′ is connected with one of the contact pieces at d^3, the opposite pole of said magnet being connected by a wire p with a contact piece p' in position to engage the armature i when the latter is closed.

One pole of the electromagnet B^2 is connected with one of the contact pieces at d^5, the other pole of said magnet being connected by a wire p^2 with a contact piece p^3 in position to engage the armature i when the latter is open. One of the contact pieces at d^2 is connected by a wire k with ground and the other is connected by a wire q, which crosses the track, with a wire s leading from one pole of the relay J′ to a contact piece q' in position to engage the armature h' in the companion tower E′ when the latter is closed. The wire l^7 leading from one pole of the main relay H is also connected by a branch wire with one of the contact pieces at d', the other contact piece at d' being connected by a wire q^2 with the line wire Q at the next preceding tower E′ to the rear.

One pole of the relay H′ in the tower E′ is connected by a wire r with the rail M to the right of the insulation. The opposite pole of said relay H′ is connected by a wire l^5 with the other rail M′ to the right of the insulation and by the branch wire l^4 and its continuation r^2 with one pole of the auxiliary relay I′. It is also connected by a branch wire l^3 with a contact piece in position to engage the armature h' when the latter is closed, as has been already noted. The same pole of the auxiliary relay I′ to which r^2 is connected is also connected by a wire r^3 with a contact piece r^4 in position to engage the relay h' when the latter is closed. The opposite pole of said relay I′ is connected by a wire r^5 through a battery R with the line wire Q.

One pole of the auxiliary relay J′ is connected by a wire s with a contact point q' in position to engage the armature h' when the latter is closed, and the opposite pole of said relay J′ is connected with the line wire Q leading to the next succeeding tower E′. The armature h' is constantly connected, by a wire s^2 through the battery S and wire s^3, with one of the contact pieces at each of the contacts f, f' and f^2. The other contact piece at the contact f is connected by a wire s^4 with one pole of the electromagnet B′. The other contact piece at the contact f' is connected by a wire s^5 with one pole of the electromagnet B and the other contact piece at the contact f^2 is connected by a wire s^6 with one pole of the electromagnet B^2. The armature h' is connected with the earth by a wire K′. The armature i' is constantly connected by a wire s^7 with the other pole of the electromagnet B. The armature j' is constantly connected by a wire t with a contact piece t' in position to engage the armature i' when the latter is open and by a branch wire t^2 with a contact piece t^3 in position to engage the armature h' when the latter is closed. The other pole of the electromagnet B′ is connected by a wire t^4 with a contact piece t^5 in position to engage the armature j' when the latter is closed. The other pole of the electromagnet B^2 is connected by a wire t^6 with a contact piece t^7 in position to engage the armature j' when the latter is open.

The main track circuit for energizing and de-energizing the main relay H′ in each of the towers E′ includes the wires r and l^5 leading from the poles of the relay H′ to the rails M and M′ respectively, the rails M and M′ intermediate of that tower and the next succeeding set of towers and the connection m^2 between the rails M, M′ including the battery m^3 at the said next succeeding set of towers.

Assuming a train to be approaching the set of signals (Fig. 5) as at G and moving in the direction of the arrow, its effect upon the signal at the tower E′ will be as follows:—As it bridged the rails M, M′ intermediate of the set of towers (Fig. 5) and a similar preceding set of towers, it cut out the battery m^3 at the set of towers (Fig. 5) from the main relay H′ at the tower E′ of the preceding set and thereby permitted its armature h' to open, as shown at tower E′, Fig. 7. Such opening of the armature h' at tower E′ at the preceding set de-energized the relay I′ of tower E′ (Fig. 5) by breaking the circuit through the battery R (Fig. 5) which held I′ energized. A circuit corresponding to this circuit may be traced complete from the relay I′ at tower E′ (Fig. 6) back to tower E′ (Fig. 5) as follows:—from one pole of relay I′ (Fig. 6) along wire r^3 to contact r^4, through armature h' and wire K′ to ground, from the opposite pole of relay I′ (Fig. 6), along wire r^5, through battery R, line wire

Q to relay J′, through relay J′ and wire s to contact q', through armature h' and wire K′ to ground. The opening of the armature i' of relay I′, caused by the de-energizing of the latter, completed the circuit through the electromagnet B which held the signal to danger and by releasing the spindle A, permitted it to revolve a one-third revolution and thereby throw the signal at E′ (Fig. 5) to safety. The circuit closed by the opening of the armature i' may be traced as follows, remembering that the contact pieces at f' were closed as shown at f' (Fig. 6) when the spindle was released to throw the signal to clear:—from one pole of the electromagnet B along wire s^7 to armature i', thence to contact t', thence along wire t, thence along wire t^2 to contact t^3, thence along armature h' to wire s^2, through battery S, along wire s^3 to contact f' and thence along wire s^5 to the opposite pole of said electromagnet B. The one-third revolution of the spindle of the tower E′ (Fig. 5) which sets the signal at that tower to "clear," at the same time opened the contact at f^4 and thereby de-energized the main relay H in tower E (Fig. 6), viz: the next succeeding tower on the left. The circuit—broken by the opening of the contact f^4 in said tower E′—may be traced as follows:—from one of the contact pieces at f^4 along wire l', across the track to battery L, thence along wire l to the next succeeding tower E (Fig. 6) to one pole of the main relay H, thence from the opposite pole of said relay along wire l^7 to contact d, thence along wire l^6 to wire m^2 to rail M′, thence back to wire l^5, to wire l^4, to wire l^3, through relay h' to wire l^2 to the other of the two contact pieces at f^4 at said tower E′ (Fig. 5). The de-energizing of the main relay H in tower E of Fig. 6 and the consequent opening of the armature h has broken the circuit through the electromagnet B of the said tower E which holds the signals of that tower to danger and which must be energized in order to set them to safety and has thereby locked the said signal at tower E (Fig. 6) to danger as a header signal.

The circuit last above referred to for energizing the electromagnet B in tower E (Fig. 6) may be traced as follows: from one pole of the said electromagnet B to the contact d^4, from the opposite pole of said electromagnet B along wire o^6 to armature j, along said armature to contact o^3, thence to wire o^4, to contact o^5, to armature h, to wire o, through battery O and wire o', back to said contact d^4. The opening of the armature h at tower E (Fig. 6) has further de-energized the auxiliary relay J at tower E (Fig. 6) and relay I at tower E (Fig. 7) and has thereby locked the signal at tower E (Fig. 7) to caution.

In using the phrase "locked at caution," I wish to be understood as saying that the signal at tower E (Fig. 7) cannot be set to other position than "caution" by a train coming in the opposite direction along the same track. This is so for the following reasons; and as preliminary thereto, attention is called to the fact that the electromagnets B′ and B^2 release the spindle when they are de-energized, while the electromagnet B releases the spindle when it is energized; and further that the electromagnet B holds the signal at danger; the electromagnet B′ holds the signal at safety and the electromagnet B^2 holds the signal at caution. If therefore a train approaching the tower E (Fig. 7) in the opposite direction from the train G (Fig. 5, under consideration) opens the armature j of the relay J in tower E (Fig. 7) to set the signal to safety in the manner hereinabove described in connection with the relay I′, tower E′ (Fig. 5), the opening of said armature j will energize the electromagnet B and the spindle in tower E will be permitted to rotate a one-third revolution, carrying the signal there to safety, but it will not be arrested at safety because the circuit through the electromagnet B′ will be broken by the opening of the armature i of the relay I in said tower E (Fig. 7) thereby permitting the spindle to rotate a second one-third revolution immediately after the completion of its first one-third revolution, thereby carrying the signal from safety to caution, where it will be held because of the energizing of the electromagnet B^2 of said tower E (Fig. 7) caused by the closing of the contact at d^5 by the circuit closer D^5 as the spindle completes its second one-third revolution.

The circuit referred to hereinabove for energizing the electromagnet B of tower E (Fig. 7) may be traced from one pole of the electromagnet B along wire o^6, to armature j, to contact o^3, to wire o^4, to contact o^5, to armature h, to wire o, through battery O, to wire o', to contact d^4 and thence to the opposite pole of said electro magnet B.

The broken circuit referred to above, which leaves the electromagnet B′ de-energized to permit the spindle to rotate its second one-third revolution, may be traced as follows:—beginning with one pole of the electromagnet B′, along wire p, to contact p', across the break to armature i, to wire o^2, to wire o^4, to contact o^5, to armature h, to wire o, through battery O, to wire o', to contact d^3, and thence to the other pole of said electromagnet B′.

The circuit referred to above which energizes the electromagnet B^2 and hence retains the signal at caution, may be traced as follows:—beginning with one pole of the electromagnet B^2, along wire p^2, to contact p^3, to armature i, to wire o^2, to wire o^4, to contact o^5, to armature h, to wire o, through battery O, to wire o', to closed contact d^5 and thence to the other pole of said electromagnet B^2. It follows, therefore, that the train in the position G (Fig. 5) has set the signal on its right at clear and has locked the next succeeding signal on its left to danger and the second succeeding signal on its left to caution. Attention will now be given to the effect which the train in the position G has had upon the signals to the rear of it, and on the right hand side, to prevent rear end collision. In order to show this effect to advantage, we will assume the train to have advanced past the sets of signals (Figs. 5, 6 and 7) and to occupy the position shown at G′ approaching the set of signals, (Fig. 8.) By cutting out the battery m^3 at the set of signals (Fig. 8) the train has de-energized the main relay H′ at tower E′ (Fig. 7) thereby permitting its armature h' to open. The opening of the armature h' has broken the circuit through the electromagnet B′ at said tower E′ (Fig. 7) permitting the signal to change from safety to caution and it has also broken the circuit through B^2, permitting the signal to straightway pass from caution to danger and it will be locked in this danger position until the train at G′ shall have passed onto the block between the sets of signals (represented at Figs. 8 and 9) and this follows as a matter of course because, as I have already shown in connection with tower E′ (Fig. 5) it is necessary to a completion of the circuit through the electromagnet B, which holds the signal at danger, that the armature h' of that tower should be closed.

The circuits which when broken de-energize the electromagnets B′ and B^2 at tower E′ (Fig. 7) may be traced as follows: from one pole of the magnet B′, along wire t^4, to contact t^5, to armature j', to wire t^2, to contact t^3, to armature h', to wire s^2, through battery S, to wire s^3, to contact f, to wire s^4, to the opposite pole of said electro magnet B′, from one pole of the electromagnet B^2, along wire t^6, to contact t^7, to armature j', to wire t^2, to contact t^3, to armature h', to wire s^2, through battery S, to wire s^3, to contact f^2, to wire s^6, to the opposite pole of said magnet B^2. The opening of the armature h' at tower E′ (Fig. 7) has also served to lock the preceding signal on the right, viz: at tower E′ (Fig. 6) to caution by de-energizing the relay J′ at said tower and permitting its armature j' to open, for, when the armature j' is open, the opening of the armature i' at that tower and the consequent completion of the circuit which energizes the electromagnet B of that tower throws the signal to safety and will at the same time provide a break in the circuit through the electromagnet B′ of that tower so that the signal will immediately pass from safety to caution.

The broken circuit which de-energizes the relay J′ in tower E′ of Fig. 6, may be traced as follows: from one pole of said relay along wire s to contact q', to armature h', to wire K′, to ground and from the opposite pole of said relay J′, along the line wire Q to the next succeeding tower through battery R, along wire r^5, to relay I′, at tower E′ (Fig. 7), to wire r^3, to contact r^4, across break to armature h', to wire K′, to ground.

The broken circuit which de-energizes electromagnet B′ at tower E′ (Fig. 6), may be traced as follows: from one pole of said magnet B′, along wire t^4, to contact t^5, across break, to armature j', to wire t^2, to contact t^3, to armature h', to wire s^2, through battery S, to wire s^3, to contact f, to wire s^4 to the opposite pole of said magnet B′.

It remains now to show what the effect upon two signals will be when two trains approach each other "head on" and to this end one train may be assumed to be in the position above referred to, viz: at G′ (Fig. 8) going in the direction of the arrow, and another train in the position G^2 (Fig. 10) and going in the opposite direction. There are two blocks between the positions of the two trains referred to and each train, when in such position, will receive—as it approaches the tower on its right, the train G′ approaching the tower E′ (Fig. 8) and the train G^2 approaching the tower E (Fig. 10)—a caution or distant signal, which will indicate to them that the next signal ahead is at danger and will permit them to creep cautiously up to the danger point.

I have already shown what the effect of the train moving from left to right will be upon the second signal in advance of it at its left and how it is that the train coming in the opposite direction can move it only to caution and I will point out particularly how it is that the train coming from right to left has had such an effect upon the signal at tower E′ (Fig. 8) that it can only show caution or distance. The train at G′ has, in the manner already described, de-energized the relay H′ of tower E′ (Fig. 7) and the opening of its armature h' has, in the manner aforesaid, de-energized the relay I′ of tower E′ (Fig. 8) permitting its armature to open and thereby close circuit through the electromagnet B, releasing the signal at tower E′ (Fig. 8) and permitting it to turn one-third of a revolution, or to the position of clear. It will not, however, remain in this position because the relay J′ of tower E′ has become de-energized by the train at G^2 (Fig. 10) coming in the opposite direction and such de-energizing of the relay J′ breaks the circuit through the electromagnet B′, which would otherwise hold the signal to clear to permit the signal to move another step viz:—to caution or distance where it is held by the energizing of the electromagnet B^2.

The broken circuit through electromagnet B′ at tower E′ (Fig. 8) may be traced as follows: from one pole of said electromagnet B′, along wire t^4, to contact t^5, across break, to armature j', to wire t^2, to contact t^3, to wire s^2, through battery S, to wire s^3, to contact f, to wire s^4, to the opposite pole of said magnet B′.

The completed circuit which energizes the electromagnet B^2 to hold the signal at caution, may be traced as follows: from one pole of the magnet B^2, along wire t^6, to contact t^7 to armature j', to wire t^2, to contact t^3, to armature h', to wire s^2, through the battery S, to wire s^3, to contact f^2, to wire s^6, to the opposite pole of said magnet B^2.

The relay J′ at tower E′ (Fig. 8) has been energized by the train at g^2 approaching in the opposite direction, as aforesaid, in the following manner: The train G^2 by cutting out the main relay H′, tower E′ (Fig. 10) and permitting its armature h' to open has broken the circuit through the main relay H of the next succeeding tower E to its rear, which in turn has de-energized the relay J in tower E (Fig. 10) thereby energizing the electromagnet B of said tower E (Fig. 10) and permitting the signal at that tower to change from danger to safety. The circuits by which these results have been attained may be traced between the towers E, E′ (Fig. 9) and the corresponding towers (Fig. 10) assuming for the moment that the train G^2 is approaching the set of towers Fig. 9 instead of the set Fig. 10. The opening of the armature h', tower G′ (Fig. 9) breaks the following circuit through the relay H of Fig. 10, beginning with one of the poles of the relay H (Fig. 10) along wire l^7, to contact d, (which, when the signal at tower E, Fig. 10, is at danger, is closed) along wire l^6, to wire m^2, to relay M′, to wire l^5, (at tower E′, Fig. 9) to branch wire l^4, to wire l^3, across break, to armature h', to wire l^2, to contact f^4, to wire l', across track, through battery L, to wire l, to the opposite pole of said relay H at tower E (Fig. 10).

The opening of the armature h of relay H, at tower E (Fig. 10) de-energizes the relay J at tower E (Fig. 9) by breaking the following circuit: From one pole of the relay J at tower E (Fig. 9), along wire n', through battery N, along wire n, through relay I, at tower E (Fig. 10), along wire n^4, to contact n^5, across break to armature h, to ground wire K, to ground; from the opposite pole of said relay J, tower E (Fig. 9), along wire n^2, to contact n^3, to armature h, to wire K, to ground. The de-energizing of the relay J at tower E (Fig. 9) permits its armature j to open and thereby completes circuit through the electromagnet B of that tower in the manner which has been hereinbefore explained, causing the signal at that tower to turn from danger to clear.

Returning now to the tower E (Fig. 10) with the train G^2 in the position there shown, its effect upon the signal of said tower E (Fig. 10) will have been, as hereinabove explained, to move the signal from danger to clear, where, if there were no train or other hinderance to the operation of the circuits, it would remain until the said train G^2 has passed it. The turning of the signal at tower E (Fig. 10) from danger has cut out the wire l^6 from the circuit through the relay H of that tower and has cut in the wire q^2, completing the following circuit through the battery R at tower E′ (Fig. 9): beginning with one pole of the relay H at tower E (Fig. 10), along wire l^7, and short branch wire, to contact d', to wire q^2, back to tower E (Fig. 9), across the track, to battery R, at tower E′ (Fig. g), through said battery to wire r^5 at said tower, through relay l', to wire r^2, to wire l^3, through relay h', to wire l^2, to contact f^4, to wire l', across track, through battery L, at tower E (Fig. 9), to wire l, to the opposite pole of the relay H, at tower E (Fig. 10). This circuit made complete through battery R at tower E′ (Fig. 9), has cut the relay J′ at tower E′ (Fig. 8) out of the effect of the said battery R, at tower E′ (Fig. 9), which is the battery relied upon to energize it, and its armature j', at tower E′ (Fig. 8), has been permitted to open, thereby breaking circuit through the electromagnet B′ which would tend to hold the signal at clear, permitting the signal to pass on from clear to caution, as shown. It therefore follows that two trains approaching each other on the track will, when they are two blocks apart, each receive a caution or distance signal, which will indicate to them that there is danger ahead and under this signal they may be permitted to creep slowly up to the intermediate danger signal or to any suitable point where a shunt track is located for purposes of passing. Finally, after a train has passed a signal on its left, that signal will be prevented from going either to clear or caution, until the train shall have passed away from that signal onto the next succeeding signal section. If this were not so, it would have the effect of giving a following train the caution signal at the third preceding set of signals in the same manner that the train approaching in the opposite direction gave such train the caution signal as above described, so that the following train would be stopped at a danger signal, an entire section behind the train in advance, while the intention is that the following train shall be stopped at the danger signal adjacent to or at the end of the block on which the obstruction is; *e. g.*, while the main relay H (Fig. 8) signal E, is open, the circuit between the relays J and I (Figs. 7 and 8) is intact, thereby preventing the signal E (Fig. 7) from going to clear or caution while the train is in the position at G′, going in the direction of the arrow. This is accomplished as follows: As soon as the signal at the tower E (Fig. 8) moves from danger, it rotates the circuit closer F^3 into position to close the contact pieces at f^3, completing the circuit as follows: from earth, tower E (Fig. 7), through wire K, to armature h, to contact n^3, through wire n^2, to relay J, through relay J to wire n', to battery N, along wire n, to relay I at tower E (Fig. 8), through said relay to wire n^4, to branch wire n^6, across track to contact f^3, and thence along wire k, to ground; thus completing the circuit through the said relays J, tower E (Fig. 7) and relay I, tower E (Fig. 8).

I have already shown that it was necessary for the armature j to be open to complete the circuit through the electromagnet B to send the signal to clear.

What I claim is—

1. A block signal system, comprising series of signals arranged along a track in interconnected sets, electric circuits under the control of a train moving along the track to control the movements of the signals, the said electric circuits being arranged to hold the signals normally at danger, means controlled by the

train for turning the signals to safety when the track is free and circuit breakers and closers controlled by certain of said electric circuits to prevent a plurality of signals in advance of a train and a plurality of signals to the rear of a train from being turned to safety by an approaching train when the track is not free, substantially as set forth.

2. A block signal system, comprising series of signals arranged along a track in interconnected sets, electric circuits under the control of a train moving along the track to control the movements of the signals, the said electric circuits being arranged to hold the signals normally at danger, means controlled by the train for turning the signals to safety when the track is free and circuit breakers and closers controlled by certain of said electric circuits to prevent a plurality of signals both in advance and to the rear of a train from being set to safety when the track is not free and at the same time permitting a signal in advance and also to the rear to be set at "caution" or "distant" by an approaching train, substantially as set forth.

3. A block signal system, comprising series of signals arranged along a track in interconnected sets, insulated track sections corresponding to the number of sets of signals, a main track circuit, including the rails of one of the insulated track sections, a battery having one of its poles connected with one of the said rails and its opposite pole with the other of said rails and a relay at one of the members of a set of signals, and electric circuits connecting the individual members of a set of signals and the adjacent sets of signals and under the control of said main track circuit to display the proper signals when a train is moving in either direction along any of the insulated track sections, substantially as set forth.

4. A block signal system, comprising series of signals, arranged along a track in interconnected sets, electric circuits connecting the several sets and members of a set to control the movements of the signals, the electric circuits at each member of a set of signals including a main and two auxiliary relays for making and breaking the circuits and a track circuit for each set of signals including the main relay of one member of the set for placing the signals under the control of a train moving along the track, substantially as set forth.

5. A block signal system, comprising series of signals arranged along a track, each signal comprising a plurality of reciprocating arms connected to move together throughout a portion of their movement and free to move independently of one another throughout another portion of their movement, means for actuating the arms to give the proper information, and electric circuits under the control of a train moving along the track to release the signal actuating mechanism at the proper intervals, substantially as set forth.

GEORGE L. THOMAS.

Witnesses:
FREDK. K. HAYNES,
GEORGE BARRY.