C. H. LAY.

RAILWAY SIGNALING.

APPLICATION FILED NOV. 21, 1914.

1,166,915.

Patented Jan. 4, 1916.

5 SHEETS—SHEET 1.

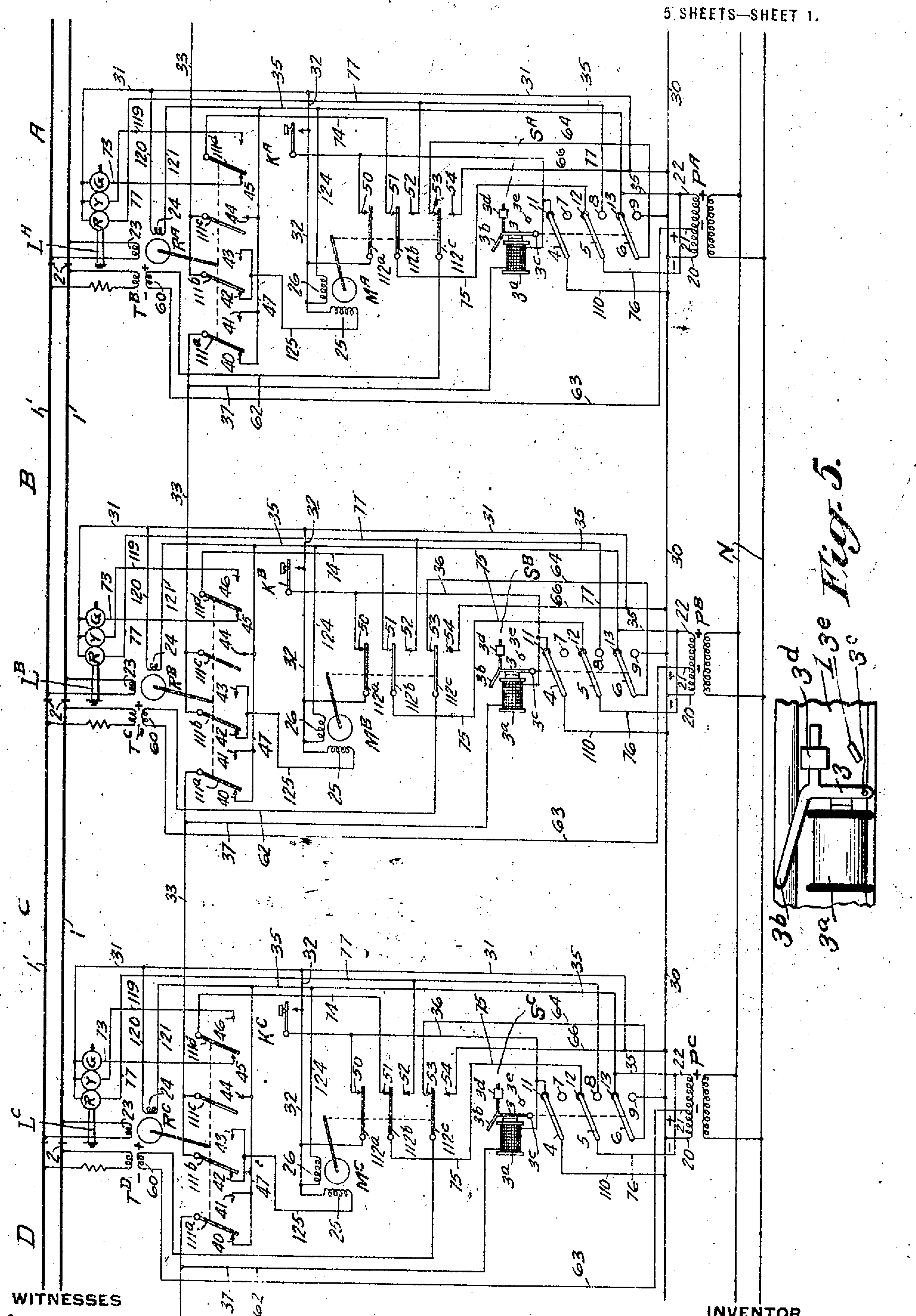

FIG. 1

Fig. 5.

WITNESSES

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5 SHEETS—SHEET 2.

FIG. 1A

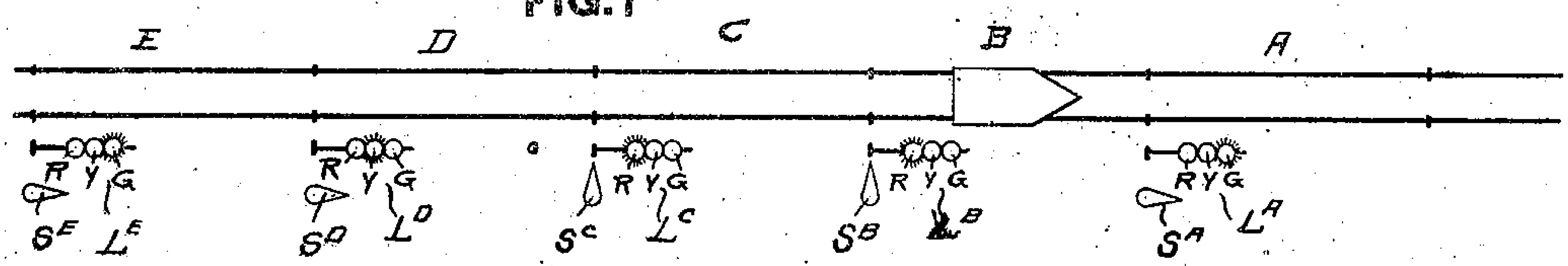


FIG. 2A

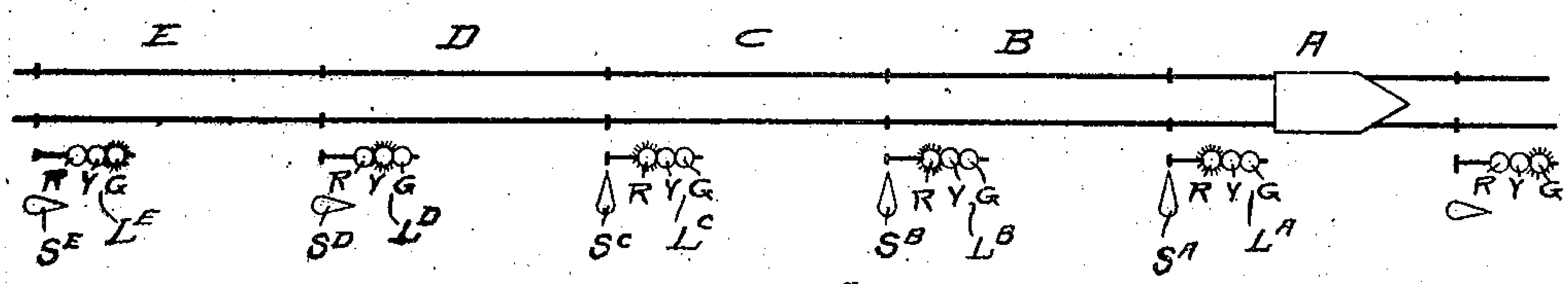


FIG. 3A

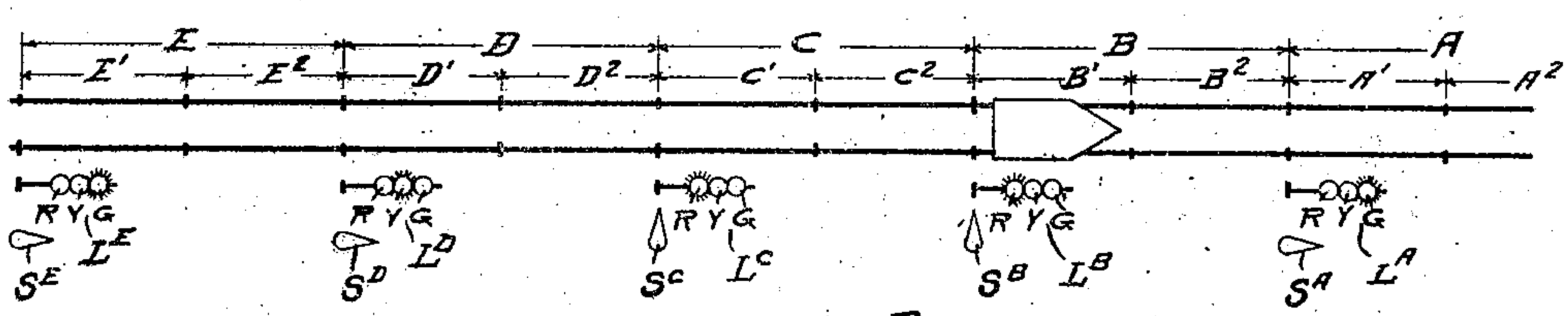


FIG. 3B

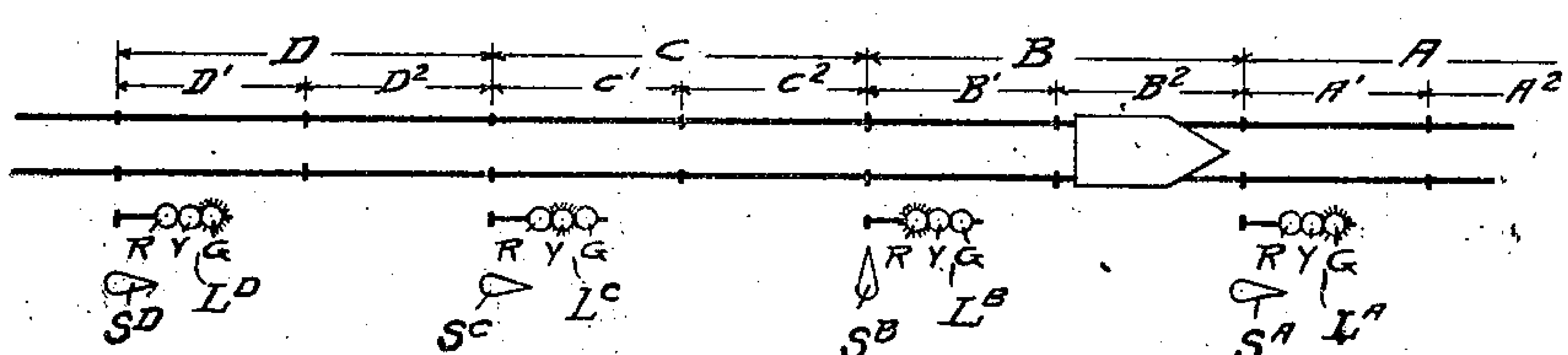


FIG. 4A

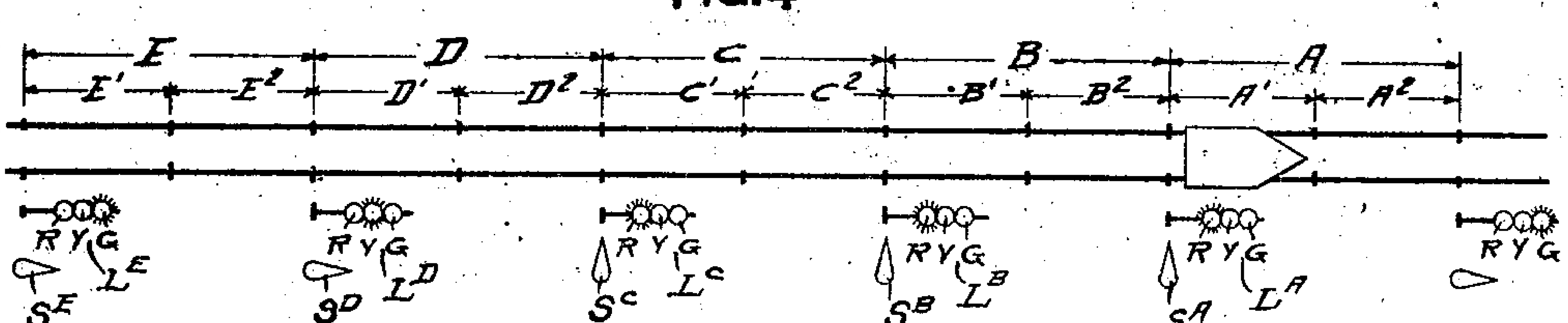
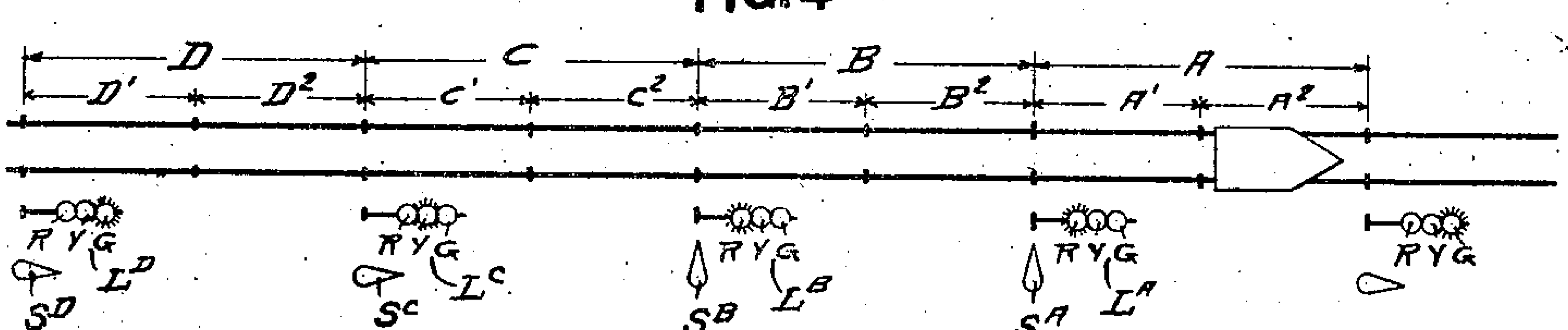


FIG. 4B



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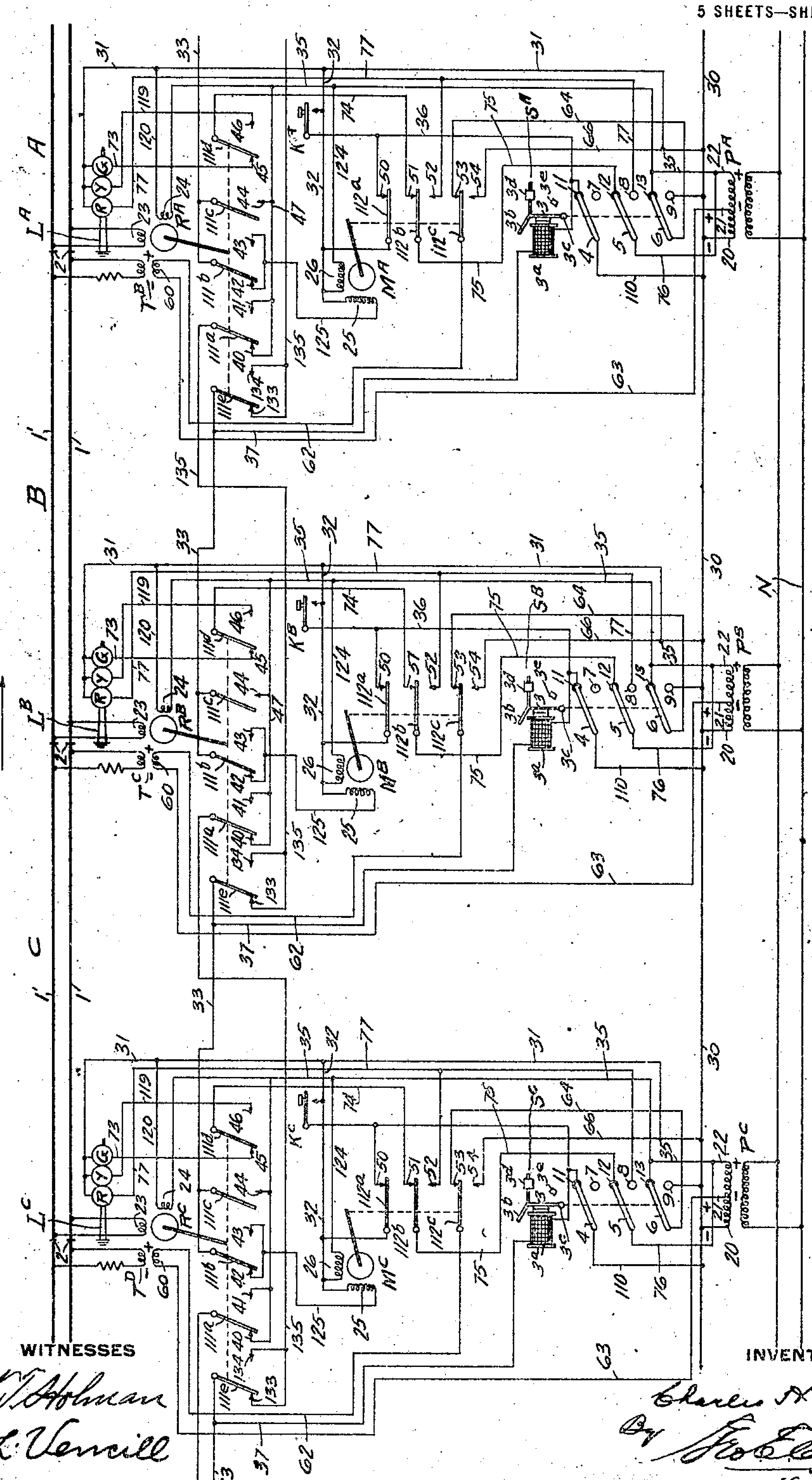
5 SHEETS—SHEET 3.

FIG. 2



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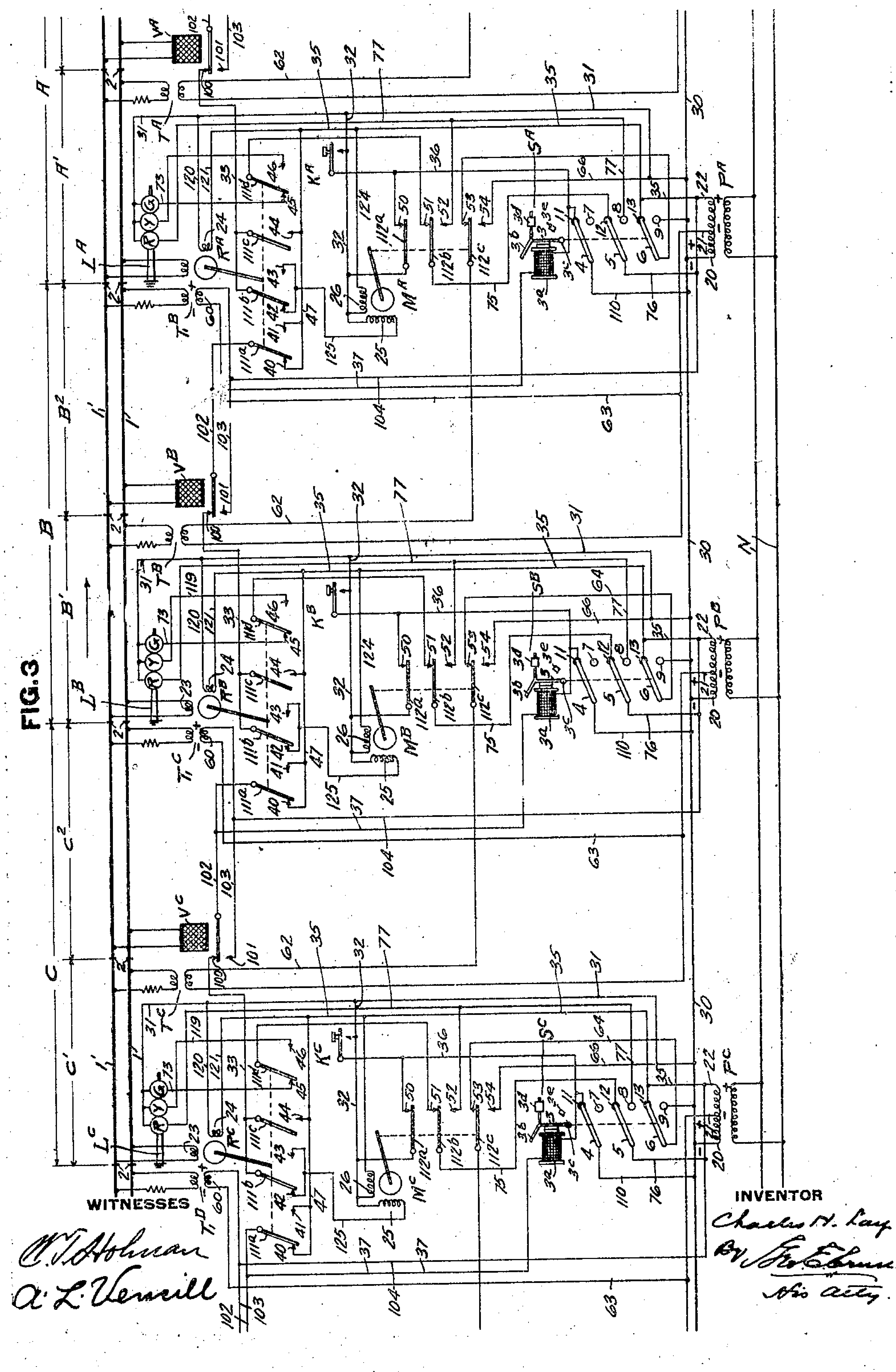
5 SHEETS—SHEET 4.

FIG. 3



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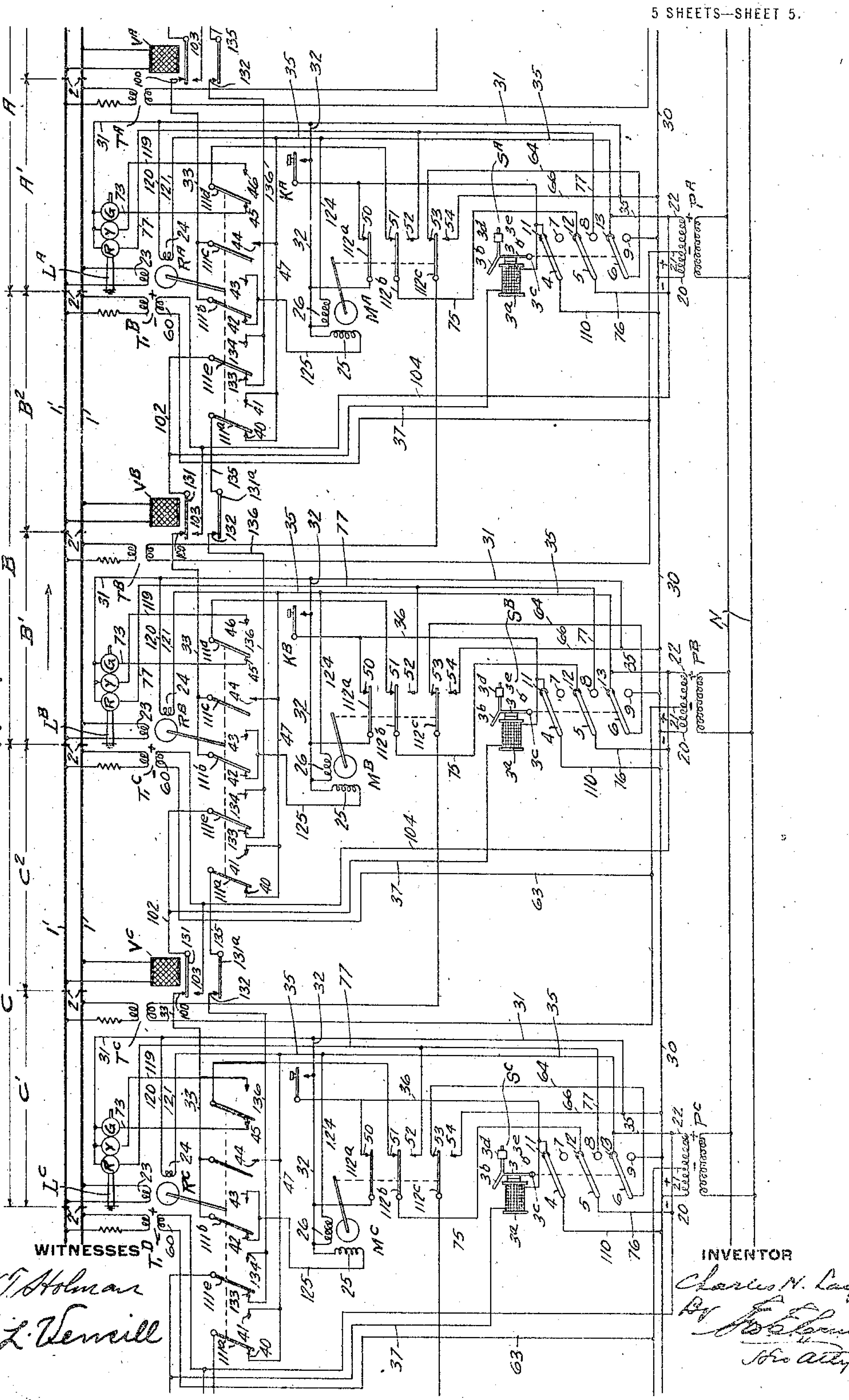
5 SHEETS—SHEET 5.

FIG. 4



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UNITED STATES PATENT OFFICE.

CHARLES H. LAY, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

RAILWAY SIGNALING.

1,166,915. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed November 21, 1914. Serial No. 873,255.

To all whom it may concern:

Be it known that I, CHARLES H. LAY, a citizen of the United States, residing at Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Railway Signaling, of which the following is a specification.

My invention relates to railway signaling, and particularly to systems of automatic signaling of the type in which the signals and other apparatus are controlled by track circuits.

I will describe certain forms of railway signaling systems embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings Figure 1 is a diagrammatic view showing one form of signaling system embodying my invention, the apparatus being arranged for one block overlap. Figs. 2, 3, and 4 are views similar to Fig. 1, but showing modifications arranged to provide two, one-half, and one and one-half block overlap respectively. Figs. 1^a, 2^a, 3^a, 3^b, 4^a, and 4^b are views showing diagrammatically the manner in which the signals and automatic stops shown in the preceding views are affected by the presence of trains. Fig. 5 is a view showing one of the automatic stops shown in the preceding views.

Similar reference characters refer to similar parts in each of the several views.

Referring to Fig. 1 reference characters 1 and 1′ designate the track rails of a railway track over which traffic moves in the direction of the arrow. These rails are divided into sections or blocks by any one of the several methods used in the art of railway signaling, such as insulated joints 2 in the rails. In the drawing I have shown two complete sections, B and C, and also the beginning and end respectively of two sections, A and D.

Located adjacent the entrances to the blocks are signals L^c, L^b, L^a, which signals as here shown are of the type in which lights only are employed for giving indications. Each signal is capable of giving three indications, namely, red for "stop," yellow for "caution," and green for "clear"—indications well understood by those versed in the art of railway signaling. The lamps for giving the red, yellow and green indications are designated R, Y and G respectively. Automatic stops, S^c, S^b, and S^a are also located at the entrances to the blocks near the corresponding light signals. As shown in Fig. 5, each automatic stop comprises an electromagnet 3^a, and a rocker arm 3 pivotally mounted at 3^c. When the electromagnet is energized it attracts arm 3, holding it in a vertical position, against the force exerted by a counterweight 3^d. This position of the arm 3 I shall call the inoperative position because the trip arm 3^b which moves with the rocker arm 3 is held below the track rail 1. When, however, the magnet 3^a is deënergized, it releases arm 3, so that counterweight 3^d swings the arm 3 into engagement with a stop 3^e. This position of the automatic stop I shall call the operative position, for trip arm 3^b is now in a vertical position and its tip is therefore raised above the top of track rail 1 so that it will engage with a trip valve placed on the car or other vehicle that runs past the automatic stop. This trip valve then operates mechanism by which the car or train is slowed down or brought to a standstill. In Fig. 1 each automatic stop S^a, etc., is similarly located with respect to the track rails, although to avoid confusion of the circuit diagram I have shown the automatic stops removed from the track rails. Operatively connected with arm 3 is a circuit controller consisting of contact arms 4, 5, 6, which make contact with points 11, 12, 13 respectively when the automatic stop is in the inoperative position, and which engage with contact points 7, 8, 9, respectively, when the automatic stop is in the operative position.

I have herein described only one form of an automatic stop, but I wish it understood that I do not limit myself to a stop of this particular kind.

Each block section is equipped with a track circuit, consisting, as usual, of a source of electric signaling current, the track rails of the section, and a relay operated by the signaling current flowing in the track circuit. In the form shown herein, the source of current is a transformer T^D, T^C or T^B located at one end of the track section, and a track relay R^C, R^B, or R^A is connected with the rails at the other end of the track section. Each relay as here shown is of the polyphase type comprising two windings 23 and 24 and a plurality of contact fingers 111^a, 111^b, 111^c, etc. These relays are of the three position type, so that when either winding of the relay is deënergized, the contact fingers are in the middle positions, and when both windings of the relay are energized, the relay "picks up" and the contact fingers swing to the left or right depending upon the relative polarity of the currents in the two windings.

Located adjacent the signals are line relays M^A, M^B, M^C, etc., each comprising two windings 25 and 26 and contact fingers 112^a, 112^b, etc. The purpose of these relays will be pointed out hereinafter.

Power for the operation of signals, relays, automatic stops and for feeding the track circuits is supplied by alternating current mains N through transformers P^C, P^B, P^A. The secondary coil of each of these transformers is tapped at the middle, so that either the full voltage or half the voltage of the coil may be used. The mains N are supplied with alternating signaling current from a suitable source which is not shown in the drawings.

The functions and operation of the circuits may be explained as follows. I will suppose the rails to be entirely unoccupied, and will consider first section B. Transformer P^B supplies, say, 110 volts between points 20 and 22. Assume that at a certain instant the voltage wave has such phase that point 22 is of higher potential than point 20. Then point 21 is negative with respect to point 22, but positive with respect to point 20.

Coil 24 of relay R^B is connected directly across the secondary of transformer P^B; the circuit for this coil being: from point 22 of transformer P^B through wires 35 and 121, coil 24, wires 120, 31 and 30 to point 20 of transformer P^B. Hence this coil is always energized. Coil 23 of the same relay is connected directly across the track, hence it is energized as long as no train is in section B. Suppose for the time being that the phase of the current through coil 23 is such that the contact fingers of relay R^B are swung to the left, as shown on the drawing. I will call this the normal pick up position, to distinguish it from the reverse pick up position when the contacts are swung to the right.

Coil 26 of line relay M^B is connected directly across the secondary of transformer P^B, the circuit being from point 22 of transformer P^B through wires 35 and 124, coil 26, wires 32, 31 and 30 to terminal 20 of transformer P^B. Hence this coil is always energized. Coil 25 of relay M^B is energized through the circuit; from terminal 22 of transformer P^A, wires 35 and 47, contact 40 or 41 and contact finger 111^a of relay R^A, wire 33, contact finger 111^b and contact 42 or 43 of relay R^B, wire 125, coil 25, wires 32, 31 and 30 to terminal 20 of transformer P^A. Hence it is evident that line relay M^B is energized as long as the track relays of blocks A and B are energized, either normal or reversed.

The automatic stop S^B is energized by the completion of the following circuit: from terminal 22 of transformer P^B, through wires 35 and 47, contact 40 or 41 and contact finger 111^a of relay R^B, wire 37, coil 3^a, wire 36, contact 50 and contact finger 112^a of relay M^B, wires 31, 31 and 30 to terminal 20 of transformer P^B. Thus it will be seen that the automatic stop when in the operative position cannot be moved to the inoperative position until the adjacent line relay is picked up and the track relay of the same block is also energized, either normal or reversed. Once stop S^B is placed in the inoperative position, however, it will remain in such position even if contact 50 of the line relay is opened, because contact finger 4 of the stop S^B then makes contact with point 11, thus bridging contact 50 of relay M^B, the circuit then being: from coil 3^a, through contact 4—11 of automatic stop S^B through wires 110 and 30 to terminal 20 of transformer P^B.

The automatic stop may be held in the inoperative position also by the following circuit: from terminal 22 of transformer P^C, wire 35, wire 47, contact 44 and contact finger 111^c of relay R^C, wire 33, wire 37, coil 3^a of automatic stop S^B, contact 4—11 of automatic stop S^B, wire 110, wire 30 to terminal 20 of transformer P^C. In other words, the automatic stop will be held in the inoperative position, even though the adjacent track relay is deënergized, until the track relay of the block in the rear picks up, *i. e.* until the rear of the train is completely out of the block in the rear.

A release key K^B is provided for each stop for use in case of emergency. By depressing this key, contact 50 of relay M^B is short circuited. Hence the automatic stop may be cleared by depressing key K^B even though relay M^B is deënergized. Once the stop is cleared it will be held in that position through contact 4—11 of the stop S^B.

Transformer T^B is energized through the following circuit: from tap 21 of transformer P^A, through wire 63, coil 60, wire 62, contact finger 112^c and contact 53 of relay M^A, wire 64, contact 6—13 of automatic stop S^A, wire 35, to terminal 22 of transformer P^A. Hence with the phase of voltage assumed above, winding 60 has the instantaneous polarity indicated on the drawing. I will call this the normal polarity of the transformer, *i. e.* that polarity which will cause the contacts of track relay R^B to swing to the left. It is evident that this polarity can be obtained only if the line relay M^A is picked up and the automatic stop S^A is in the inoperative position. If the automatic stop S^A is in the operative position, relay M^A being picked up, then contact 6—9 of stop S^A is closed, instead of contact 6—13; thus coil 60 of transformer T^B is energized by the part 21—20 of transformer P^B. Hence the polarity of coil 60 is the reverse of that indicated on the drawing. However, if the line relay M^A is deënergized, contact 53 is broken and contact 54 is made. This contact 54 is connected by means of wires 66 and 30 to terminal 20 of transformer P^A. Then coil 60 of transformer T^B is energized by the circuit; from point 21 of transformer P^A, wire 63, coil 60, wire 62, contact finger 112^c and contact 54 of relay M^A, wires 66 and 30 to point 20 of transformer P^A. Thus, regardless of the position of the automatic stop, as long as line relay M^A is deënergized transformer T^B has the polarity opposite to that indicated on the drawing.

The effect of the reversal of polarity of transformer T^B is to cause relay R^B to reverse, *i. e.* to pick up to the right instead of the left as shown on the drawing. The light displayed by the signal L^B depends upon the following conditions. Green lamp G is illuminated upon completion of the following circuit: terminal 22 of transformer P^B, wire 76, contact 5—12 of automatic stop S^B, wire 75, contact finger 112^b and contact 51 of relay M^B, wire 74, contact finger 111^d and contact 45 of relay R^B, wire 73, lamp G, wires 31 and 30 to terminal 20 of transformer P^B. Hence a green light is displayed only when track relay R^B is energized normal, line relay M^B is picked up, and the automatic stop is in the inoperative position.

Yellow lamp Y is illuminated upon the completion of the same circuit as the above, except that contact 46 must be closed instead of contact 45 so that current flows through wire 119 and lamp Y. Therefore, to obtain a yellow light, the track relay R^B must be energized reversed, the line relay M^B must be picked up and the automatic stop S^B must be in the inoperative position.

Red lamp R is illuminated upon the completion of the following circuit: from terminal 22 of transformer P^B, through wire 76, contact 5—8 of automatic stop S^B, wire 77, lamp R, wire 31 and 30 to terminal 20 of transformer P^B. Thus whenever the automatic stop S^B is in the operative position, a red light is displayed by signal L^B. But the circuit through lamp R may also be completed as follows: from terminal 22 of transformer P^B, through wire 76, contact 5—12 of automatic stop S^B, wire 75, contact finger 112^b and contact 52 of relay M^B, wire 77, lamp R, wires 31 and 30 to terminal 20 of transformer P^B. Hence, in case line relay M^B is deënergized, but the automatic stop is in the inoperative position, a red light will also be displayed.

What has been said about block section B applies equally well to the remaining block sections. This is evident, of course, from the identity of the apparatus for the several sections.

The operation of the apparatus shown in Fig. 1 will best be understood by reference to Fig. 1^a, wherein I have shown a plurality of successive block sections each equipped with a signal and an automatic stop as in Fig. 1. Block section B being occupied by a train, the track relay R^B for this section is in the deënergized or middle position, so that both lamps G and Y of signal L^B are extinguished because their circuits are open at contact 111^d. Line relay M^B is deënergized because its circuit is open at contact 111^b of relay R^B, and stop S^B is in the operative position because its circuit is open at contact 111^a of relay R^B. Lamp R of signal L^B is therefore illuminated because its circuit is closed at contact 5—8 operated by stop S^B. In section C, the track relay R^C is energized in such direction that its contact arms are swung to the right because the right hand terminal of primary 60 of transformer T^C is connected with terminal 20 of transformer P^B by contact 112^c—54 of relay M^B. Hence the circuit for lamp G of signal L^C is open at contact 111^d of relay R^C. Relay M^C is deënergized because the circuit for its winding 25 is open at contact 111^a of relay R^B, hence the circuit for lamp Y of signal L^C is open at contact 112^b of relay M^C. Stop S^C is in the operative position because its circuit is open at contact 112^a of relay M^C, hence the circuit for red lamp R of signal L^C is closed at contact 5—8 of stop S^C. In section D the track relay P^D is energized in such direction that its contact arms are swung to the right because the line relay M^C is deënergized, and the line relay M^D for section D is energized because the track relays for sections D and C are both energized. Hence the stop S^D is in the inoperative position because its pick-up circuit is closed at contact 112^a of relay M^D for section D and at contact 111^a of the track relay for the same section. Lamp Y of the signal L^D is therefore illuminated because its circuit is closed at contact 111^d—46 of track relay R^D and at contact 112^b—51 of line relay M^D and also at contact 5—12 of stops S^D. In section E the signal and the stop are in normal condition because the track relay is energized in normal direction and the line relay is energized. As the train proceeds into section A it will deenergize the track relay and the line relay for this section so that the green lamp of signal L^A will become extinguished and the red lamp will become illuminated at once through contact 112^b—52 of the line relay and contact 5—12 of the stop. The stop S^A will remain in the inoperative position however until the entire train has left section B because it is energized through contact 111^c of track relay R^B until this relay becomes energized.

It will be seen from the foregoing that with the arrangement of apparatus shown in Fig. 1, when a section is occupied by a train the signal for that section and for the section next in the rear both indicate "stop", while the signal for the second section in the rear of the occupied section indicates "caution"; and the automatic stops for the occupied section and for the section next in the rear are in the operative position. Hence a full block overlap is provided, that is, the minimum distance between trains is the length of one block section, and a following train may not approach at full speed to within two blocks distance from a preceding train. To receive a clear indication a following train must be at least three blocks behind a preceding train.

The length of overlap may be increased by controlling the winding 25 of each line relay M by a greater number of track relays in advance of the line relay. Thus, to provide two blocks overlap, the circuit for coil 25 of the line relay is passed in series through the contacts of the track relay for the corresponding block and through the contacts of the track relays of the two blocks in advance, as shown in Fig. 2. In this view each track relay, R^C, R^B or R^A is equipped with an additional contact finger 111^c which makes contact with point 133 when the relay is energized in the normal direction and with point 134 when the energization of the relay is reversed. The circuit through which coil 25 of line relay M^C is energized is then: from terminal 22 of transformer P^A, through wires 35 and 47, contact 40 or 41 and contact finger 111^a of relay R^A, wire 135, contact 133 or 134 and contact finger 111^c of relay R^B, wire 33, contact finger 111^b and contact 42 or 43 of relay R^C, wire 125, coil 25 of relay M^C, wires 32, 31 and 30 to terminal 20 of transformer P^A. The other parts of the circuits are exactly like those of Fig. 1.

Fig. 2^a shows a pair of track rails divided into blocks A, B, C, D, etc., each block being equipped with apparatus as shown in Fig. 2. Suppose a train is in block A. Then the track relay R^A is deënergized, so that the circuit for coil 25 of relay M^A is broken and the upper contacts of this relay are opened. Thereby automatic stop S^A is deënergized and moves to the operative position, and the polarity of transformer T^B is reversed. A red light is displayed at the entrance to block A because the automatic stop S^A is in the operative position. In block B the track relay R^B is energized reversed, due to the reversed polarity of transformer T^B. Line relay M^B is deënergized because track relay R^A is deënergized. Hence the automatic stop S^B is in the operative position, the track transformer T^C is of reversed polarity and a red light is shown at the entrance to the block. In block C conditions are similar to those in block B. The track relay R^C is energized reversed, the line relay M^C is deënergized, the automatic stop S^C is in the operative position, the track transformer T^D is of reversed polarity and a red light is displayed by the signal at the entrance to the block. Also in block D the track relay R^D is energized reversed, but the line relay M^D of this block is energized because the track relays of the blocks D, B, and C are energized. Hence the automatic stop S^D moves to the inoperative position. Thereby the polarity of transformer T^E is made normal. A yellow light is displayed by the signal at the entrance to this block because the track relay R^D is energized reversed. Finally, in block E, the track relay R^E is energized normal, the line relay M^E is energized, the automatic stop S^E is in the inoperative position, and the track transformer T^F is of normal polarity. A green light is shown by the signal at the entrance to the block, because the track relay R^E is energized in the normal direction. Thus the minimum distance between trains, when the apparatus is arranged as in Fig. 2, is two blocks, and a following train may not approach at full speed to within three blocks distance from a preceding train. To receive a clear indication a following train must be at least four blocks behind a preceding train.

Referring now to Fig. 3, I have here shown an arrangement of apparatus by which a half block overlap may be secured. Each block is divided into two sub-sections by additional insulated joints 2; thus block C is subdivided into sub-sections C^1 and C^2. I provide also additional alternating current, two position relays V^C, V^B and V^A which I shall call auxiliary track relays, each placed as shown in the middle of a block at the entrance end of the forward sub-section. Furthermore, transformers T^D, T^C, T^B connected directly across transformers P^C, P^B, P^A are substituted for transformers T^C, T^B, T^A at the exit ends of the block sections. The latter transformers are each placed at the middle of a block and are energized through the same circuits as shown in Fig. 1. The energizing circuit for a line relay, M^C for instance, is as follows: from terminal 22 of transformer P^B, through wires 35 and 47, to contact 40 or 41 and contact finger 111^a of relay R^B, wire 102, contact 100 of relay V^C, wire 33, contact finger 111^b and contact 42 or 43 of relay R^C, wire 125, coil 25 of relay M^C, wires 32, 31 and 30 to terminal 20 of transformer P^B. Therefore, in order to energize the line relay, the adjacent track relay contacts must be closed, either normal or reversed, the front contact of the auxiliary relay must be closed, and the contacts of the track relay of the block in advance must be closed, either normal or reversed. When the relay V^C is deënergized, the back contact closes the following circuit: from terminal 22 of transformer P^B, through wires 104 and 103, contact 101, wires 102 and 37, magnet winding 3^a of automatic stop S^B, contact 4—11 of automatic stop S^B, wire 110 to terminal 20 of transformer P^B. Therefore, once the automatic stop is in the inoperative position, it will be held so as long as the back contact of the relay of the subsections in the rear is closed. Hence when a train is leaving sub-section B^2 of block B, for instance, the automatic stop at the entrance to block A will be held in the inoperative position until the entire train has left block B.

Referring now to Fig. 3^a as well as to Fig. 3, if a train occupies subsection B′ of block B, the track relay R^B is deënergized, whereby the circuit of the line relay M^B is opened. Thus the automatic stop S^B is caused to move to the operative position and the polarity of track transformer T^C is reversed. A red light is displayed at the entrance to the block B, because the automatic stop is in the operative position. In block C the track relay R^C is energized reversed, due to change of polarity of transformer T^C. But line relay M^C is deënergized because the contacts of the track relay R^B of block B are open. With the line relay contacts open the automatic stop cannot be moved to the inoperative position, hence a red light is displayed at the entrance to block C, and the polarity of transformer T^D is reversed. Similarly, in block D the track relay is energized reversed. The line relay of block D is energized. Hence the automatic stop moves to the inoperative position and the polarity of track transformer T^E becomes normal. Since the reverse contacts of the track relay R^D are closed, a yellow light is displayed at the entrance to block D.

Conditions in block E are the same as in block D with the exception of the fact that the track relay is energized normal, which causes the green light to be shown at the entrance to block E. Now, assume the train to be in sub-section B^2 of block B, as shown in Fig. 3^b. Then relay V^B is deënergized, whereby the circuit of line relay M^B is kept open, even though track relay R^B is energized normally. Thus automatic stop S^B cannot move to the inoperative position, track transformer T^C is of reversed polarity and a red light is displayed at the entrance to block B.

In block C, the track relay R^C is energized reversed. Line relay M^C is also energized, because track relays V^C and R^B are both picked up. Thus automatic stop S^C will move to the operative position and transformer T^D becomes of normal polarity. The yellow light shows at the entrance to block C because the reverse contacts of relay R^C are closed. The same conditions prevail in block D, except that the track relay R^D is energized normally. Therefore a green light is displayed at the entrance of this block.

The above description show that the minimum distance between two trains may be as low as half a block. Thus an average closer spacing of trains can be obtained than with the arrangement shown in the preceding views.

To provide one and one-half block overlap I may arrange the apparatus as shown in Fig. 4. This arrangement differs from that shown in Fig. 3 only as follows. Each auxiliary track relay V^A, V^B, etc., is provided with an additional front contact, *i. e.*, a contact finger 131^a making contact with point 132. Also, each track relay R^A, R^B, etc. is furnished with an additional contact finger 111^e. which makes contact with point 133 when the relay is energized normally and with point 134 when the energization of the relay is reversed. The circuit by means of which coil 25 of relay M^C may be energized is as follows:—from terminal 22 of transformer P^A through wires 35 and 47, contact points 40 or 41 with contact finger 111^a of relay R^A, wire 135, contact finger 131^a with contact 132 of relay V^B, wire 136, contact 133 or 134 with contact finger 111^e of relay R^B, wire 102, contact finger 131 with contact 100 of relay V^C, wire 33, contact finger 111^b with contact 42 or 43 of relay R^C, wire 125, coil 25 of relay M^C, wires 32, 31 and 30 to terminal 20 of transformer P^A. Hence it is evident that the line relay of any block is energized when the main track relay and the auxiliary track relay of the same block are energized, the main track relay and the auxiliary track relay of the adjacent block in advance are energized, and the main track relay of the second block in advance is energized.

To explain the operation of the signaling system as shown in Fig. 4, assume a train to occupy sub-section A′ of block A, as shown in Fig. 4^a. Then track relay R^A of that block is deënergized, so that the circuit of line relay M^A is opened and its contact fingers drop. Thus the automatic stop S^A is caused to move to the operative position and the polarity of transformer T^B is reversed. A red light is displayed at the entrance to block A because the automatic stop is in the operative position.

In block B the track relay R^B is energized reversed, due to the reversal of polarity of transformer T^B. But line relay M^B is deenergized because the contacts of track relay R^A are open. Hence the automatic stop is in the operative position, the transformer T^C is of reversed polarity and a red light is displayed at the entrance to block B. Similarly, the track relay R^C of block C is energized reversed, the line relay M^C is deënergized, the automatic stop is in the operative position, the track transformer T^D is of reversed polarity and a red light is shown at the entrance to block C. Also in block D the track relay R^D is energized reversed, but the line relay M^D is energized. Hence the automatic stop moves to the operative position and the polarity of track transformer T^E becomes normal. A yellow light is displayed at the entrance to block D, because the reverse contacts of relay R^D are closed.

Conditions in block E are the same as in block D, with the exception that the track relay R^E of block E is energized normal. Thus a green light is caused to be shown at the entrance to that block. In this case, then, the minimum distance between trains is two blocks. If however, the train occupies sub-section A^2 of block A as shown in Fig. 4^b, then the minimum distance between that train and a following one becomes one and one-half block as the following discussion will show.

In block A, the relay V^A is deënergized, whereby the circuit of line relay M^A is kept open, even though track relay R^A is energized normally. Thus automatic stop S^A cannot move to the inoperative position, track transformer T^B is energized reversed and a red light is displayed at the entrance to block A.

The track relay R^B of block B is energized reversed the line relay M^B is deënergized, the automatic stop S^B is in the operative position, the track transformer T^C is of reverse polarity, and a red light shows at the entrance to block B. In block C the track relay is energized reversed. Line relay M^C is energized, therefore the automatic stop S^C moves to the operative position. Thus the polarity of transformer T^D is made normal. A yellow light is shown at the entrance to block C because track relay R^C is energized reversed. Conditions in block D are the same as those of block C, except that relay R^D is energized normal, therefore a green light is displayed at the entrance to the block. Thus it is evident that the minimum distance between two successive trains is one and one-half blocks. A following train may not approach at high speed to within two and one-half blocks distance from a preceding train, and to receive a clear indication a following train must be at least three and one-half blocks behind a preceding train.

The above illustration of my system of signaling with modifications to give various lengths of overlap suffice to show that my system can be easily modified to give any desired length of overlap.

Although I have herein shown and described only a few forms of railway signaling embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In railway signaling, a plurality of successive block sections, track circuits for the sections each including a track relay responsive to reversals of current, a line relay for each section, means for controlling each line relay by the track relay for the same section and by the track relay for a section in advance, means controlled by each line relay for supplying current of one polarity or the other to the track circuit for the section in the rear according as said relay is closed or open, and a signal for each section controlled by the track relay and line relay for the section.

2. In railway signaling, a plurality of successive block sections, track circuits for the sections each including a track relay responsive to reversals of current, a line relay for each section, means for controlling each line relay by the track relay for the same section and by the track relay for a section in advance, the line relay being energized only when the track relays by which it is controlled are energized, means controlled by each line relay for supplying current of one polarity or the other to the track circuit in the rear according as the line relay is energized or deënergized, a signal for each section adapted to indicate clear and caution, a clear indication circuit and a caution indication circuit for each signal which circuits are controlled by the line relay and the track relay for the same section, and one or the other of said signal circuits being closed according as the track relay is energized in one direction or the other.

3. In railway signaling, a plurality of successive block sections, track circuits for the sections including track relays, an automatic stop for each section located at the entrance end of the section and capable of an operative and an inoperative position, a circuit for each stop for holding the stop in inoperative position and controlled by the track relay for the same section, said circuit being closed when the track relay is energized, and a branch circuit for each stop independent of said latter track relay and controlled by a track relay for the section in the rear, said branch circuit being closed when the track relay in the rear is deënergized, whereby the stop is held in the inoperative position until

a train entering the section for which the stop is provided has passed entirely out of the section in the rear.

4. In railway signaling, a plurality of successive block sections, track circuits for the sections including track relays, a line relay for each section controlled by the track relay for the section and by the track relay for a section in advance, said line relay being energized when said track relays by which it is controlled are energized, an automatic stop for each section capable of an operative and an inoperative position, a circuit for each stop for holding it in the inoperative position and controlled by the track relay and the line relay for the same section, said stop circuit being closed when both of said relays are energized, a contact operated by each stop and closed when the stop is in the inoperative position, and a branch for each stop circuit around the line relay contact and including said stop-operated contact.

5. In railway signaling, a plurality of successive block sections, track circuits for the sections including track relays, a line relay for each section controlled by the track relay for the section and by the track relay for a section in advance, said line relay being energized when said track relays by which it is controlled are energized, an automatic stop for each section capable of an operative and an inoperative position, a circuit for each stop for holding it in the inoperative position and controlled by the track relay and the line relay for the same section, said stop circuit being closed when both of said relays are energized, a manually operable circuit controller for each stop, and a branch for each stop circuit around the line relay contact and including said manually operable circuit controller, whereby the stop circuit may be closed by hand when the line relay is deënergized.

6. In railway signaling, a plurality of successive block sections, track circuits for the sections including track relays, a line relay for each section controlled by the track relay for the section and by the track relay for a section in advance, said line relay being energized when said track relays by which it is controlled are energized, an automatic stop for each section capable of an operative and an inoperative position, a circuit for each stop for holding it in the inoperative position and controlled by the track relay and the line relay for the same section, said stop circuit being closed when both of said relays are energized, a contact operated by each stop and closed when the stop is in the inoperative position, and a branch for each stop circuit around the line relay contact and including said stop-operated contact, and a second branch for each stop circuit independent of the track relay for the corresponding section and controlled by a track relay for the section in the rear, said second branch being closed when the latter track relay is deënergized whereby the stop is held in the inoperative position until a train entering the section for which the stop is provided has passed entirely out of the section in the rear.

7. In railway signaling, a plurality of successive block sections, track circuits for the sections each including a track relay responsive to reversals of current, a line relay for each section, means for controlling each line relay by the track relay for the same section and by the track relay for a section in advance, means controlled by each line relay for supplying current of one polarity or the other to the track circuit for the section in the rear according as said relay is closed or open, a signal for each section, a clear indication circuit for each signal closed when the track relay and the line relay for the same section are energized, and a stop indication circuit for each signal closed when the line relay for the same section is deënergized.

8. In railway signaling, a plurality of successive block sections, track circuit for the sections each including a track relay responsive to reversals of current, a line relay for each section, a circuit for each line relay which circuit is closed when the track relay for the same section and the track relay for the section next in advance are energized, an automatic stop for each section, means for each stop for holding it in the inoperative position when the track relay and the line relay for the same section are energized, means for each section for supplying signaling current of one polarity to the track circuit for the section when the stop for the section in advance is in the inoperative position and the line relay for said section in advance is energized and for supplying signaling current of the opposite polarity to said track circuit when the line relay for said section in advance is deënergized, and a signal for each section controlled by the track relay, the line relay, and the stop for the same section.

9. In railway signaling a plurality of successive blocks each comprising sub-sections, track circuits for the sub-sections each including a track relay, the relay for the rear sub-section of each block being responsive to reversals of current, a line relay for each block controlled by the track relays for the same block and by the track relay for the rear sub-section of the block next in advance, means controlled by each line relay for supplying signaling current of one polarity or the other to the track rails of the rear sub-section of the block in the rear according as

said relay is closed or open, means for supplying signaling current to the other sub-section or sub-sections of each block, and a signal for each block controlled by the line relay for the block and by the track relay for the rear sub-section of the block.

10. In combination, a plurality of successive sections of a railway track, a signal and an automatic stop for each section, track circuits including track relays for the sections, a circuit for each section for the control of the signal for such section, said circuit comprising two line wires extending through the section, a local circuit for each stop controlled by the track relay for the corresponding section, and a branch circuit for each stop independent of said latter track relay and controlled by a track relay for the section in the rear, said branch circuit comprising the same two line wires as the signal controlling circuit for the section in the rear of said stop.

11. In combination, a plurality of successive sections of a railway track, track circuits including track relays for the sections, a signal and an automatic stop for each section, a circuit for each signal for the control thereof, each circuit including a line wire extending through the section and a common wire extending through the several sections, each circuit being controlled by the track relay for the corresponding section and by the track relay for the section in advance so that said circuit is closed only when both of said relays are energized, and a retaining circuit for each automatic stop including the common wire and the line wire for the section in the rear, each retaining circuit being controlled by the track relay for the said section in the rear so that said circuit is closed only when said relay is deënergized.

12. In combination, a plurality of successive sections of a railway track, a signal and an automatic stop for each section, a circuit for each signal comprising line wires extending through the corresponding section, a retaining circuit for each automatic stop extending through the section in the rear and including the same line wires as the signal circuit for the latter section, and track circuits for the sections including track relays for the control of said signal and automatic stop circuits.

13. In railway signaling, a plurality of successive block sections, track circuits for the sections, each including a track relay, a signal for each section, an automatic stop for each section, capable of an operative and an inoperative position, two line wires running parallel to the block section, a circuit for each signal for controlling said signal, said circuit including contacts of the track relay adjacent to said signal, the two line wires, and contacts of the track relay of the section in advance, a circuit for each automatic stop for holding the stop in the inoperative position and controlled by the track relay for the corresponding section, said circuit being closed when the said track relay is energized, and a branch circuit for each stop including said two line wires for the section in the rear, the branch circuit being independent of said latter track relay and controlled by a track relay for the section in the rear, said branch circuit being closed when the track relay in the rear is deënergized, whereby the stop is held in the inoperative position until a train entering the section for which the stop is provided has passed entirely out of the section in the rear.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES H. LAY.

Witnesses:
H. S. Loomis,
A. C. Nolte.