No. 834,129. PATENTED OCT. 23, 1906.

L. A. HAWKINS.

BLOCK SIGNAL SYSTEM.

APPLICATION FILED APR. 7, 1906.

4 SHEETS—SHEET 1.

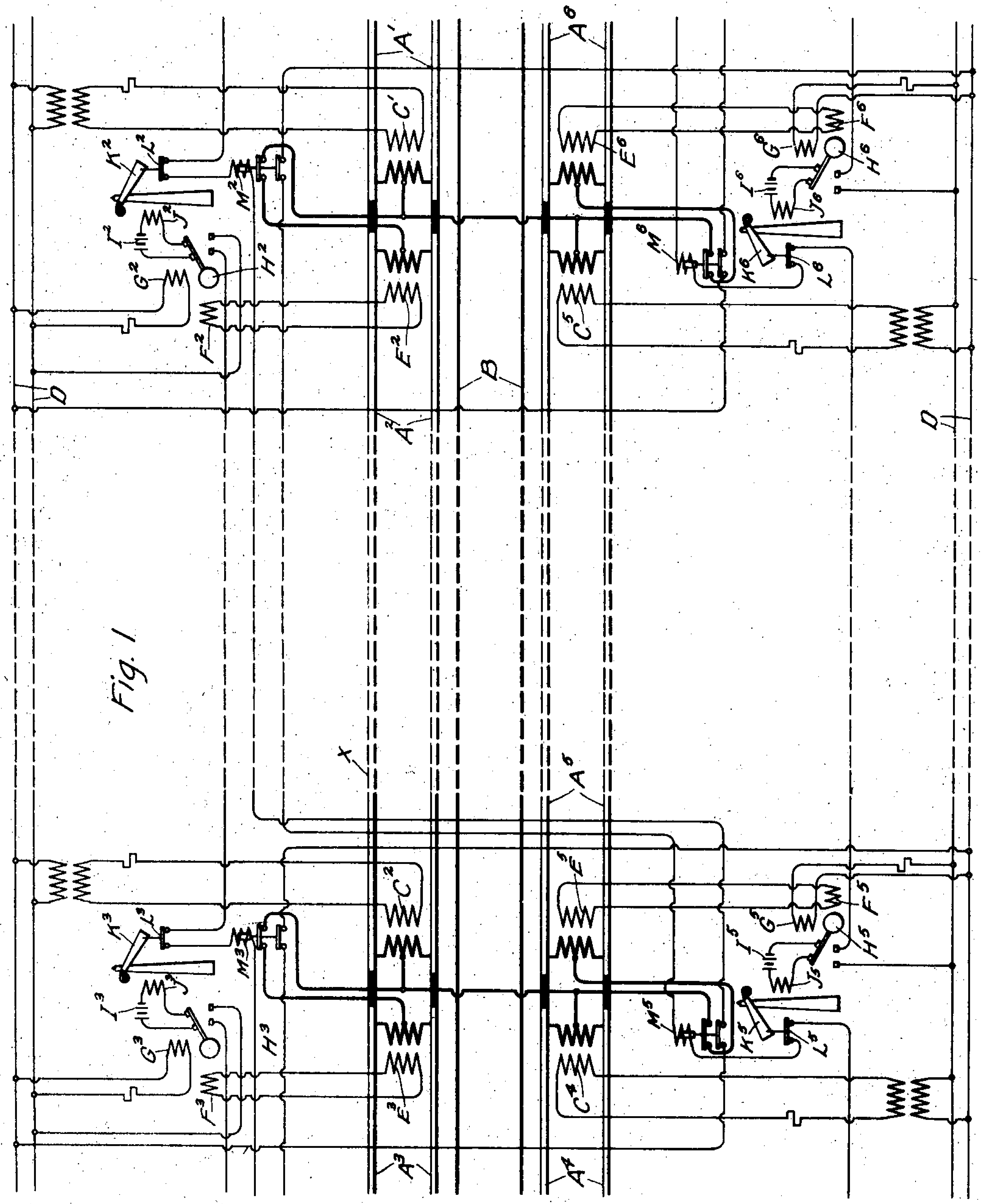

Fig. 1

Witnesses;
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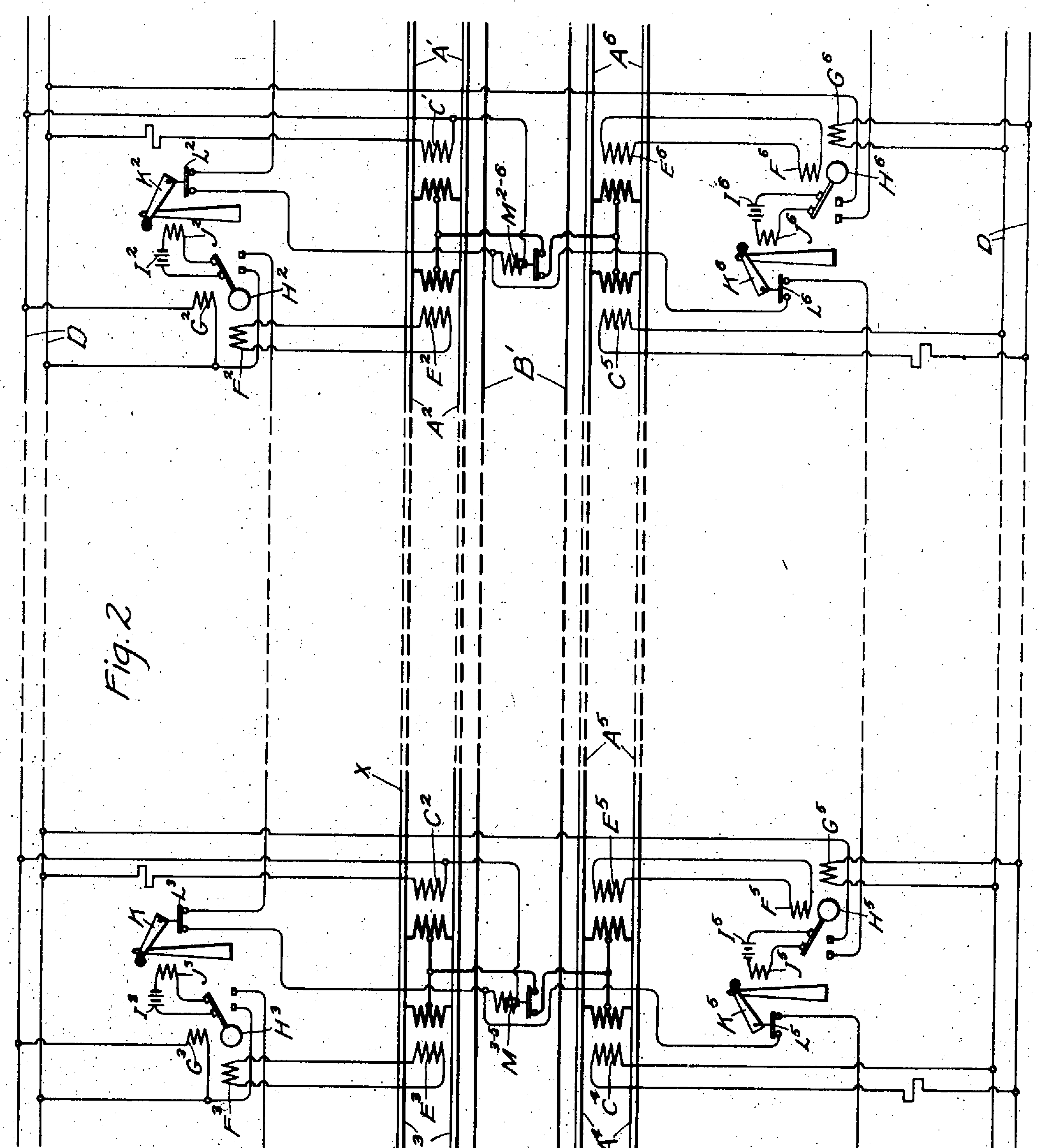

Fig. 2

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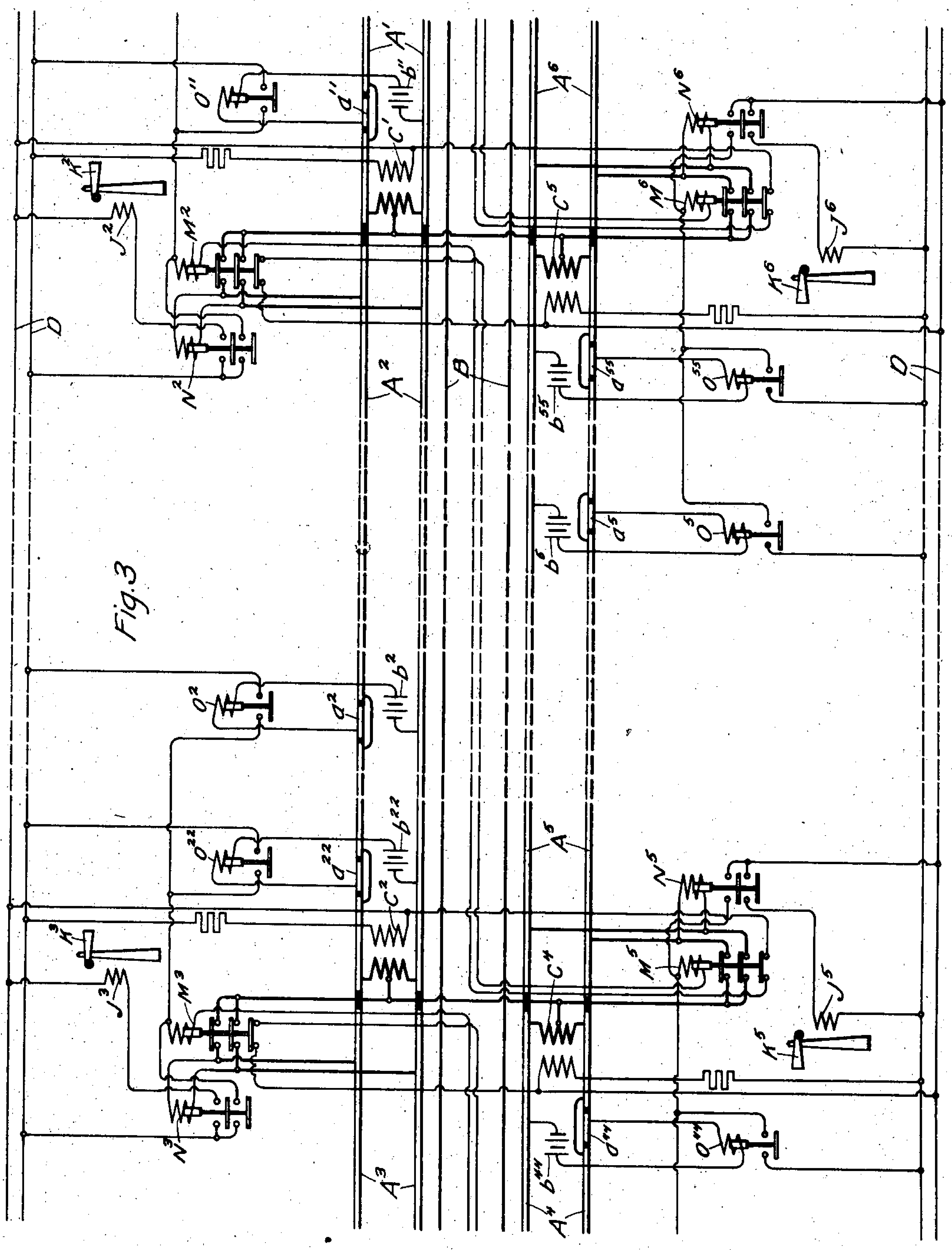

Witnesses;
Murray D. Badgley
Helen Orford

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4 SHEETS—SHEET 4.

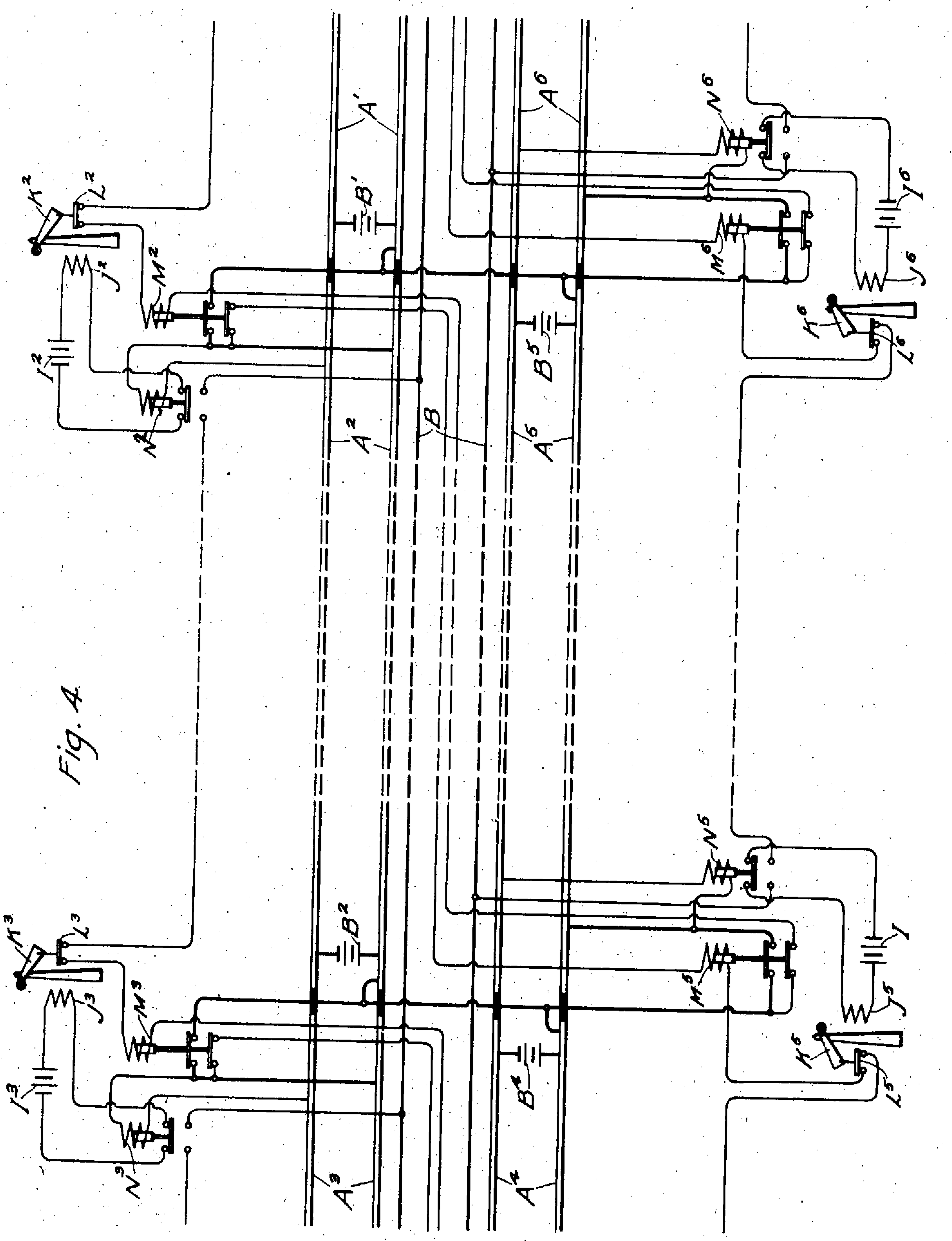

Fig. 4

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Helen Orford

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UNITED STATES PATENT OFFICE.

LAURENCE A. HAWKINS, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

BLOCK-SIGNAL SYSTEM.

No. 834,129. Specification of Letters Patent. Patented Oct. 23, 1906.

Application filed April 7, 1906. Serial No. 310,515.

To all whom it may concern:

Be it known that I, LAURENCE A. HAWKINS, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Block-Signal Systems, of which the following is a specification.

My invention relates to block-signal systems for electrically-operated roads employing the rails as the return-conductor for the power-current. In such roads it is the practice to form connections between the adjacent blocks of the same track adapted to afford a path for power-current, but so arranged that the signal-current will not pass from one block to another. Several methods of forming this connection are well known in the art. It also sometimes becomes desirable to cross-connect parallel tracks, so that if the rail-circuit of a block of one track has an unduly high resistance, due to defective bonding, it will not produce a drop of voltage in the system, since another track is connected in parallel with it. This cross connection between the tracks introduces certain difficulties, since a block-signal system as ordinarily arranged will not detect a broken rail if the tracks are cross-connected. This is obvious from the fact that one or both rails of each block are connected in parallel with another track, so that a break may occur in the rail without opening the signal-circuit. Consequently a whole rail might be removed and the signal for that block nevertheless give a clear indication.

The object of my invention is to avoid this source of danger; and my invention in its broadest aspect consists of providing automatic means controlling the cross connections and arranged to break the cross connections at the proper time.

More specifically stated, my invention consists in inserting a switch in the cross connection from an end of a block to the other track and providing means controlled by a train in the preceding block for breaking the cross connection. In other words, whenever a train is approaching a block its presence in the preceding block serves to isolate the block it is approaching, so that if a rail is broken in that block it will be indicated by the signal.

My invention further comprises an arrangement of the automatic controlling means such that the cross connections are never broken except when necessary for safety. For this purpose I control the switch in the cross-connection not only by a train in the preceding block, but also by the signal for the block to which the switch belongs, so that if the signal is already at "danger" the cross connection is not opened, and just as soon as the signal goes to "danger" upon the train entering the block the switch is closed—*i. e.*, a block is isolated only when the signal for that block is at "clear" and a train is in the preceding block.

My invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 shows diagrammatically an electrically-operated road provided with a block-signal system arranged in accordance with my invention, and Figs. 2 to 4 show modifications.

In the drawings, A′, A^2, and A^3 represent portions of three blocks in one track, and A^4, A^5, and A^6 represent portions of blocks in the other track.

B represents the supply-conductors for the power-current—*i. e.*, the third rails or trolley-wires.

C′ C^2, &c., represent transformers which supply alternating signal-current to the track-circuits and which are connected directly or through step-down transformers to the alternating-current line-wires D.

I have illustrated in Fig. 1 and shall describe my invention as applied to a block-signal system employing alternating current for the signal-circuits, since on roads operated by direct current, which are at present in the great majority, it is desirable to use alternating current for the signal-circuits, as by so doing interference between the signal and power-current may readily be prevented. I desire it to be understood, however, that in its broadest aspect my invention is not limited to signal systems employing any particular kind of current for the signal-circuits nor any particular arrangement of connections between blocks.

E^2 represents a transformer connected to the opposite end of the block A^2 and supplying one coil F^2 of the track-relay for that block. This relay is shown as of the polyphase induction type, the other primary relay-coil G^2 being connected directly or through a step-down transformer to the alternating-current line-wires D. I have indicated this type of relay, since it is one which is not affected by fluctuations of power-current in the primary of the transformer E^2 which supplies the track-coil. The short-circuited secondary member H^2 is provided with a contact member which when both coils F^2 and G^2 are energized closes a circuit through a source of current I^2 and the operating mechanism J^2 of the signal K^2. The operating mechanism is merely indicated diagrammatically, and it will be understood that any well-known type may be employed.

It will be seen that the central point of the primary of transformer E^2 is connected to the central point of the secondary of transformer C′, supplying the adjacent block of the same track. This connection is arranged to afford a path for the power-current, so that the rails of the track may act as return-conductor, and the particular connection shown—*i. e.*, between equipotential points of the alternating-current signal-circuits is the same arrangement as is described in Patents Nos. 645,907 and 647,741, issued to Bedell March 20, 1900, and April 17, 1900, respectively. As pointed out in those patents, this equipotential connection enables the same conductors to carry two currents of different kinds without mutual interference, since the direct current tends to divide equally between the two portions of the transformer-winding and has therefore no magnetizing effect.

The arrangement as thus far described is one which has been proposed heretofore for use in electrically-operated roads and has been described in detail only for the purpose of giving a clear understanding of my present invention, the specific arrangement and connections above described being in no way essential to my invention in its broader aspects.

It will be seen from the drawings that not only are adjacent blocks of the same track connected together, but cross connections are also made between the parallel tracks. With this cross connection it is evident that a break may occur in one of the rails of a block—as, for instance, at the point X in the block A^2—without putting the signal for that block at "danger," since under these conditions current may flow from the central point of the secondary of transformer C^2 through the cross connection to the opposite block, through the two portions of the primary of transformer E^5 in opposite direction through the rails of block A^5, through the two portions of the secondary of transformer C^5 in opposite directions, through the cross connection to the central point of the primary of transformer E^2, through the lower half of the primary winding, and through the lower rail A^2 back to the second lower terminal of transformer C^2, and this current in the primary of transformer E^2 may be sufficient to energize relay-coil F^2, so as to hold signal K^2 at "clear."

In order to prevent an accident from this cause, I insert automatic switches in the several cross connections, as shown. Thus, for instance, a switch controlled by the magnet-coil M^3 is arranged when opened to disconnect the entrance end of the block A^3 from the opposite track, and consequently when this switch is open a broken rail in that block is no longer shunted by the opposite track; but the signal-circuit is positively opened and the signal must go to "danger." For controlling this switch I include the magnet-winding M^3 across the line-wires D in series with three sets of contacts, one set being the back contacts of the track-relay for the block A^2, another set being controlled by the signal K^3 and closed when that signal is at clear position, and a third set controlled by an automatic switch in the opposite track one block ahead. Consequently when the signal K^3 is at "clear" and a train enters the block A^2, short-circuiting the primary of transformer E^2, and thereby deënergizing relay-coil F^2, the movement of the secondary member H^2 to the relay will close the back contacts of the relay, thereby closing a circuit if the automatic switch of the other track is closed through the magnet M^3, which opens and holds open the switch which it controls, thereby cutting off one end of the block A^3 from the opposite track. Consequently if a rail is broken in the block A^3 the signal K^3 will indicate "danger," and the train approaching in the block A^2 will be properly warned.

It will be seen that the switch is so arranged in the cross connections that the operation of the magnet M^3 does not disturb the connection between the block A^2 and the opposite track. Furthermore, if the signal K^3 is at "danger" the magnet M^3 does not operate, and if the magnet operated, owing to the signal K^3 being at "clear," the switch controlled by the magnet is at once closed again when the front wheels of the train enter block A^3. In other words, the cross-connections are closed at all times, thereby securing the maximum conductivity of the system, except when it is necessary that these connections should be broken in order to protect against possible danger.

As has been said above, the circuit of the actuating-magnet for each automatic switch comprises contacts of the automatic switch for the opposite track one block ahead. The reason for thus interlocking the automatic switches is to prevent the return-circuit for the power-current formed by the track-rails from being broken entirely.

By reference to Fig. 1 it will be seen that if magnets M^2 and M^5 were simultaneously energized the return-circuit for the power-current would be completely broken. For this reason the circuit of magnet M^2 is extended through contacts controlled by magnet M^5, and the circuit of magnet M^5 similarly includes contacts controlled by magnet M^2. Consequently if either magnet is energized and its switch is opened the circuit of the other magnet is broken, so that its switch cannot be opened. In this way a complete opening of the power-circuit is prevented, and at the same time protection against a broken rail is not interfered with, for it will be seen that if magnet M^5 is energized so as to open its switch and if there is a broken rail in block A^2 at X the alternating signal-current of block A^2 can find no path through the parallel block A^5, and consequently the signal K^2 will properly indicate "danger." When relays are employed of the type indicated in Fig. 1 or of any other type not affected by an unbalanced pulsating power-current in the track-transformer, the automatic switches need not necessarily be inserted in the cross connections at the point shown in Fig. 1, but instead may be inserted at the points shown in Fig. 2. By this modification the number of switches required is halved and the interlocking connections dispensed with.

In the arrangement shown in Fig. 2 each automatic switch acts simply to disconnect a block of one track from the opposite track without disconnecting it from the adjacent end of the adjacent block of the same track. This arrangement with blocks of ordinary length gives sufficient protection against a broken rail, for if there is a broken rail in block A^2 at X, for instance, the signal-current from the secondary of transformer C^2 must flow the total length of blocks A^5, A^6, and A^4 in order to reach the other end of block A^2. This distance is ordinarily so great that there is no danger that sufficient signal-current will flow through the circuit as described above to energize the relay to close the signal-circuit if a broken rail exists. The connections of the actuating-magnets for the automatic switches may be understood from an inspection of the drawings. One terminal of magnet M^{35} is connected to the upper line-wire D and the other terminal is connected to the lower line-wire D through two parallel circuits, one passing through switch L^3 and the back contacts of relay-armature H^2 and the other passing through switch L^5 and back contacts of the track-relay for block A^4. (Not shown.) Thus magnet M^{35} will be energized if either signal K^3 or K^5 is at clear position and the track-relay of the preceding block is energized. In other words, magnet M^{35} will be energized if signal K^3 is at "clear" and a train is in block A^2 or if signal A^5 is at "clear" and a train in block A^4, or both. Consequently any block which a train is approaching will be disconnected from the opposite track as long as the signal for that block is at clear position. The same principle may be applied to "normal danger" systems as well as to "normal clear," and in such systems the application of this principle makes it possible to employ track-relays of the usual solenoid type, rendering it unnecessary to use track-relays specially designed so as not to be affected by the power-current. Fig. 3 shows one arrangement of automatic switches applied to a normal danger system. The central point of the secondary of transformer C′, supplying the alternating signal-current to block A′ is connected through switches controlled by magnet M^2 to both rails of block A^2. The track-relay N^2 is connected directly across the track-rails; the transformer shown in Figs. 1 and 2 between the track-circuit and the track-relay being omitted. The relay itself is shown as of the simple solenoid type. Its winding is normally short-circuited by the switch-contacts of magnet M^2, and consequently it normally maintains the circuit of the signal-actuating mechanism J^2 open, so that the signal K^2 is normally at "danger." Whenever magnet M^2 is energized, it disconnects one end of both rails of block A^2 both from block A′ and from the opposite track, and at the same time the short circuit is removed from the relay N^2. Thus the relay N^2 is cut off from any power-current which might affect it and at the same time is ready to respond to a flow from the signal-current in the block A^2, so that if no train is in the block the signal K^2 will be "clear."

In order to control the actuating-magnets for the automatic switches, I provide short insulated sections and relays connected to them. For instance, in block A^2 I provide a short section a^2 which may be of a single-rail length or even less. This is bridged by a conductor connecting the rails on opposite sides of the insulating-section. Between the insulating-section and the opposite rail of the block is connected a relay O^2 and a battery b^2, so that whenever a train connects the insulated section a^2 to the opposite rail the relay O^2 is energized. When the relay O^2 is energized, it closes a circuit from the lower line-wire D, through the magnet M^3 and through the contacts of the automatic switch at the entrance to block A^4. (Not shown.) Provided the automatic switch is closed, magnet M^3 is energized when relay O^2 is energized, thereby disconnecting block A^3 from block A^2 and from the opposite track and removing the short circuit from the relay N^3. This relay, in addition to closing the actuating-circuit of signal K^3, closes a maintaining-circuit for magnet M^3, so that the switches controlled by magnet M^3 remain open, the relay N^3 energized, and the signal K^3 at clear until the train enters block A^3.

It will be seen that if a train were in block

A^3 at the time that a second train in block A^2 passed over the insulated rail-section a^2, relay N^3 would not be energized by the opening of the switch controlled by magnet M^3, and consequently signal K^3 would not clear. In order to provide for such a contingency, I insert a second insulated rail-section a^{22} close to the exit end of the block A^2. If signal K^3 has not cleared, the train comes to rest on the insulated section a^{22} and waits there until the other train passes out of block A^3. As soon as this happens relay N^3 is energized, signal K^3 is cleared, and the train in block A^2 may proceed. The insulated section a^{22} would be placed at a point in the track where the train would naturally come to rest on finding the signal K^3 at "danger," while the section a^2 would be placed a sufficient distance back in the block so that the signal K^3 would clear in time to prevent the engineer from seeing it at "danger" and applying the brakes. The actuating magnet for the automatic switches are interlocked in precisely the same manner as described in Fig. 1, and it is believed that these connections require no further explanation.

If only a single rail of each track is employed for the return-conductor for the power current, the connections may be somewhat simplified, as shown in Fig. 4. In this figure the batteries B' and B^2, &c., are indicated as the sources of signal-current for the track-circuits, but any other sources may be employed, if preferred. The switch controlled by magnet M^2 connects, when closed, one rail of blocks A' and A^2. The other two rails of these blocks are always insulated from each other. The track-relay N^2 is connected across the rails of block A^2, and is shown as of the simple solenoid type. This type of relay may be employed, since when magnet M^2 is energized the block A^2 is disconnected from the power-circuit, so that the relay N^2 cannot be affected by the power-current. The circuit of magnet M^2 includes the switch L^2, controlled by signal K^2 and the back contacts of the track-relays for the block A'. It also includes a contact controlled by magnet M^5 for the purpose of interlocking magnet M^2 and M^5, as has been heretofore explained. The actuating-magnets, as shown in this figure, are supplied with current directly from the power-circuit. The operation is precisely the same as has been heretofore explained with reference to Fig. 1. When a train is in block A', the track-relay for that block is deënergized, thereby closing its back contacts, so that if signal K^2 is at "clear" and magnet M^5 not energized the magnet M^2 will open its switch, disconnecting block A^2 from the other blocks, so that the the relay N^2 will surely detect a broken rail or a train in the block or anything else which would properly cause a danger indication of the signal K^2.

I have shown the switch and magnet only diagrammatically, and in practice they may be of any suitable construction. It is not at all necessary that the switch should be held closed by gravity and opened by the magnet, as shown in the drawings; but any other desired arrangement may be used. Consequently I do not desire to limit myself to the particular construction and arrangement of parts here shown, but aim in the appended claims to cover all modifications which are within the scope of my invention.

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

1. In a block-signal system for electrically-operated roads having parallel tracks, connections between the track-circuits of adjacent parallel blocks adapted to afford a return-path for the power-current, and automatically-operated means controlling said connections.

2. In a block-signal system for electrically-operated roads having parallel tracks, connections between the track-circuits of adjacent parallel blocks adapted to afford a return-path for the power-current, switches inserted in said connections, and automatic operating means for said switches.

3. In a block-signal system for electrically-operated roads having parallel tracks, connections between track-circuits of adjacent parallel blocks adapted to afford a path for the power-current, and means controlled by train movements for breaking said connections.

4. In a block-signal system for electrically-operated roads having parallel tracks, connections between track-circuits of adjacent parallel blocks adapted to afford a path for the power-current, switches inserted in said connections, and operating means for said switches controlled by train movements.

5. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, and controlling means for said switch controlled by a train in the preceding block.

6. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, and controlling means for said switch controlled by the signal apparatus of the preceding block.

7. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, and controlling means for said switch controlled both

by the signal apparatus of said block and by the signal apparatus of the preceding block.

8. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, and means for automatically opening said switch when the signal for said block is at "clear" and a train is in the preceding block.

9. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, and a magnet-winding controlling said switch.

10. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, a magnet-winding controlling said switch, and means controlled by a train in the preceding block controlling said magnet-winding.

11. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, a magnet-winding controlling said switch, and a circuit for said magnet-winding comprising switch-contacts controlled by a train in the preceding block.

12. In a block-signal system for electrically-operated roads having parallel tracks, a connection from the track-circuit of a block to a parallel track-circuit, said connection being adapted to afford a path for the power-current, a switch in said connection, a magnet-winding controlling said switch, and a circuit for said magnet-winding comprising switch-contacts controlled by the signal apparatus for said block and contacts controlled by a train in the preceding block.

13. In a block-signal system for electrically-operated roads having parallel tracks, connections between adjacent ends of the track-circuits of adjacent blocks in the same track and between both of said track-circuits and the parallel track, and automatic means for breaking the connection between one of the first-mentioned track-circuits and the parallel track without disturbing the connection between the other of the first-mentioned track-circuits and the parallel track.

14. In a block-signal system for electrically-operated roads having parallel tracks, a conductor connecting one end of the track-circuit of a block to the adjacent end of the preceding block, a switch inserted in said conductor, and a connection from the other track to a point in said conductor between said switch and the preceding block.

15. In a block-signal system for electrically operated roads having parallel tracks, a conductor connecting one end of the track-circuit of a block to the adjacent end of the preceding block, a switch inserted in said conductor, a connection from the other track to a point in said conductor between said switch and the preceding block, and means controlled by train movements, for opening said switch.

16. In a block-signal system for electrically-operated roads having parallel tracks, means for supplying alternating current to the rails of a block, an inductive winding connected across the rails at one end of the block, a connection from said block to a parallel track adapted to form a path for the power-current, and automatic means controlled by train movements for breaking said connection.

17. In a block-signal system for electrically-operated roads having parallel tracks, means for supplying alternating current to the rails of a block, an inductive winding connected across the rails at one end of the block, a connection from said block to a parallel track, a switch inserted in said connection, and operating means for said switch controllable by a train in the preceding block.

18. In a block-signal system for electrically-operated roads having parallel tracks, means for supplying alternating current to the rails of a block, an inductive winding connected across the rails at one end of the block-a connection from said block to a parallel track, a switch in said connection, and means for automatically opening said switch when the signal for said block is at "clear" and a train is in the preceding block.

19. In a block-signal system for electrically-operated roads having parallel tracks, means for supplying alternating current to the rails of a block, an inductive winding connected across the rails at one end of the block, a connection from said block to a parallel track, a switch in said connection, and a magnet-winding controlling said switch.

In witness whereof I have hereunto set my hand this 6th day of April, 1906.

LAURENCE A. HAWKINS.

Witnesses:

BENJAMIN B. HULL,
HELEN ORFORD.