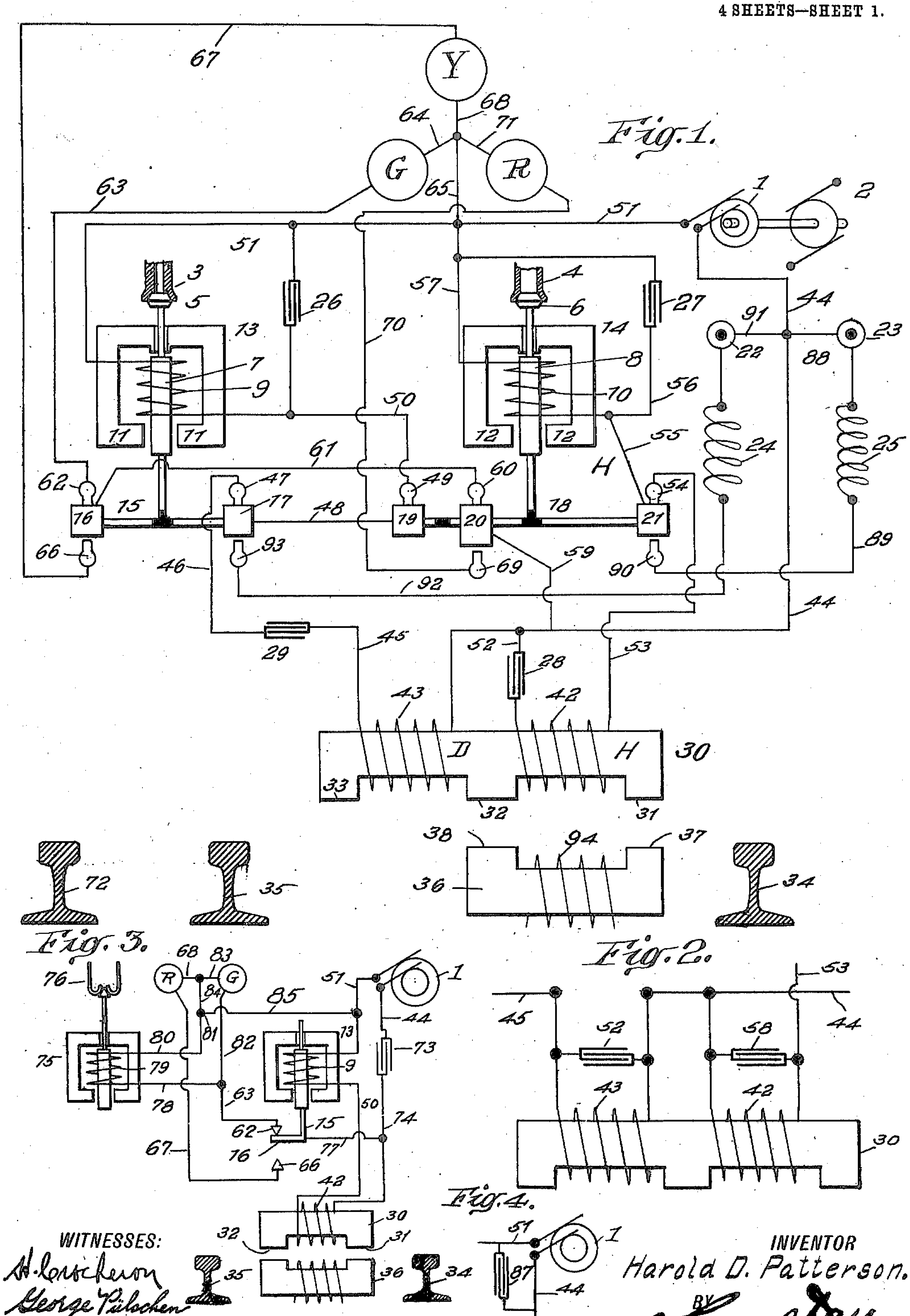
H. D. PATTERSON.

RESONANT CAB SIGNALING SYSTEM.

APPLICATION FILED SEPT. 28, 1908.

951,546. Patented Mar. 8, 1910.

4 SHEETS—SHEET 1.



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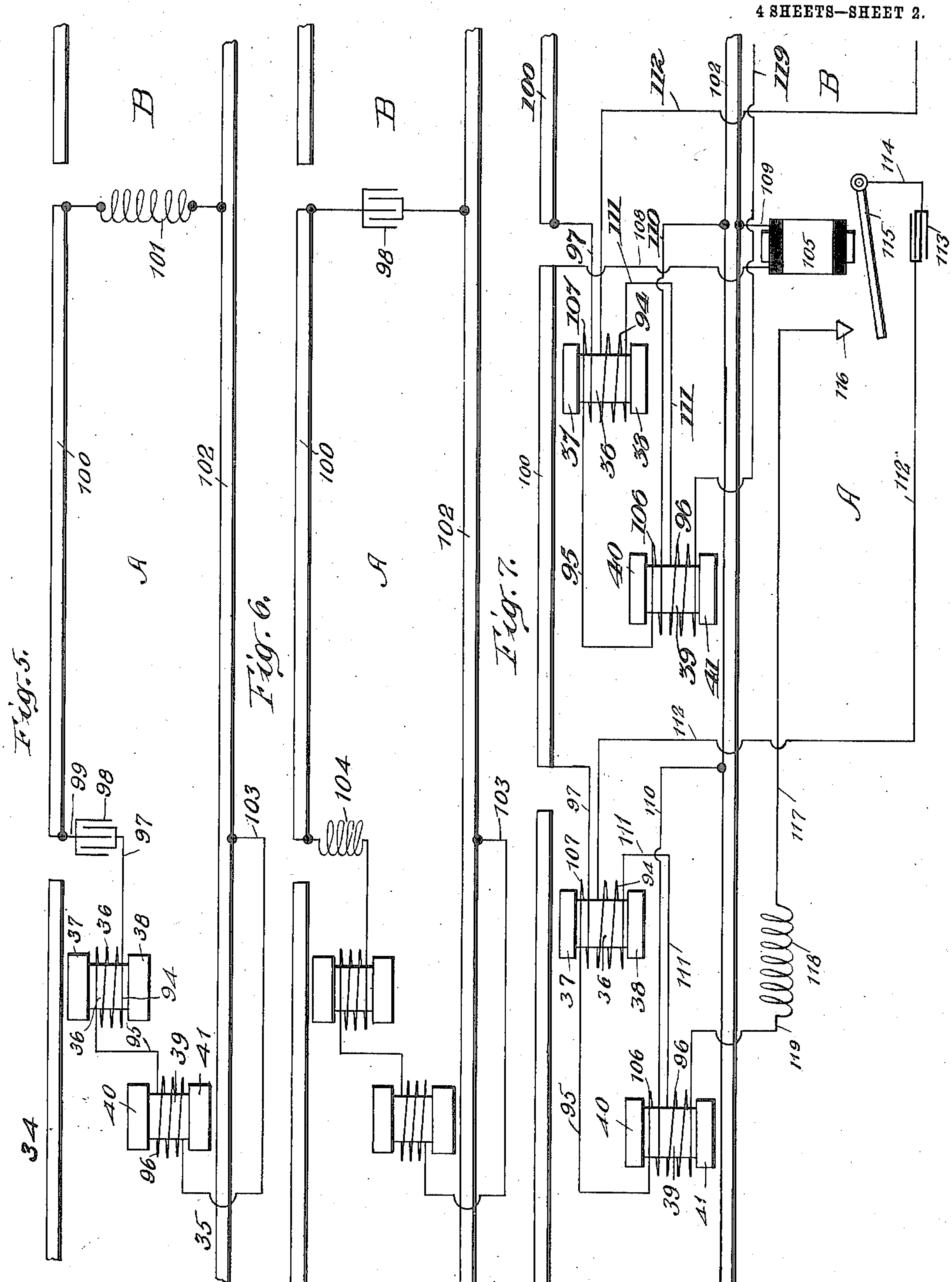

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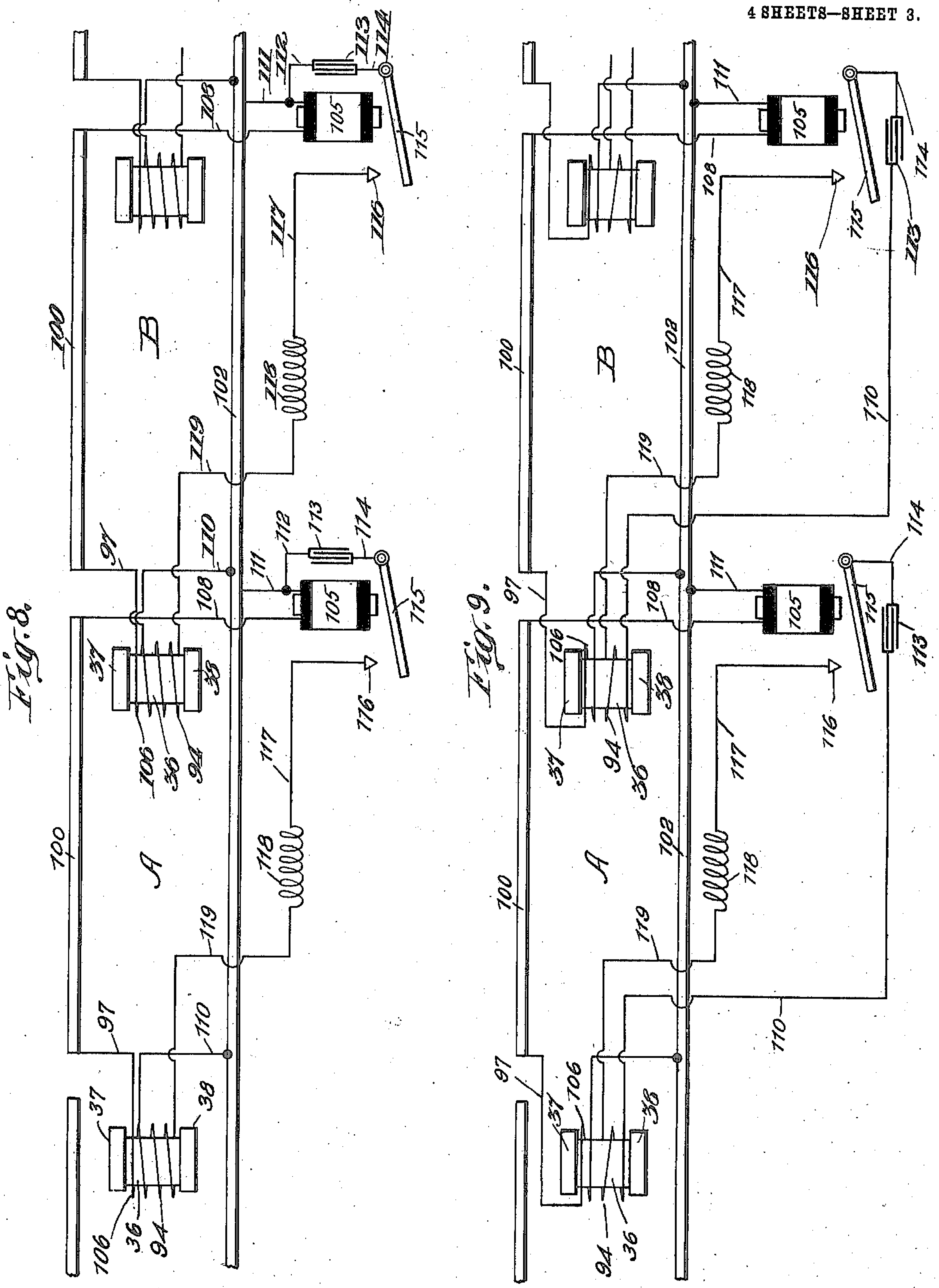

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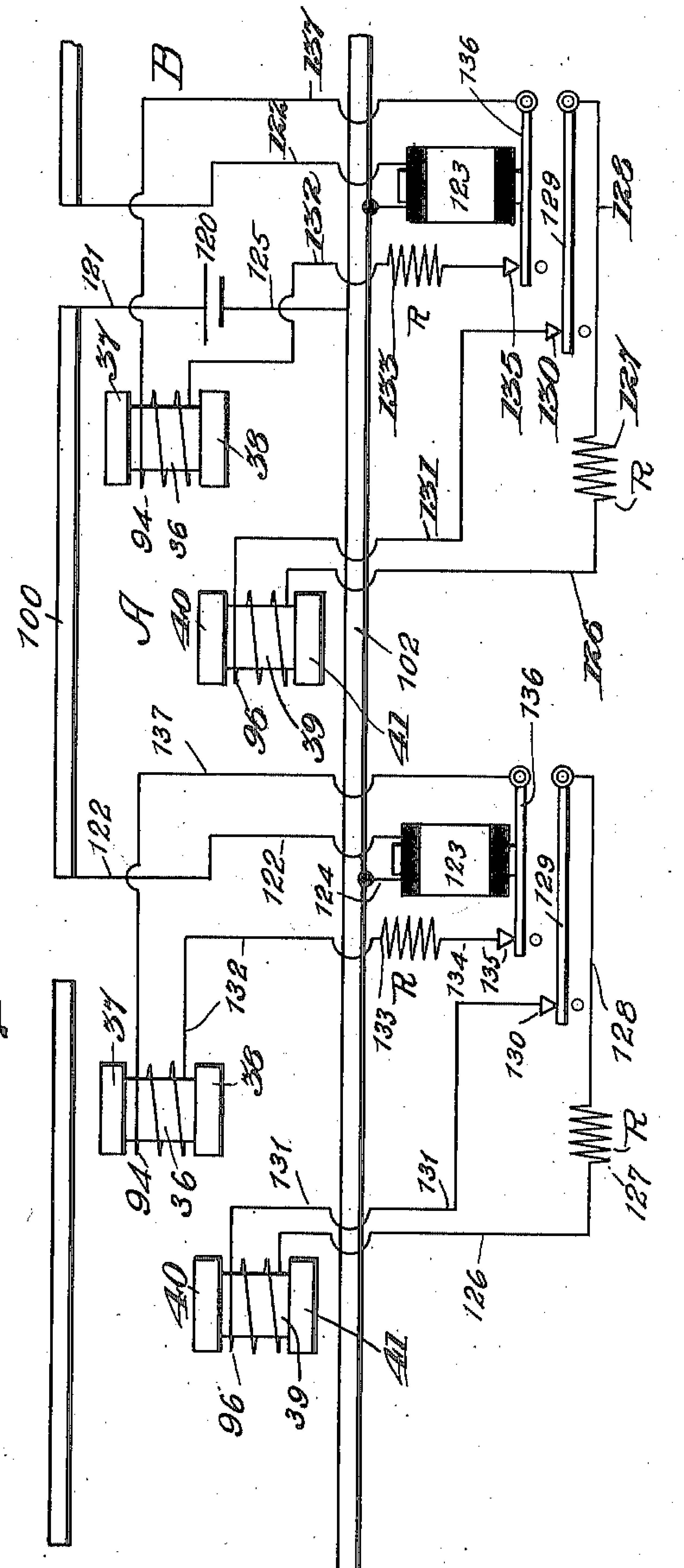

Fig. 10.

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UNITED STATES PATENT OFFICE.

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RESONANT CAB SIGNALING SYSTEM.

951,546. Specification of Letters Patent. **Patented Mar. 8, 1910.**

Application filed September 28, 1908. Serial No. 455,180.

To all whom it may concern:

Be it known that I, Harold D. Patterson, a citizen of the United States, and a resident of Mount Vernon, county of Westchester, and State of New York, have invented certain new and useful Improvements in Resonant Cab Signaling Systems, as set forth in the following specification.

This invention relates to a system for controlling the movements of trains on a railway. The term "controlling" includes the controlling function accomplished by the display of suitable signals and also an actual automatic control of a train involving the actuation of either braking mechanism or propulsion mechanism or both. Systems involving the automatic control of such apparatus on a train are frequently designated "cab systems", it being understood that the word "cab" designates any suitable part of the entire train and not necessarily the cab to a locomotive, although the cab to the locomotive is frequently the place for the installation of the various automatic train controlling devices in such a system.

Broadly it is an object of this invention to improve in general cab train controlling systems.

A further object of the invention is to provide for the operation of such a system without the employment of a traveling contact device of any kind which is constrained physically to contact with stationary or movable track contacts, in order to effect the proper control of the operation of the system and to do away with any bodily movable track instrument arranged to coöperate with a traveling device on a train and to control the same by reason of its position. Heretofore mechanical tripping contacts and electrical contacting devices have been used and have been found to be more or less unreliable as they necessarily required the accomplishment of perfect contact notwithstanding the many times unfavorable track conditions such as accumulations of snow, ice, rust, etc., which hindered the movement of mechanical parts, or prevented electrical contact being certain.

The invention contemplates the employment of both cab and track circuits.

Another object of the invention is to provide a suitable cab circuit, including a translating device and so arranged that the condition of the track circuit may govern the actuation of said translating device, while the source of energy is on the train and a transformer with a multiple-part core is employed—one winding in a cab circuit and the other winding in the track circuit—as the means for energizing the track circuit from the cab circuit.

It is to be understood also that an object of this invention is to provide for the traffic controlled actuation of the cab translating devices by means of an energizing electric circuit, the flow of current through which to control the translating devices is not established or discontinued in response to varying traffic conditions but which current flow has its character or condition altered in accordance with traffic conditions to effect the proper actuation of the translating device or devices. In connection with this feature it is to be understood that a change in the power factor of the alternating current employed in said circuit described is one of the changes in character or condition of the current flow contemplated and sufficient to effect the desired traffic controlled actuation of the translating devices. To this end it has been found that the combination with a cab circuit of a condenser or condensers giving a reactance factor opposite to the inductance of the primary winding of the cab half-transformer is efficient for the purpose of increasing the traffic controlled variation of current for the cab translating device. This change in condition for the current flow in a cab translating device may be effected by reducing the reluctance of the magnetic circuit for a primary winding included in a cab circuit by positioning an iron core at the track in its path when carried by the train and so as to reduce its air gap. To maintain the safety condition for the current flow in said translating device the effect of the said reduced reluctance may be offset by causing said magnetic circuit to dissipate an equivalent amount of electric energy. This may be done by providing the equivalent of a short circuited winding for the core at the track. To accomplish this a winding may be provided for the track core and suitable means be provided for causing it to be substantially short circuited or open circuited according to the effect desired. To accomplish the substantial short circuit it is preferable to provide a resonant circuit including substantially equal but opposite reactance factors, namely,—an inductance and a condenser suitably proportioned for the purpose according to the frequency of the alternating current employed and so positioned that even grounded line wires cannot establish a false short circuit because either the condenser or the inductance alone would be in the circuit through the grounds to choke down the energy consumption for the circuit. With such a resonant circuit substantially an open circuit is created by shunting out either the inductance or the condenser. The accomplishment of this is contemplated to be effected by danger traffic condition such as the presence of a train in a block, while an actually open circuit would be effected by the danger condition caused by the breaking of a line wire. Thus the system is one in which all error is on the side of safety, which is an object of the invention.

Further objects of the invention are to provide proper apparatus and coöperating circuits in the cab, as will be set forth more at length in the following description and accompanying claims.

The above and still further objects of the invention will likewise be apparent from the following description and drawings which form part of this application, in which like characters designate corresponding parts, and in which—

Figure 1 is a diagram illustrating the cab circuits and apparatus in their relation to the track; Fig. 2 is a diagram indicating a modification of part of the circuits shown in Fig. 1; Fig. 3 is a diagram corresponding to that of Fig. 1 but showing a modification for receiving home actuations and not home and distant actuations; Fig. 4 is a diagram showing a modification of the connections of a condenser for the cab circuits; Fig. 5 is a diagram indicating one embodiment of a suitable track circuit for the system; Fig. 6 is a diagram of the modified embodiment of a suitable track circuit for the system; Fig. 7 is a modified embodiment of suitable track circuits for the system involving track relays; Fig. 8 is also an embodiment of track circuits showing another modification involving track relays; Fig. 9 is an embodiment of still another modification of suitable track circuits for the system and involving track relays; Fig. 10 is still another embodiment of track circuits suitable for the system involving track relays and independent sources of energy for certain track circuits.

Referring now more in detail to the drawings a description will first be given of the apparatus and circuits for the installation in the cab.

Cab apparatus.—1 indicates a suitable independent source of electrical energy shown in the form of an alternating current generator driven by a source of mechanical power 2 which may be an electric motor, as indicated, or any suitable source of power.

G, R, and Y indicate suitable translating devices and, as shown, respectively, green—saftey, red—danger, and yellow—caution, indicating lamps.

3 and 4 indicate part of the brake mechanism for the train and in the embodiment shown indicate respectively a small and a larger escape duct connecting with the air-brake system for the train.

5 and 6 indicate respectively plugs coöperating with ducts 3 and 4.

7 and 8 indicate respectively cores mechanically connected with the plugs 5 and 6 and operable by the magnetic effect of the coils 9 and 10 and together with magnetic yokes 11 and 12 make up the magnetic circuits for the respective translating or train controlling devices, indicated by 13 and 14. Mechanically connected to the core 7 is a frame 15 carrying suitable insulated movable contact devices 16 and 17. Mechanically connected to the core 8 is a frame 18 operatively carrying suitable insulated movable contact devices 19, 20 and 21.

22 and 23 indicate respectively push buttons for restoring circuits which will hereinafter be described.

24 and 25 indicate respectively compensating inductance coils for the restoring circuits.

26, 27, 28 and 29 indicate respectively suitable condensers which may or may not be employed in the various circuits as will hereinafter be set forth.

30 indicates the primary core of a multiple part transformer. It is shown in Fig. 1 diagrammatically in front elevation and as having a cross section of substantially E shape and providing a plurality of downwardly projecting pole faces 31, 32 and 33. This core 30 should be fixed to a part of the train as to the locomotive and may be secured to any suitable part on the locomotive so that the pole faces 31, 32 and 33 are horizontal and clear the tread of the rails 34 and 35. It is to be understood that the core 30 may be constructed according to well known transformer practice, as of magnetic iron laminated if desired. This core should be of an extent longitudinal to the train sufficient to insure the proper duration of super-position relative to the home secondary or track core 36 when the train is in motion. The secondary core 36 may be positioned at the track and should have its upwardly projecting pole faces 37 and 38 so placed as to vertically aline with the corresponding pole faces 31 and 32 of the core 30 and they may preferably be positioned beneath the tread of the rails 34 and 35. A separation of one inch between the faces 37,

38 and 31, 32, has been found satisfactory. The core 36 may of course be made in accordance with well known transformer practice and corresponds in many respects with core 30. Its longitudinal extent being determined by the longitudinal extent of core 30, speed conditions, etc. The pole faces 32 and 33 are designed to coöperate with a second or distant secondary core 39 having coöperating pole faces 40 and 41 which coöperate with said pole faces 32 and 33 just as do pole faces 37 and 38 coöperate with pole faces 31 and 32. Both secondary cores may be similar only placed in different lateral positions at the track, as indicated.

42 indicates the home primary winding for core 30 while 43 indicates the distant primary winding for core 30.

The apparatus and circuits are shown normal in Fig. 1.

Cab circuits and conditions.—The safety lamp G is normally lighted and the caution and danger lamps Y and R are normally unlighted. In the embodiment shown, the small exit tube 3 and the larger exit tube 4 are held closed by the plugs 5 and 6, the translating devices 13 and 14 being operatively energized.

The distant cab circuit may be traced as follows:—generator 1, wire 44, coil 43, wire 45, condenser 29, wire 46, front contact 47, movable contact 17, wire 48, movable contact 19, front contact 49, wire 50, coil 9, wire 51, back to generator 1. This circuit normally carries sufficient current of a suitable condition or character normally to energize distant translating device 13 which comprises two parts: one part 5 normally closing the small escape tube 3 and another part 15 being a circuit controlling device. Obviously, if desired, these two parts 5 and 15 might be operated by either a plurality of separate cores 7 of the single core 7 as shown and as described. Inasmuch as the energizing current for coil 9 normally flows, it is sometimes desirable to distort the power factor of the circuit so that a useless waste of power is not occasioned. The coils 43 and 9 of this circuit obviously present a certain amount of inductance in the circuit and it has been found to be desirable sometimes to effect the distortion of the power factor by means of condensers. To satisfy different conditions a condenser 29 may be connected in series in the circuit as is the condenser 29 or the condenser 26 may be connected across the terminals of the coil 9 or again a condenser 52 may be connected across the terminals of coil 43 as shown in Fig. 2 or various combinations of condensers connected in various ways may be employed.

The use of a condenser in series with a coil such as 43 is important because a certain change, effected by traffic control, in the inductance of coil 43, causes a greater proportionate change in the condition of the current flowing through the translating device 9 than what would result if no condenser were present.

The home cab circuit may be traced as follows:—generator 1, wire 44, wire 52, condenser 28, coil 42, wire 53, front contact 54, movable contact 21, wire 55, wire 56, coil 10, wire 57, wire 51, back to generator 1. The condensers 27 and 28 are shown similarly related to this circuit and for similar purposes as are the condensers 26 and 29 of the distant cab circuit. It is also to be understood that a condenser 58 may be connected across coil 42, as indicated in Fig. 2, if desired. This circuit has flowing in it normal current of such condition and character as to energize translating device 14 causing the part 6 to close large escape tube 4 and to hold the circuit controlling mechanism in the position shown. The normal energizing circuit for safety lamp G may be traced as follows:—generator 1, wire 44, wire 59, movable contact 20, front contact 60, wire 61, movable contact 16, front contact 62, wire 63, lamp G, wire 64, wire 65, wire 51, back to generator 1. The normally open circuit for caution lamp Y may be traced as follows:—generator 1, wire 44, wire 59, movable contact 20, front contact 60, wire 61, movable contact 16, back contact 66, wire 67, lamp Y, wire 68, wire 65, wire 51, back to generator 1. The normally open circuit for danger lamp R may be traced as follows:—generator 1, wire 44, wire 59, movable contact 20, back contact 69, wire 70, lamp R, wire 71, wire 65, wire 51, back to generator 1. In this figure a third rail 72 is indicated and it is to be understood that the system described in this application might be used in connection with electric railways of the type employing a continuous one rail return or of the type employing a continuous one rail return together with an opposite broken rail suitably bonded by well known inductance bonds and which bonds are selective against the signaling current, which should preferably be of different character as to phase and frequency from the character of the propulsion current which may traverse the said inductance bonds against comparatively little re-actance.

In Fig. 3 there is illustrated diagrammatically an installation of apparatus and circuits for the cab in which only a home cab circuit is shown and in which the primary core of the transformer has but a single pair of poles 31 and 32 and a single coil 42. In this figure the home cab circuit may be traced as follows:—generator 1, wire 44, condenser 73, wire 74, coil 42, wire 50, coil 9, wire 51, back to generator 1. This circuit normally energizes controlling device 13 which in this embodiment operates only the circuit translating device 15. A separate controlling device is shown, indicated by 75, and controlling a propulsion circuit by means of switch 76, it being understood of course, that the switch 76 may control the power circuit for the propulsion current or any other suitable part of the propulsion mechanism.

The normally energized circuit for signal lamp G and for normally energizing controlling device 75 may be treated as follows:—generator 1, wire 44, condenser 73, wire 74, wire 77, movable contact 16, front contact 62, wire 63, thence branching into two parallel paths—one, wire 78, coil 79, wire 80 to point 81; the other, wire 82, lamp G, wires 83 and 84 to point 81; thence together over wires 85 and 51, back to generator 1.

The normally open circuit for danger lamp R, may be traced as follows:—generator 1, wire 44, condenser 73, wire 74, wire 77, movable contact 16, back contact 66, wire 67, danger lamp R, wires 68, 84, 85 and 51, back to generator 1.

Fig. 4 shows a condenser 87 connected across the terminals of generator 1 and may be employed at will in the other figures and as will be understood.

Referring again to Fig. 1 the home restoring circuit may be traced as follows:—generator 1, wire 44, wire 88, push button 23, inductance 25 (which is substantially equal to that of coil 42), wire 89, back contact 90, movable contact 21, wire 55, wire 56, coil 10, wire 57, wire 51, back to generator 1. The distant restoring circuit may be traced as follows:—generator 1, wire 44, wire 91, push button 22, inductance 24 (which may be substantially equal to that of coil 43), wire 92, back contact 93, movable contact 17, wire 48, movable contact 19, front contact 49, wire 50, coil 9, wire 51, back to generator 1. The two restoring circuits above are respectively normally open between contacts 90, 21 and 93, 17. A break between contacts 19 and 49 will be present in the distant restoring circuit in case the home controlling translating device or relay 14 is deënergized.

Track circuits.—The applicant has taken advantage of the inherent reactance to the flow of the alternating current in traffic rails. It has been found that this reactance is considerable for the length of the ordinary block section due to the magnetic nature of the rails. In many signaling systems this reactance in a rail circuit has been disadvantageous. On the other hand in the present system it is utilized in effecting train control.

The embodiment of one successful track circuit is shown diagrammatically in Fig. 5. In this figure, 36 is the home secondary core, previously described, and having upwardly presented pole faces 37 and 38, and its secondary coil or winding 94 of a suitable number of turns but of low ohmic resistance. This core may be located at the track any suitable distance in advance of the block section A to be tested. Farther from the block section A is located the distant secondary core 39, with a winding 96 the same as 94. The longitudinal distance between cores 36 and 39 may be determined to suit desired conditions and also the location of the home secondary core 36 in advance of the block section.

The distant track circuit may be traced as follows:—coil 96, wire 95, coil 94, wire 97, condenser 98, wire 99, traffic rail 100, cross bond 101, continuous track rail 102, wire 103 back to coil 96. When the home test is being made the home track circuit is traced in the same manner except that the coil 94 serves as a source of energy instead of the coil 96. It is to be understood in this embodiment that the cross bond 101 may be of the inductance type as indicated and of any suitable construction or of the conductance type if desired. The condenser 98 is proportioned so as to nullify the combined inductance due to one of the coils 94 or 96, the number of turns and the inductances in which are equal; the inductance of the track rails for the circuit; and the inductance of the bond 101. There results therefore a resonant circuit. The coil 94 or the coil 96, when it is serving as the secondary of the transformer and consequently is the source of alternating current for the track circuit is not considered in the calculation of inductance for the track circuit for obvious reasons.

A modified embodiment is illustrated in Fig. 6. The secondary cores and coils may be the same and located the same as in Fig. 5. Additional inductance, however, may be inserted in the track circuits, as between the coil 94 and the traffic rail 100. It is indicated by 104. In this embodiment the far end of traffic rail section 100 is cross connected to rail 102 through the condenser 98. In this embodiment the condenser 98 is proportioned just as it was in the embodiment shown in Fig. 5. For some purposes, however, its location at the far end of the block section is desired, especially in case of long blocks when the fall of the potential due to the impedance through the rails and leakage across from one to the other is considerable.

It is to be understood of course, that the installation illustrated in Figs. 5 and 6 for block sections A may be repeated indefinitely for succeeding block sections B, etc., as desired.

Another embodiment of track circuits is illustrated in Fig. 7. In this embodiment a relay is employed in connection with the track circuits. In this installation a relay device is indicated by 105. The embodiment is merely illustrative and it is to be understood that the relay device may be of any suitable character capable of responding to the current in the track circuit and of controlling its relay circuit, as will hereinafter be apparent. This relay device may have one or more coils, at least one of which is energized by the track circuit. For section A two secondary cores 39 and 36 are provided just as in the installation shown in Figs. 5 and 6. These cores, however, have each a separately connected winding 106 and 107 respectively, in addition to the winding 96 and 94 previously described.

The distant track circuit for section A may be traced as follows:—winding 106, wire 95, winding 107, wire 97, rail section 100, wire 108, one coil of relay 105, wire 109, rail 102 wire 110, back to winding 106. The home track circuit for this section is the same as the distant track circuit, except that winding 107 serves as the source of electrical energy.

The distant track relay circuit for section A may be traced as follows:—coil 96, wire 111, coil 94, wire 112, condenser 113, wire 114, circuit closer 115, front contact 116, wire 117, inductance 118, wire 119, back to coil 96. The home track relay circuit is the same only coil 94 is the source, not coil 96. If desired, the inductance 118 may be omitted from this circuit. The condenser 113 is proportioned so as to be equal and opposite to the entire inductance of the circuit with the exception of the mutual inductance due to the several turns of one of the coils, either 94 or 96. A portion of a similar installation is shown for section B and shows how it may be repeated indefinitely for any desired number of sections.

A modification of the installation shown in Fig. 7 is shown in Fig. 8, except that but a single secondary core 36 is provided for each block section, thus insuring merely a home test for each section. This core is provided, as is the same core shown in Fig. 7 with one winding 94, and also with an independently connected winding 106. The installation is shown complete for two block sections A and B, and may be repeated indefinitely. The track circuit for either section may be traced as follows:—winding 106, wire 97, rail 100, wire 108, one coil of relay 105, wire 111, rail 102, wire 110, back to winding 106. The track relay circuit for this installation may be traced as follows:—coil 94, wire 110, rail 102, wire 111, wire 112, condenser 113, wire 114, circuit closer 115, front contact 116, wire 117, inductance 118, wire 119, back to coil 94. In this circuit the condenser 113, is also proportioned so as to be equal and opposite to the inductance of the entire circuit with the exception of the inductance due to winding 94. In this case the inductance due to a section of rail 102, must be calculated.

In Fig. 9 a similar system but slightly modified is illustrated. In this system the track relay circuit does not include the rail 102. All other circuits are the same as described for the embodiment shown in Fig. 8. Therefore the track relay circuit alone will be traced as follows, the tracing being applicable for the installations in both sections A and B:—coil 94, wire 110, condenser 113, wire 114, circuit closer 115, front contact 116, wire 117, inductance 118, wire 119, back to coil 94. The condenser 115 for this circuit is proportioned so as to be equal and opposite to the entire inductance of the circuit with the exception of the inductance due to winding 94.

In Fig. 10 there is illustrated still a different type of installation for the track circuits. In this installation, the track circuit for each section is provided with its own independent source of electro-motive force. It should be understood that, although but one complete installation for one block section A is illustrated and apparatus for block section B, the installation may be repeated indefinitely for as many sections as desired throughout the railway system. In this installation the track circuit is also normally closed but, in addition, normally is energized and may be traced as follows:—source 120, wire 121, rail section 100, wire 122, relay 123, wire 124, rail 102, wire 125, back to source 120. The distant track relay circuit may be traced as follows:—coil 96, wire 126, resistance 127, wire 128, circuit closer 129, front contact 130, wire 131, back to coil 96. The home track relay circuit may be traced as follows:—coil 94, wire 132, resistance 133, wire 134, front contact 135, circuit closer 136, wire 137, back to coil 94. These two track relay circuits are normally closed as shown. It is to be understood that the cores 36 and 39 may be the same as those described in connection with Figs. 5, 6 and 7, and in fact all other parts similarly numbered are the same.

Operation.—The cab apparatus and circuits are shown in normal condition, in which showing the relays 13 and 14 are operatively energized and the escape ducts 3 and 4 from the air brake system are both closed and the safety lamp G is lighted. The direction of movement for the train and train installation is from left to right in Figs. 5 to 10 inclusive and should be imagined as being vertically toward the observer, in the diagrams of Figs. 1, 2 and 3. Under normal conditions the reluctance of the magnetic circuits for coils 42 and 43 is largely due to the large air gap between poles 31, 32, and 32, 33, respectively. Consequently quite a considerable magnetizing current must flow through coils 42 and 43. This magnetizing current flowing is sufficient operatively to energize the relay devices 13 and 14 in the circuits previously traced. As the train advances the core 30 will pass first over the secondary or distant core 39, the pole faces 32 and 33 alining respectively with pole faces 40 and 41. When the primary and secondary cores are superposed they coöperate and the secondary core 39 will materially reduce the reluctance of the magnetic circuit for primary coil 43 and reduce the necessary energizing current for this coil, provided no other conditions exist. Other conditions do exist, however, namely, the secondary core 39 is provided with a secondary winding 96. The magnetic lines traversing core 39 induce an electric potential in the winding 96 and cause a flow of current in the distant track circuit. As previously described, when the track circuit is in normal condition, it is resonant. The flow of current through the secondary coil 96 is therefore comparatively large as it is limited merely by the ohmic resistance of the track circuit. In order to supply this large flow of current in the secondary coil, as much or more magnetizing energy must flow in the primary winding 43 about primary core 30 and in coil 9 as or than normally flows. Thus when the track circuit is clear, the distant cab circuit, energizing relay 13 is maintained operative for relay 13. Should a train be present in block section A, so as to bridge across from rail section 100 to rail 102, the wheels and axles of this train will shunt out a material portion of the inductance of the track circuit, when the track circuit is as illustrated in Fig. 5 or a material portion of the capacity of the track circuit when the same is as shown in Fig. 6. The unbalanced capacity or inductance remaining in the track circuit will then alter the condition of the current flowing through the secondary coil 96. In the embodiments illustrated its power factor will materially be shifted so that the magnetizing energy flowing through coil 43 will be reduced to such an extent that the same energy current which flows also through coil 9 or relay 13 will be insufficient operatively to energize this relay; the plug 5 will be removed from the exit duct 3 which will allow the gradual escape of air from the air brake train line and gradually apply the air brakes to the train to check its speed; movable contact 16 will break connection with front contact 62; and make connection with back contact 66; and movable contact 17 will break connection with front contact 47 and make contact with back contact 93. The distant cab circuit for coil 9 is therefore permanently broken between points 47 and 17. The circuit for safety lamp G is broken between 62 and 16, and the circuit for caution lamp Y is closed between points 16 and 66 so as to display the necessary caution indication. The train then proceeds cautiously until home secondary core 36 is reached. After receiving the caution indication, the circuits may be restored to normal conditions by the engineer by pushing the button 22 which independently energizes the distant cab circuit, previously traced, by means of the distant restoring circuit previously traced, it being understood that the contacts are so arranged that this restoration may be accomplished.

Upon reaching the home secondary core 36, the current through primary winding 42 is controlled in the same manner as was the current for primary winding 43, previously described. If the track circuit is normal and substantially resonant, the home cab circuit will be kept normal and the train may proceed. However, should a train be occupying block section A, the current flowing through primary winding 42 will be reduced so that home relay 14 is no longer energized, the plug 6 will open exit duct 4 which permits the escape of air from the air brake line sufficiently rapidly to bring the train to a quick stop. At the same time movable contacts 19, 20 and 21 break connection with front contacts 49, 60 and 54 respectively, and the movable contacts 20 and 21 make connection with back contacts 69 and 90 respectively. The break between contacts 49 and 19 opens the circuit for distant relay 13, which assumes its deënergized position, previously described, opening the exit duct 3 to facilitate the exhaust of air pressure from the train line. The caution circuit, one break in which was thereupon closed by contact 16 making connection with back contact 66, is, however, maintained open by the break between front contact 60 and movable contact 20. Movable contact 20 contacting with back contact 69 closes the circuit for and energizes danger lamp R. A permanent break in relay 14's own circuit occurs between movable contact 21 and front contact 54, while one break in the home restoring circuit is closed between contacts 21 and 90. The train is then brought to a full stop and cannot proceed until the home cab circuit has been restored to normal conditions. This may be accomplished by operating the push button 23, which completes the home restoring circuit previously traced and restores the relay device 14 to normal conditions. The push button 23 may be mounted in any suitable locality. The distant circuit may then be restored by pushing push button 22 which operation has previously been described. The train may then proceed cautiously until a safety indication is received.

It is to be understood that this system of controlling the cab apparatus illustrated is equally applicable to controlling cab apparatus and circuits provided with modified apparatus and with additional cautionary apparatus insuring the cautious advance of the train.

When used in connection with the track circuits as illustrated in Fig. 7, the operation of my system is similar to that described but subject to modified steps. In particular, either the core 39 or the core 36 is magnetized according to whether the one or the other is superposed by traveling primary core 30, so that either the coil 106 or 107 serves as a source of electro-motive force for the track circuit, completing the same through the relay 105 if the block is clear. The relay 105 is then operatively energized to cause circuit closer 115 to contact with front contact 116 completing a resonant circuit through coils 94 and 96, similar to the other resonant circuits previously described. The flow of current through this resonant circuit will be sufficiently large to cause a normal flow of current through the testing primary winding about core 30, that is through winding 43 or 42 and the corresponding cab relay device 13 or 14 will remain operatively energized. In case, however, a train is present in section A, its wheels and axles will shunt out relay 105 preventing circuit closer 115 from closing the track relay circuit previously traced. The necessary flow through the energizing primary winding either 43 or 42 will consequently be insufficient operatively to energize the corresponding cab relay 13 or 14, and the consequent caution or danger indication or train control, as previously described, will result. In the track installation shown in Fig. 7, the number of turns in coils 94 and 96 greatly exceeds the number of turns of coils 106 and 107 respectively.

The operation of the system in connection with a track installation as shown in Fig. 8 is illustrative of its operation when merely home tests are capable. In this installation merely the home secondary cores 36 are illustrated. The secondary winding 94 is present but has a few coils indicated by 106 separately connected to serve as the source of energy for the track circuit which has previously been traced. The operation of the system in response to this track installation is fundamentally the same as that described in connection with Fig. 7. Reference should be had, however, particularly to the cab installation illustrated in Fig. 3, in which the primary or traveling core 30 has but a single winding, that is the home winding 42. When the core 30 passes over core 36, core 36 is magnetized so as to set up a flow of current in the track circuit, previously traced, and to energize the relay 105 if the block section A is clear. Relay 105 causes circuit closer 115 to close the resonant track relay circuit previously described, which in turn causes a normal flow of current in the cab circuit previously described. However, should a train be present in the block section or should the circuit be accidentally broken, the relay 105 will not be energized and the interposition of the core 36 with the open circuited winding so as to decrease the reluctance of the magnetic circuit for the primary winding 42 will cause a decrease in the flow of current in the cab circuit so that relay 13 will not be operatively energized. Then movable contact 16 will break connection with front contact 62, thereby cutting out the circuit for the safety lamp and will make connection with back contact 66 to close the danger circuit. The breaking of connection with front contact 62 also deënergizes train controlling device 75 to effect the opening of switch 76. The opening of switch 76 may be utilized to cut off the propulsion current from the propulsion motors or to cut off the supply of steam to the cylinders of the locomotive by means of a suitable relay apparatus all well known in the art. Movable contact 16 will make connection with back contact 66 and close the circuit for danger lamp R to give a danger indication. This cab installation may be restored to normal position by a restoring circuit similar to that shown and described in connection with Fig. 1. This operation will, of course, be repeated indefinitely when each block section of the system is tested.

In Fig. 9 is illustrated a system of track circuits and apparatus substantially the same as was shown in Fig. 8. The only difference is in that an independent conductor 110 is employed in the track relay circuit instead of using the continuous rail 102 for a conductor. The operation of this installation will therefore be understood from the description of the operation of the installation shown in Fig. 8, as it is the same.

At this point it may be well to call attention to the arrangement of the track relay circuits illustrated in Figs. 7, 8, 9. It is to be noted that the condenser 113 is inserted in one conductor leading to the circuit closer 115, while the inductance is inserted in the other conductor leading to circuit closer 115. By this arrangement, should either one or the other of these conductors be grounded or, for that matter, should an accidental crossing occur, it would be practically impossible so to effect a resonant condition for the circuit and thereby make possible the giving of a false safety indication when tested. To this end it may be preferable to locate the condenser 113 adjacent to the circuit controlling device 115 and the inductance 118 adjacent to the secondary core 36. In general it is the object so to position the condenser and inductance relatively to the circuit as to prevent the bringing about of a resonant condition from an accidental crossing or grounding of the circuit conductors. Obviously, if an absolute break should occur due to accident in the circuit, there would be a complete open circuit for the secondary winding of the secondary core and the consequent result would be a danger indication in the cab, as would be desired.

In Fig. 10 the track circuit previously traced is not merely normally closed but is also normally energized by an independent source 120. This circuit maintains the track relay 123 normally energized and this relay normally holds both the home and the distant relay track circuits closed. It will be obvious to those skilled in the art that this track circuit is similar to the normally closed track circuit used frequently for semaphore block signaling and in fact the track relay of such a semaphore system might serve when provided with suitable contacts illustrated for the relay 123, or in fact suitable circuit closers might be operated directly by the semaphore arm to accomplish the functions of the circuit closers of relay 123. This is the condition which exists when the block section is clear, that is unoccupied by a train and the rail circuit unbroken. The resistances 127 and 133 in the distant and home relay circuits are merely sufficient to prevent an excessive current flow in the secondary coils 96 and 94, when their respective cores 39 and 36 are superposed by and coöperate with the traveling primary core 30. The same result may be obtained by properly designing the secondary coils 96 and 94 to give a smaller electromotive force. Obviously, when a distant test is made by means of distant secondary core 39 and distant secondary coil 96, a substantially short circuited secondary winding is met with and the consequent flow of energy therethrough will be sufficiently great to maintain the normal value of the flow of energy through the distant relay 13 at the cab and maintain a safety indication. The same conditions as to core 36 and coil 94 will be met with upon making the home test of block section A. However, should block section A be occupied by a train or should the rail circuit be broken, the relay 123 will be deënergized and the circuit closers 129 and 136 will open the distant and the home track relay circuits respectively. Consequently, when a test of each of these circuits is made, there will be no flow of energy therein and the coöperative interposition of either of the distant secondary core 39 or the home secondary core 36 in the corresponding magnetic circuits for the distant and the home primary coils 43 and 42 would so decrease the reluctance of these magnetic circuits as to reduce the flow of energy in the distant and home cab circuits so as to prevent the distant and home relays 13 and 14 being operatively energized. This would cause the necessary train control as previously described. It is, of course, to be understood that either the home or the distant track relay circuits shown in Fig. 10 could be rendered normally resonant circuits.

The result of an accidental break in the rail circuit, shown in Figs. 5 and 6, is an open circuit for the secondary coils of cores 39 and 36, and consequently would occasion the display of a danger indication in the cab, regardless of whether or not the section having the broken rail was occupied by a train.

It will be understood from the nature of the apparatus described, that it is desirable that the generator 1 on the cab should supply a constant potential and, of course, be capable of supplying current to the various circuits which it energizes in accordance with the demand put upon it. As a certain amount of current must constantly flow in the cab circuits and must constantly magnetize the primary core 30 and operatively energize the cab translating devices 13 and 14, it is desirable that as little power be consumed, as possible. To this end various manners of connecting condensers in the cab circuits have been illustrated for the purpose of distorting the power factor therein. It is, of course, to be understood that in practice all the condensers shown, as for instance in Fig. 1, would not necessarily be used or needed, and need not be connected, necessarily, as shown, but with one or more of the other modified manners of connecting them and as shown by Figs. 2, 3 and 4, might be used as described alone or in combination. Furthermore, although the two coils 42 and 43 in the cab installation are shown wound on a single primary core 30, in which pole 32 is common to the magnetic circuits of both coils 42 and 43, it is to be understood that this common pole construction is merely for the sake of economy in material. Fig. 3 shows the form of core having two poles for a single primary winding independent of the poles for the core of any other winding. It is also to be understood that the number of turns in the secondary coils at the track may have any desired ratio to the number of turns in their coöperative primary coils. Thus the two part transformer may either step down or step up, as described, the potential of generator 1 in its energization of the track circuits.

This description is not supposed to be a specific description of the various apparatus suitable in the system, as it is to be understood that any suitable apparatus such as translating devices (which term is used in its broad sense), cores, bonds, etc. may be employed. The translating devices 13 and 14 in the cab installation should be such as to be properly energized by a certain strength of current flow and should cease to be operatively energized upon a certain decrease in the strength in the current flow. With commercial apparatus and commercial circuits it is contemplated that six tenths of an ampere is a satisfactory strength for the operative energization of the relays 13 and 14. It has been found that a train occupying a block section, will reduce this normal current approximately 40% and that a broken rail will reduce this normal current approximately 56%. This current is more than sufficient to insure satisfactory operation of devices such as 13 and 14. It is also to be understood that the track relay devices may be of any desirable and suitable kind known in the art. In cases where sensitive relays are desirable, relays of the type described in Struble patent 863,667 or in Towsend patent 804,176, might be used and are contemplated. In Fig. 5 an inductance bond 101 is shown while in Fig. 6 a condenser or capacity bond 98 is shown. Whichever kind is to be used it is to be considered in the calculation of the resonant circuit and the two types will be referred to generally by the term "reactance bond." It is also contemplated that combinations of the various circuits and devices illustrated and described other than the combinations shown would be possible and within scope of this invention.

This application specifically applies to track circuits in which one or both of the traction rails are divided into insulated sections, as shown by the various figures. It is, however to be understood that the broad features of the system, apply equally well to track circuits in which both of the traction rails are continuous but which is claimed specifically in my copending application, Serial Number 455,179, filed on even date herewith.

What is claimed and what is desired to be secured by United States Letters Patent is:—

1. In a cab train controlling system, a source of alternating potential carried in the cab; a train-controlling device in the cab; a train electro-magnetic device suspended over the track; a circuit including said source and said train electro-magnetic device and controlling said train-controlling device; a track electro-magnetic device positioned in the path of the traveling field of said train electro-magnetic device; and a traffic controlled normally resonant circuit at the track closed through said track electro-magnetic device and including substantially equal but opposite reactance factors.

2. In a cab train controlling system, a source of alternating potential carried in the cab; a train-controlling device in the cab; a train electro-magnetic device suspended over the track; a circuit including said source and said train electro-magnetic device and controlling said train-controlling device; a track electro-magnetic device positioned in the path of the traveling field of said train electro-magnetic device; and a traffic controlled normally resonant circuit at the track closed through said track electro-magnetic device and opposite portions of the traffic rails, and including substantially equal but opposite reactance factors.

3. In a cab train controlling system, a two part transformer core, one part being a primary core having a primary winding and carried by the cab, the other part being a coöperable secondary core positioned at the track; a source of alternating current on the cab; a translating device and a condenser in the cab; a normally closed exciting circuit for said primary core including said source, said primary winding, said condenser and said translating device and normally carrying current of a condition operatively to energize said translating device; a traffic controlled means operable upon said secondary core to maintain the normal value of the current for said translating device upon clear traffic conditions and when said cores are in coöperative relations, by offsetting the consequent reduction in the reluctance of the magnetic circuit of said primary core by causing the dissipation of electric energy.

4. In a cab train controlling system, a two-part transformer core, one part being a primary core, having a primary winding and carried by the cab, the other part being a coöperable secondary core having a secondary winding and positioned at the track; a source of alternating potential in the cab; a translating device in the cab; a normally closed exciting circuit for said primary core including said source, said primary winding and said translating device and normally carrying current of a condition operatively to energize said translating device; a block section; a closed normally resonant circuit including said secondary winding and suitably proportioned inductance and capacity, said resonant circuit having such relation to the traffic rails of said block section that the presence of a train in the sections or a broken rail will destroy the resonant condition of said resonant circuit and consequently reduce the possible flow of energy in said circuit.

5. In a cab train controlling system, a two-part transformer core, one part being a primary core having a primary winding and carried by the cab, the other part being a coöperable secondary core having a secondary winding and positioned at the track; a source of alternating potential in the cab; a translating device in the cab; a normally closed exciting circuit for said primary core including said source, said primary winding and said translating device and normally

carrying current of a condition operatively to energize said translating device; a block section; a closed normally resonant track circuit including said secondary winding, the opposite rails of said section and suitably proportioned capacity all in series, whereby the presence of a train in said section or a broken rail will destroy the resonant condition of said track circuit and consequently reduce the possible flow of energy in said circuit.

6. In a cab train controlling system, a two part transformer core, one part being a primary core having a primary winding and carried by the cab, the other part being a coöperable secondary core having a secondary winding and positioned at the track; a source of alternating potential in the cab; a translating device in the cab; a normally closed exciting circuit for said primary core including said source, said primary winding and said translating device and normally carrying current of a condition operatively to energize said translating device; a block section including an insulated rail section; a closed normally resonant track circuit including said secondary winding, the opposite rails of said section, an inductance in addition to that of the rails, and suitably proportioned capacity all in series, whereby the presence of a train in said section or a broken rail will destroy the resonant condition of said track circuit and consequently reduce the possible flow of energy in said circuit.

7. In a cab train controlling system, a two-part transformer core, one part being a primary core, having a primary winding and carried by the cab, the other part being a coöperable secondary core having a secondary winding and positioned at the track; a source of alternating potential in the cab; a translating device in the cab; a normally closed exciting circuit for said primary core including said source, said primary winding and said translating device and normally carrying current of a condition operatively to energize said translating device; a block section including an insulated rail section; a closed normally resonant track circuit including said secondary winding, said insulated rail section, a reactance bond, and the opposite rail of said block section all in series and also including suitably proportioned capacity, whereby the presence of a train in said block section or a broken rail will destroy the resonant condition of said track circuit and consequently reduce the possible flow of energy in said circuit.

8. In a cab train controlling system, a home and a distant two-part transformer core, one part of each being a primary core having a primary winding and carried by the cab, the other part of each being a cooperable secondary core having a secondary winding and positioned at the track; a source of alternating potential in the cab; a home and a distant translating device in the cab; a normally closed home cab circuit including said source, the home primary winding and the home translating device and a circuit breaker normally held closed by said translating device; a normally closed distant cab circuit including said source, the distant primary winding and the distant translating device and a circuit breaker normally held closed by said translating device; both of said cab circuits normally having a current flow operatively to energize the translating devices; a track controlled means comprising a circuit including said secondary winding for each of said secondary cores and for effecting traffic controlled dissipation of the electric energy and thereby modifying the coöperative effect of said home and distant secondary cores upon the corresponding primary cores and consequently upon the operative flow of current through said home and distant translating devices to effect traffic controlled train control upon both home and distant tests; and means at the cab for restoring each of the cab circuits to normal condition independently of the track circuits.

9. In a cab train controlling system, a home and a distant two-part transformer core, one part of each being a primary core having a primary winding and carried by the cab, the other part of each being a coöperable secondary core having a secondary winding and positioned at the track; a source of alternating potential on the cab; a home and a distant translating device in the cab; a normally closed home cab circuit including said source, the home primary winding and the home translating device; a normally closed distant cab circuit including said source, the distant primary winding and the distant translating device, both of said cab circuits normally having a current flow operatively to energize the translating devices; a block section including an insulated rail section; a resonant track circuit including both the home and the distant secondary windings, said insulated rail section, the opposite rail of the block section and a resonating capacity, all in series.

10. In a cab train controlling system, a home and a distant two-part transformer core, one part of each being a primary core having a primary winding and carried by the cab, the other part of each being a cooperable secondary core having a secondary winding and positioned at the track; a source of alternating potential on the cab; a home and a distant translating device in the cab; a normally closed home cab circuit including said source, the home primary winding, the home translating device and a circuit breaker normally held closed by said

translating device; a normally closed distant cab circuit including said source, the distant primary winding, the distant translating device and a circuit breaker normally held closed by said translating device; both of said cab circuits normally having a current flow operatively to energize the translating devices; a block section including an insulated section; a resonant track circuit including both the home and the distant secondary windings, the opposite rails of the block section and a resonating capacity all in series; and means at the cab for restoring each of the cab circuits to normal condition independently of the track circuits.

11. In a cab train controlling system a source of substantially constant potential alternating electromotive force in the cab; a translating device in the cab having a bias to danger condition; a condenser in the cab; a discontinuous core of magnetic material having a primary winding and forming part of the magnetic circuit for said primary winding and carried by the cab; a closed and energized cab circuit including said source, said translating device, said condenser and said primary winding, by means of which the condition of the current in the said translating device, due to the normal high reluctance of said discontinuous core, normally maintains it in safety condition; a stationary core of magnetic material positioned at the track in the path of the magnetic field of said discontinuous core in the cab, to reduce the reluctance of the magnetic circuit for said primary winding when said cores are in juxtaposition; and means at the track for causing the said magnetic circuit for said primary winding, under safety track conditions, to dissipate electric energy to maintain the safety condition of said translating device, when said cores are juxtaposed and the reluctance of their combined magnetic circuit is consequently reduced.

12. In a cab train controlling system a source of substantially constant potential alternating electromotive force in the cab; a translating device in the cab having a bias to danger condition; a discontinuous core of magnetic material having a primary winding and forming a part of the magnetic circuit for said primary winding and carried by the cab; a closed and energized cab circuit including said source, said translating device and said primary winding, by means of which the condition of the current in the said translating device, due to the normal high reluctance of said discontinuous core, normally maintains it in safety condition: one or more condensers combined with the devices of said cab circuit to offset the inductance of said primary winding; a stationary core of magnetic material positioned at the track in the path of the magnetic field of said discontinuous core in the cab, to reduce the reluctance of the magnetic circuit for said primary winding when said cores are in juxtaposition; and means at the track for causing the said magnetic circuit for said primary winding, under safety track conditions, to dissipate electric energy to maintain the safety condition of said translating device, when said cores are juxtaposed and the reluctance of their combined magnetic circuit is consequently reduced.

13. In a cab train controlling system a source of substantially constant potential alternating electromotive force in the cab; a translating device in the cab having a bias to danger condition; a discontinuous core of magnetic material having a primary winding and forming a part of the magnetic circuit for said primary winding and carried by the cab; a closed and energized cab circuit including said source, said translating device and said primary winding, by means of which the condition of the current in the said translating device, due to the normal high reluctance of said discontinuous core, normally maintains it in safety condition; one or more condensers combined with the devices of said cab circuit to offset their inductance; a stationary core of magnetic material positioned at the track in the path of the magnetic field of said discontinuous core in the cab, to reduce the reluctance of the magnetic circuit for said primary winding when said cores are in juxtaposition; a secondary winding for said stationary core; and means at the track for connecting said secondary winding across a path of low impedance upon safety track conditions and for increasing said impedance when the track is broken or occupied, to annul the reluctance reducing effect of said stationary core in the one instance and to maintain it in the other instance.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

HAROLD D. PATTERSON.

Witnesses:
C. E. HAUSELMANN,
EDSON B. SAMMIS.