Oct. 29, 1935.

L. R. ALLISON ET AL

2,019,063

CONTROL SYSTEM

Filed June 29, 1931

3 Sheets-Sheet 1

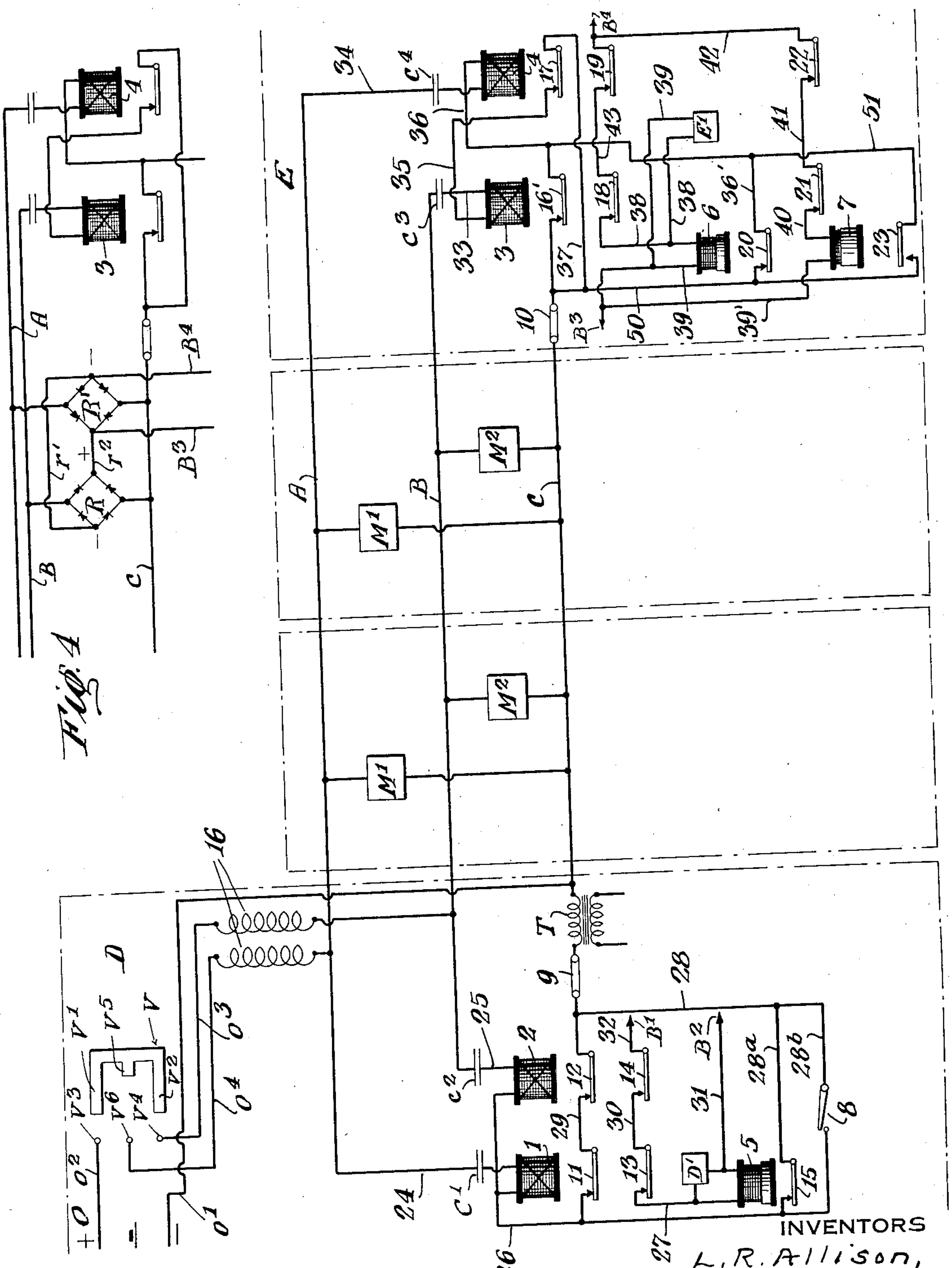

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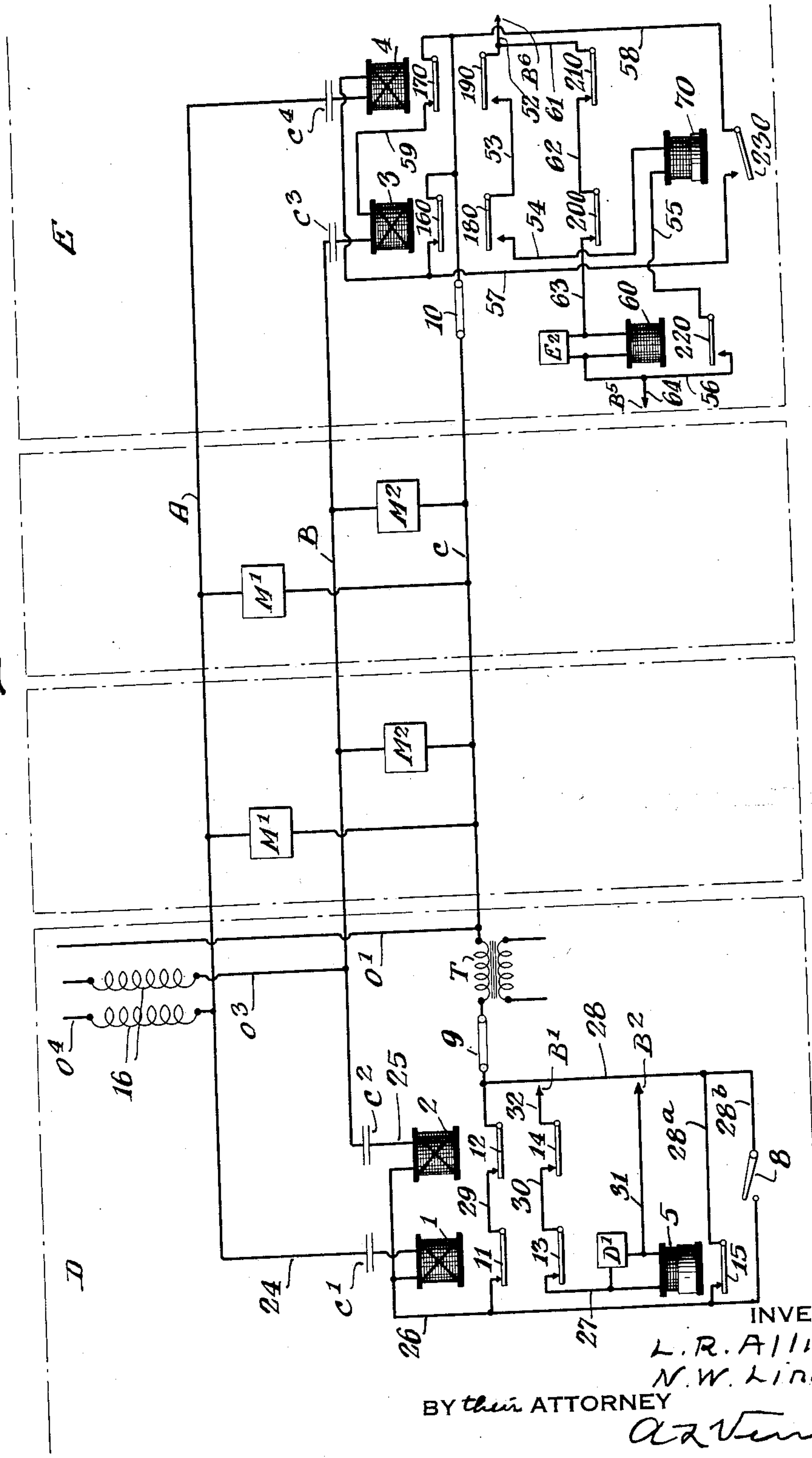
Fig. 2



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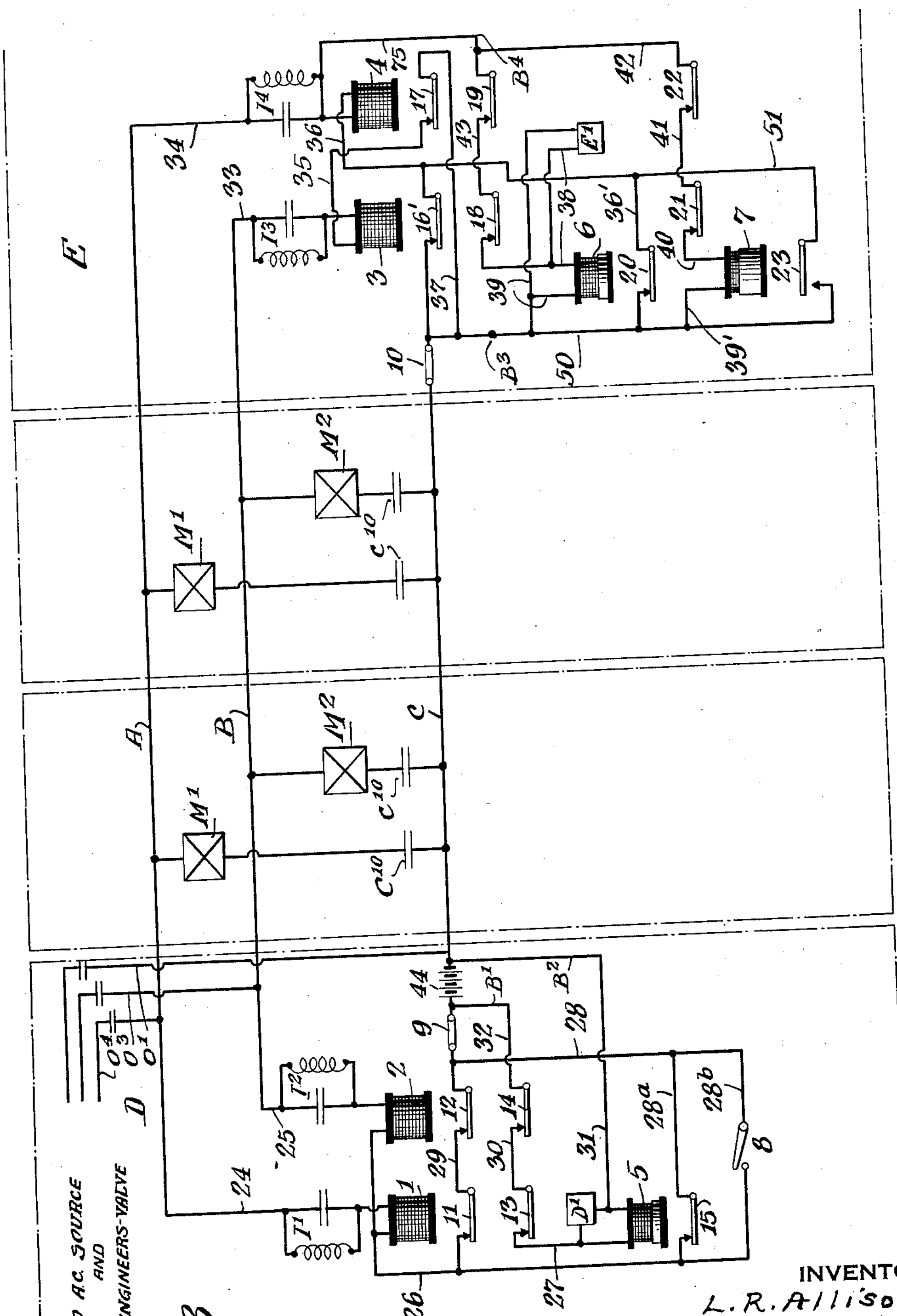

Fig. 3

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CONTROL SYSTEM

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5 Claims. (Cl. 177—311)

This invention relates to control systems, and, although it has been primarily designed for employment in connection with brake-control means on trains, its utility is by no means to be limited to such function as it is susceptible of use in other fields.

The main object and feature of the invention is the provision of means for testing or indicating the integrity of one or more circuits that control normally deenergized translating means without, however, energizing said translating means when testing the circuit or circuits.

In the accompanying drawings the invention is disclosed in several concrete and preferred forms, in which:

Fig. 1 is a diagrammatic view of circuits that constitute one form of the invention:

Fig. 2 is a diagrammatic view similar to Fig. 1 showing a modified form of the invention:

Fig. 3 is a diagrammatic view similar to Figs. 1 and 2 showing a second modified form of the invention: and

Fig. 4 is a detail view of a rectifying means that may be employed in connection with the arrangements shown in Figs. 1 and 3.

The construction shown in Fig. 1 will first be considered.

In the exemplification shown in the drawings, there are two circuits which here have one path in common, said path being conveniently indicated by conductor C, reference characters A and B indicating line wires which in conjunction with common path C and other devices to be presently described constitute two line circuits. These line circuits may be conceived as extending from a control station D to a remote station E, and in the present instance said control station is one of a plurality of cars, such as the cab of the engine, and said remote station is another one of a plurality of cars, such as the caboose of a train. Any number of intervening cars may, of course, be present, and it will be seen that the line circuits extend from car to car. M^1 indicates a translating device, here a traffic-controlling device such as a brake-control magnet, connected across conductors A and C. M^2 indicates a similar translating device connected across conductors B and C. M^1 and M^2 are of the type of brake-control means that are normally deenergized, and which when energized apply the brakes. Any suitable means may be provided to energize M^1 and M^2. In the present instance is shown a source of direct current O having one lead o^1 connected to path C and the other lead o^2 connected through wires o^3 and o^4 to either one or both of line conductors B and A. The arrangement is here such that when the engineer's brake valve V is in the position shown in the drawings, that is in release, running or holding position, the contacts are open and no current is supplied to the line wires, but that when valve V is moved to bring contacts v^1, v^2 and v^5 into engagement with contacts v^3, v^4 and v^6, current is supplied to both M^1 and M^2 to thereby energize them and give a service application of the brakes. When valve V is moved into an intermediate or lap position in which contacts v^1 and v^2 are in engagement with contacts v^3 and v^4 but in which contacts v^5 and v^6 are out of engagement, M^2 only is energized whereby the brake application already made is maintained.

It will be understood that with such construction it is desirable to provide means for testing the integrity of the line conductors so that the engineer may be assured at all times that the brakes will function if operated. Also, on long freight trains, it is desirable that the crew in the caboose be kept informed as to the dependability of the brakes.

Accordingly, the following means, or their equivalent, are provided to test the integrity of the line circuit:

Any suitable means may be employed to supply current, of a character different from that supplied by source O, to the line conductors, said means taking here the form of a transformer T, the secondary of which is included in line conductor C. **1** and **4** indicate two quick-release alternating current relays, one on the engine and the other on the caboose, which are connected in series with each other and conductors A and C. **2** and **3** indicate two additional quick-release alternating current relays, one on the engine and the other on the caboose, connected in series with each other and conductors B and C. While four single element relays have been shown it will be obvious that, instead thereof, two double element relays of the dynamic type, one on the engine and one on the caboose, may be used. Each of said relays controls an armature or circuit breaker (**11**, **12**, **16**^{1} and **17**), the circuits through the relays being closed when all of the armatures engage their front contacts. When the circuits are thus closed, current from the secondary of transformer T will flow over armature **12**, wire **29**, armature **11**, wire **26**, coil of relay **1**, wire **24**, conductor A, wire **34**, coil of relay **4**, wire **36**, armature **16**^{1}, and conductor C back to secondary of T. Current will also flow from wire **26**, to coil of relay **2**, over wire **25**, conductor B, wire **33**, coil of relay **3**, wire **35**, armature 17 and wires 37 and 50, conductor C and back to secondary of transformer T. Thus relays 1 and 4 are in multiple with relays 2 and 3, and it will be evident that a break or other defect in any of the line conductors, with the consequent deenergization of any one of relays 1, 2, 3 and 4, will cause all of armatures 11, 12, 16^1 and 17 to drop thereby rupturing the entire system so far as the flow of testing current from secondary of transformer T is concerned. Obviously relays 1, 2, 3 and 4 and their armatures may be considered indicating means, but it is preferred to have indicating means in addition to said relays and also to provide signaling means. Such additional indicating and signaling means can conveniently be coordinated with shunting devices for starting the system in operation, and in the present instance take the following form: D^1 is an indicating device, on the engine, such as a lamp which receives current from any suitable source, such as a battery connected to points B^1 and B^2, over wires 31 and 27, armature 13 of relay 1, wire 30, armature 14 of relay 2, and wire 32. Connected in multiple with light D^1 is a direct-current slow-release relay 5. 28 indicates a shunt around armatures 11 and 12, said shunt having two branches, one, 28^a, leading over armature 15 of relay 5, and the other, 28^b, leading through switch 8. E^1 is an indicating device, on the caboose, such as a lamp which receives current from any suitable source, such as a battery connected to points B^3 and B^4, over wires 39 and 38, armature 18 of relay 3, wire 43 and armature 19 of relay 4. Connected in multiple with lamp E^1 is a direct-current slow-release relay 6. A shunt is provided around armature 16^1, consisting here of wire 51 leading from wire 36, armature 23 (and its back contact) of relay 7, and wire 50 leading to conductor C, and this shunt has another branch or parallel path 36^1, connecting wires 51 and 50, and leading through armature 20 of relay 6. Relay 7 is here energized, by means of current received from battery B^3—B^4, over wires 39^1 and 40, armature 21 of relay 3, wire 41, armature 22 of relay 4, and wire 42. As indicated, relay 7 is a direct-current slow-release relay, the release period of which is greater than that of relay 6. 9 and 10 indicate two signaling keys in conductor C.

Let it be assumed that all relays are deenergized and all armatures are down, that keys 9 and 10 are closed and switch 8 is open. To set the system in operation, switch 8 is closed and, as armature 23 of relay 7 is in its down-position against its back contact, the following circuit will be established: current from secondary of transformer T will flow over shunt 28 and branch 28^b thereof, over switch 8, along wire 26 to coil of relay 1, over wire 24, conductor A, wire 34, coil of relay 4, over wires 36 and 51, armature 23 of relay 7, wire 50, and conductor C back to secondary of transformer T. The effect of this is to pick up armatures 11 and 13 of relay 1, and armatures 17, 19 and 22 of relay 4. This permits current to flow from wire 26 to coil of relay 2, over wire 25, conductor B, wire 33, coil of relay 3, wire 35, armature 17 of relay 4, wires 37 and 50, and conductor C back to secondary of transformer T. The result of this is to pick up armatures 12 and 14 of relay 2, and armatures 16^1, 18 and 21 of relay 3. The further result of this is (in the engine) to light lamp D^1 and to energize relay 5 thereof picking up armature 15, and (in the caboose) to light lamp E^1, to energize relay 6 to thereby pick up armature 20, and to energize relay 7 to thereby pick up armature 23 from engagement with its back contact. The system now being in operation, switch 8 can be opened without breaking the circuits. Key 9 or 10 may now be opened momentarily to send signals from the engine to the caboose or vice versa. The effect of this momentary opening of a key like 9 or 10 is to deenergize relays 1, 2, 3 and 4 thereby dropping their armatures and to extinguish lights D^1 and E^1. Slow-release relays 5 and 6 will, however, remain energized long enough to hold armatures 15 and 20 in their up-position if key 9 or 10 is again moved to its closed position quickly enough. The result is that when key 9 or 10 is again closed current will flow as previously described in connection with the placing of the system in operation, except that, instead of passing over switch 8 on the engine and over armature 23 of relay 7 on the caboose, the current will flow over armature 15 of slow-release relay 5 of the engine, and over armature 20 of slow-release relay 6 of the caboose. Therefore, all the relays will again become energized and lamps D^1 and E^1 will be lighted.

Suitable blocking or filtering means, such as are well-known in the art, may be inserted in the various leads to segregate the current of source O from that delivered by source T. For instance, choke coils 16 may be inserted in leads o^3 and o^4 and magnets M^1 and M^2 can be protected from the alternating current by having a high impedance, and condensers C^1, C^2, C^3 and C^4 can be inserted in wires 24, 25, 33 and 34 to protect the relays from the direct current of source O. In the present instance, said condensers serve the additional purpose of tuning out the reactance of relays 1, 2, 3 and 4 to thereby reduce the voltage required from transformer T, and also reduce the shunting effect of magnets M^1 and M^2.

From the foregoing, it will be understood that any defect in the system that will cause one or more of relays 1, 2, 3 and 4 to become deenergized and to remain deenergized for a longer period than the release time of relays 5 and 6 will cause the whole system to become deenergized, so far as the testing current is concerned, and will give indication of this condition both on the engine and caboose. Such defects, or failure in the integrity of the circuits, may be caused by an "open" or rupture in one of the three conductors A, B and C, by a short-circuit between conductors A and C, or by a short-circuit between conductors B and C. A short-circuit between conductors A and B would not be detected, because these two conductors are at the same potential, but since said conductors are so to speak tied together when the engineer's brake valve is in the position where contacts v^1, v^5 and v^2 engage contacts v^3, v^6 and v^4, a service application of the brakes can be effected notwithstanding the existence of such short-circuit and therefore its detection is not very essential. The integrity of condensers C^1, C^2, C^3 and C^4 is likewise checked by the testing current and any defect detected. Thus an "open" in any of the four condensers will deenergize the relays in the same way that any "open" in any of the wires would, and a short-circuit in a condenser will detune its associated relay and will reduce the current in such relay below the release value of such relay. It has been pointed out that the slow release period of relay 7 is of greater duration than that of relay 6, and the reason for this will now be pointed out in detail. If, for instance, a short-circuit should develop between conductors B and C, then relay 3 would not receive current sufficient to energize it, and consequently armatures 16^1, 18 and 21 would drop. This would cut-off current both to relays 6 and 7, and if relay 7 should drop its armature 23 earlier or at the same time that relay 6 drops armature 20, it will be evident that a shunt would be created around armature 16^1 over wires 36 and 51, armature 23 and its back contact and wire 50 to conductor C. Relays 1, 2 and 4 would therefore remain energized and the defect or short-circuit would not be detected. By making relay 7 slower in its release than relay 6, contact 23 will not drop and close the shunt, at that point, until it is certain that relay 3 has broken (at 16^1) the circuit of relay 4 a sufficient length of time to cause relays 1 and 4 to drop their armatures and to thereby indicate the defect in the circuit means. The arrangement just described has, however, a disadvantage in that if relay 7 for any reason fails to pick up armature 23, then a permanent shunt will exist around armature 16^1, and if a short-circuit should develop between conductors B and C, relays 1, 2 and 4 would fail to release.

In order to overcome this objection the arrangement shown in Fig. 2 may be used. In Fig. 2 the equipment carried by the engine is the same as that previously described in connection with Fig. 1, the same three conductors A, B and C are retained and the same relays 3 and 4 are employed. In this case, relay 70, which corresponds to relay 7 of Fig. 1, is normally deenergized, and relay 60, which corresponds to relay 6 of Fig. 1, is a quick-release relay. In the modification shown in Fig. 2, armatures 160, 170, 200 and 210 cooperate with front contacts in a manner similar to armatures 16^1, 17, 21 and 22 of Fig. 1. Armatures 180 and 190, which correspond to armatures 18 and 19 of Fig. 1, cooperate with back contacts. Armature 230, which corresponds to armature 23 of Fig. 1, cooperates with a front contact, and armature 220, which corresponds to armature 20 of Fig. 1, is placed under the control of relay 60 and engages a back contact. It will now be seen that, when relays 3, 4 and 60 are deenergized, current will flow from a battery, connected to points B^5 and B^6, over wire 52, armature 190 and its back contact, to wire 53, armature 180 and its back contact, wire 54, relay 70, wire 55, armature 220 and its back contact and wire 56. This energizes relay 70, picks up armature 230 and closes the shunt at that point. If switch 8 is now closed, current will be supplied from the secondary of transformer T to relays 1 and 4, as explained in connection with Fig. 1. But from relay 4 the current will flow over wire 57, armature 230 and wire 58 to conductor C thereby picking up armatures 170, 190 and 210. This will permit current to flow from secondary of transformer T, in the manner described in connection with Fig. 1, to relays 2 and 3 and from the latter over wire 59 and armature 170 to conductor C, thereby picking up armatures 160, 180 and 200. Current will now flow from the battery, connected to points B^5 and B^6, over wire 52, wire 61, armature 210, wire 62, armature 200, wire 63, in multiple through relay 60 and light E^2 and over wire 64. Armature 220 will now be picked up, and, after the release time of relay 70 has expired, armature 230 will drop. It will now be understood that if for any reason relay 70 should fail to pick up its armature 230 it will not be possible to start the system in operation and lights D^1 and E^2 will not be energized. Signaling by means of key 9 or 10 can also be carried on in the system of Fig. 2. If one of said keys is opened relays 1, 2, 3 and 4 will become deenergized thereby dropping armatures 11, 12, 13, 14, 160, 170, 180, 190, 200 and 210. This will deenergize relay 60 and extinguish lights D^1 and E^2. Relay 70 will now pick up its armature 230 thereby establishing the shunt around armature 160. If the key is now closed before the release period of relay 5 expires it will be evident that the shunt over armature 15 will have been maintained, and therefore relays 1, 2, 3, 4 will again become energized, relay 60 and lights D^1 and E^2 will likewise become energized and relay 70 will become deenergized.

In Fig. 1, the direct current utilized in energizing the caboose equipment is described as coming from a battery connected to leads B^3 and B^4. It will be understood, however, that it is immaterial how this current is obtained. For instance, as shown in Fig. 4, direct current could be obtained from two rectifiers, one R connected between conductors B and C, and another R^1 connected between conductors A and C. In this instance lead B^4 is connected to rectifier R^1 from whence leads a wire r^1 to rectifier R and from the latter leads another wire r^2 back to rectifier R^1 and to lead B^3.

It will be obvious that the current used to test the circuit need not be alternating current, and that the current used to actuate the brake-control means need not be a direct current; it is sufficient if the two currents have such different characteristics as to permit them to be readily segregated. In Fig. 3 is shown the same layout as in Fig. 1, except that alternating current is used to energize the brake control means and direct current is used for testing purposes. In other words: a battery 44 is used in place of transformer T and leads B^1 and B^2 can then still receive current from a separate battery as in Fig. 1 or they can be connected on opposite sides of battery 44 as will be evident. To prevent the flow of alternating current in the direct current relays, tuned impedances I^1, I^2, I^3 and I^4 are inserted in wires 24, 25, 33 and 34. Relays 6 and 7 and lamp E^1 can receive direct current in the manner described in connection with Fig. 1 or relays 6, 7 and lamp E^1 can be connected to wire 50 in which event wire 42 is connected by a wire 75 to wire 34 and to tuned impedance I^4. In order to protect the brake-actuating relays M^1 and M^2 from the direct current used for testing purposes, condensers C^{10} are placed in series with said relays. Wires o^1, o^4 and o^3 lead to an alternating source of current through an engineer's valve similar to that shown at V in Fig. 1, but choke coils 16 are omitted.

It is considered unnecessary to trace the circuits that arise under various operating conditions in Fig. 3, as it would be practically a repetition of the description associated with Fig. 1. The circuit of Fig. 3 has one advantage over that shown in Fig. 1 in that the brake-operating magnets constitute no load whatever on the current source (here battery 44) that supplies the testing current.

We claim:

1. A control system including two line conductors and a common path all extending between two stations, two relays at each station, a first circuit including one of said conductors and the winding of the first relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the second relay at the second station, a second circuit including the other of said con-

ductors and the winding of the second relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the first relay at the second station, a shunt around said front contacts of the relays at the first station including a normally open manually closable switch, a shunt around said front contact of the second relay at the second station, and means for closing said second shunt when either or both of the relays at the second station are deenergized.

2. A control system including two line conductors and a common path all extending between two stations, two relays at each station, a first circuit including one of said conductors and the winding of the first relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the second relay at the second station, a second circuit including the other of said conductors and the winding of the second relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the first relay at the second station, a shunt around said front contacts of the relays at the first station including a normally open manually closable switch, a shunt around said front contact of the second relay at the second station including a back contact of a fifth relay, and a circuit for the winding of said fifth relay including a front contact of each of the other relays at the second station.

3. A control system including two line conductors and a common path all extending between two stations, two relays at each station, a first circuit including one of said conductors and the winding of the first relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the second relay at the second station, a second circuit including the other of said conductors and the winding of the second relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the first relay at the second station, a shunt around said front contacts of the relays at the first station including a normally open manually closable switch, a shunt around said front contact of the second relay at the second station including a front contact of a fifth relay, a sixth relay located at the second station, a circuit for the winding of said sixth relay including a front contact of each of the first two relays at the second station, and a circuit for the winding of said fifth relay including a back contact of each of the first two relays at the second station as well as a back contact of said sixth relay.

4. A control system including two line conductors and a common path all extending between two stations, two relays at each station, a first circuit including one of said conductors and the winding of the first relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the second relay at the second station, a second circuit including the other of said conductors and the winding of the second relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the first relay at the second station, a shunt around said front contacts of the relays at the first station including a normally open manually closable switch, a shunt around said front contact of the second relay at the second station, means for closing said second shunt when either or both of said relays at the second station are deenergized, an auxiliary shunt around said front contacts of said relays at the first station including a front contact of a slow releasing relay, a circuit for the winding of said slow releasing relay including front contacts of the first relays at the first station, a second auxiliary shunt around said front contact of the second relay at the second station including a front contact of a second slow releasing relay, a circuit for the winding of said second slow releasing relay including front contacts of the first two relays at the second station, manual means at one of said stations for opening both of said first mentioned circuits, and an indicator at the other station controlled by the first two relays at such station.

5. A control system including two line conductors and a common path all extending between two stations, two relays at each station, a first circuit including one of said conductors and the winding of the first relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the second relay at the second station, a second circuit including the other of said conductors and the winding of the second relay at each station as well as said common path and a front contact of each relay at the first station and a front contact of the first relay at the second station, a shunt around said front contacts of the relays at the first station including a normally open manually closable switch, a shunt around said front contact of the second relay at the second station, including a front contact of a slow releasing relay, means for energizing said slow releasing relay when the first two relays at the second station are open, an auxiliary shunt around said front contacts of said relays at the first station including a front contact of a slow releasing relay, a circuit for the winding of said slow releasing relay including front contacts of the first relays at the first station, manual means at one of said stations for opening both of said first mentioned circuits, and an indicator at the other station controlled by the first two relays at such station.

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