

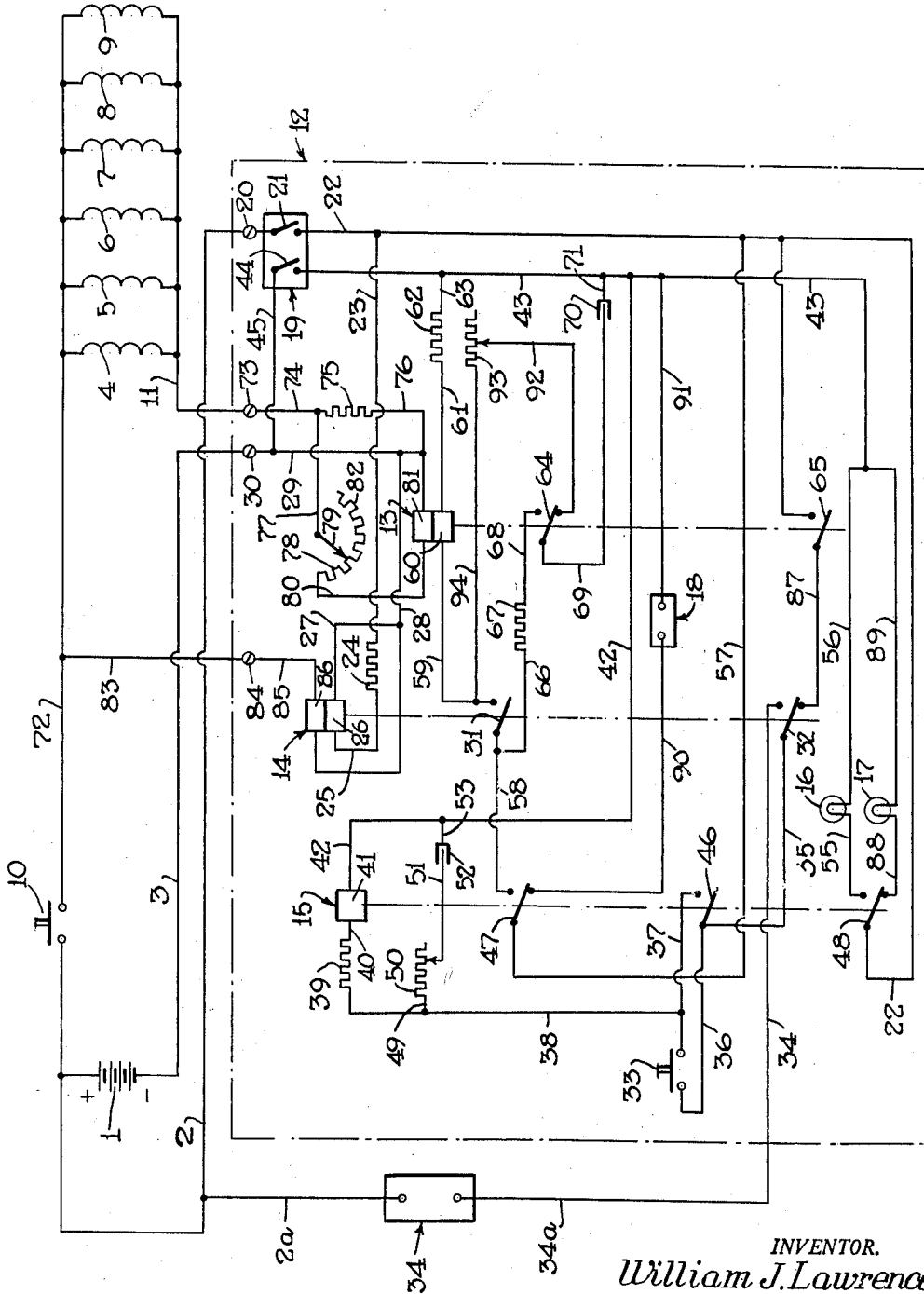
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ELECTRIC CIRCUIT CHECKING EQUIPMENT

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ELECTRIC CIRCUIT CHECKING EQUIPMENT

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This invention relates to a circuit checking means and more particularly, to an apparatus that may be adapted to be associated with a control circuit of electro-pneumatic brake apparatus employed on a train of cars, and to selectively signal integrity or lack of integrity of the said control circuit and accompanying electrical devices and pneumatically actuated electric controllers associated therewith.

Electro-pneumatic brake systems in use on present-day railway trains, employ control wires or circuits which extend from the locomotive or control car at the head end of the train to all the cars in the train. These control circuits usually include two magnet valves, the application magnet valve and the release magnet valve, on each car of the train, the magnet valves being controlled through the train wire circuits by a pneumatically operated switch or controller which is normally located on the locomotive.

The desirability of continuously indicating the integrity or lack of integrity of the electrical control circuits and of the magnet valves and pneumatic controllers has been previously recognized, and various means and methods have been proposed and employed for this purpose. An arrangement for this purpose is described in the pending application, Serial No. 102,836, filed July 2, 1949, of C. M. Hines, now Patent No. 2,573,442, which is assigned to the assignee of this invention.

In the above mentioned pending application, the integrity check is made, while the brakes are released, by use of a Wheatstone bridge arrangement, and while the brakes are applied, by use of a current-responsive relay in a common return wire circuit of the train. However, any momentary fault in the release control circuit and the common return wire circuit which causes the current in the current-responsive relay to decrease below its normal predetermined value effects the same "fault" indication as does a serious prolonged fault.

It is an object of the present invention to provide an improved circuit-checking apparatus of the type disclosed in the above mentioned application, characterized in that the occurrence of fault in the release control circuit or in the common return wire does not cause the circuit checking apparatus to give an indication of a fault unless the fault is of prolonged duration.

It is another object of my invention to provide an improved circuit-checking apparatus of the type referred to in the foregoing object, and further characterized in that any momentary de-

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crease of current in the release control circuit will not cause the circuit-checking apparatus to effect a fault indication.

The above objects together with other objects which will be made apparent in the subsequent description of my invention, are obtained by apparatus to be hereinafter described when read in connection with the accompanying drawing, wherein the single figure shows a simplified diagrammatic view of an electro-pneumatic control apparatus embodying my improved circuit-checking and signalling system.

While a simplified control apparatus embodying only one control circuit is shown in the drawing for the purpose of illustrating the nature and utility of my novel circuit-checking system, it will be understood that the system illustrated and described herein is intended to and may be applied to function with any similar electric control apparatus embodying a plurality of electrical controlling units in a plurality of control circuits. Therefore, even though this circuit-checking system is for particular use in electro-pneumatic brake control systems usually having two or more control circuits, it will be described herein, for the sake of simplicity, in connection with only one control circuit, taken to be the release control circuit.

The control circuit shown includes a source of direct current voltage, such as a battery 1, a battery supply wire 2, and a battery return wire 3, a plurality of magnet valve devices represented by the release magnet valve coils 4, 5, 6, 7, 8 and 9 (one for each of a corresponding number of different cars), a switch device 10, representing the usual pneumatically operated master controller switch, for completing a circuit to energize said magnet coils, and a common return wire 11. It should be understood that any number of magnet coils may be checked, but for purposes of illustration, only six such coils are shown herein.

The circuit-checking and signalling apparatus shown in the drawing may be embodied in or attached to a suitable casing or panel board 12, and comprises a two-winding relay 13, a two-winding relay 14, and a single winding relay 15, each of these said relays having several contact members for completing circuits which are described hereinafter.

This apparatus also comprises signalling devices which are illustrated herein as an "all-clear" lamp 16, a "fault" lamp 17, and an audible warning bell or buzzer 18.

This apparatus also comprises a cabinet 34

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containing a Wheatstone bridge and coding equipment (not shown) which functions to check the integrity of the control circuit and, incidental thereto, supplies a pulsating D. C. voltage to a wire 34a, when the control circuit is not energized. Cabinet 34 represents and includes the Wheatstone bridge arrangement and coding relays and circuits used and described in the mentioned pending application Serial No. 102,836 of C. M. Hines, but since such details are not required for an understanding of my present invention, cabinet 34 is shown in outline form only. It should be understood that suitable connections (not shown) are provided between the Wheatstone bridge and coding equipment in cabinet 34 and the control circuit such that the equipment is automatically disconnected from the control circuit when the control circuit is energized and thus automatically ceases to supply a pulsating D. C. voltage to wire 34a at such time. Thus, so long as the switch device 10 is in its open position and the magnet coils 4, 5, 6, 7, 8 and 9 consequently deenergized, the circuit-checking apparatus in cabinet 34 will check the integrity of the control circuit in the manner explained in the mentioned pending application, Serial No. 102,836. That part of the checking apparatus which functions while the control circuit is energized is depicted in detail in the drawing since my improvement is concerned directly therewith. The operation of this portion of the checking equipment will now be described.

To condition the apparatus for operation, the operator first closes a two-pole switch 19 to establish a circuit which may be traced from the plus + terminal of battery 1 by way of the battery supply wire 2 to the B+ terminal post 20 on the panel 12, thence through the switch contact member 21 of the switch 19, a B+ wire 22, a wire 23, a current limiting resistor 24, a wire 25, the lower winding 26 of the relay 14, a wire 27, a wire 28, and a wire 29 to a B- terminal post 30 on panel 12, and thence to the negative (-) terminal of battery 1 by way of the battery return wire 3. The completion of this circuit causes the relay 14 to be energized to its picked-up position, thereby closing the contact member 31 and moving contact member 32 of the said relay to its upper closed position. With the relay 14 energized to its picked-up position, the operator now closes a switch 33 which establishes a circuit for energizing relay 15, which circuit may be traced from the plus (+) terminal of battery 1 by way of the battery supply wire 2, a wire 2a, the bridge and coding arrangement in cabinet 34 which delivers pulsating voltage to a wire 34a, a contact member 32 of relay 14 in its upper closed position, a wire 35, a wire 36, the closed switch 33, a wire 37, a wire 38, a current-limiting resistor 39, a wire 40, winding 41 of relay 15, a wire 42, the B- wire 43, a closed contact member 44 of switch 19, a wire 45, and a wire 29 to the B- terminal post 30, and thence to the negative (-) terminal of battery 1 by way of the battery return wire 3. The completion of this circuit causes the relay 15 to be energized to its picked-up position, thereby closing the contact member 46 and moving the contact members 47 and 48 to their respective upper closed positions. After the contact member 46 of relay 15 is closed, the operator may open the switch 33 and relay 15 then maintains its own energizing circuit by the "stick" circuit completed through the closed contact member 46 of said relay, which parallels switch 33.

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In parallel with the winding of relay 15, is a branch circuit consisting of wire 49, resistor 50, wire 51, a condenser 52 and a wire 53. Condenser 52 is thus charged simultaneously upon energization of the winding of relay 15. Accordingly when the circuit for energizing the winding of relay 15 is interrupted, condenser 52 discharges current through the winding of relay 15 to maintain relay 15 picked-up for a short time interval after the energizing circuit is interrupted for a purpose hereinafter made apparent.

So long as the relay 15 is energized to its picked-up position, contact member 48 thereof is actuated to its upper closed position, thereby completing a circuit for energizing the "all-clear" lamp 16 which indicates an absence of fault in the control circuit consisting of battery 1, battery supply wire 2, and the battery return wire 3 while the switch 10 is open. This circuit may be traced from the B+ wire 22 to the contact member 48 in its upper closed position, thence by wire 55, the all clear-lamp 16, and wire 56, to the B- wire 43.

Also, when the relay 15 is energized, the contact member 47 of relay 15 is thereby actuated to its upper closed position to complete a circuit for energizing relay 13 to its picked-up position, thereby causing the contact member 64 of relay 13 to move to its upper closed position, and a contact member 65 of relay 13 to move to its closed position. This circuit may be traced from the B+ wire 22 by way of wire 57, contact member 47 in its upper closed position, wire 58, closed contact member 31 of relay 14, wire 59, the lower winding 60 of relay 13, wire 61, resistor 62, and the wire 63 to the B- wire 43.

The energization of relay 13 to its picked-up position and the consequent movement of contact member 64 to its upper closed position completes a loop circuit in parallel with the lower winding 60 of relay 13, which circuit consists of a wire 66, a resistor 67, a wire 68, contact member 64 in its upper closed position, wire 69, condenser 70 and a wire 71. Condenser 70 is thus charged so that when the circuit just described for energizing relay 13 becomes interrupted, the current discharged from condenser 70 through the delay or loop circuit continues to energize the winding of relay 13 and cause the relay to remain picked-up for a short time interval, for a purpose hereinafter made apparent.

The switch 10 represents a contact member of the usual master controller device. If the switch 10 is open, the release control circuit shown herein is deenergized (brake release position of the switch 10), and if the switch 10 is closed, the release control circuit is energized (brake application position of said switch).

The conditions described thus far are the normal conditions of the circuit checking and signalling apparatus with the switch 10 open and no fault existing in the battery supply and return circuit of the magnets 4 to 9.

Assuming that no fault exists in the circuit to be checked, the magnet coils 4, 5, 6, 7, 8 and 9 are energized by closing the switch 10, and the following conditions result:

Switch 10 is effective when closed to complete a circuit for energizing magnet coils 4, 5, 6, 7, 8 and 9. This circuit extends from the battery supply wire 2, by way of switch 10, a wire 72, the various magnet coils 4, 5, 6, 7, 8 and 9, the common return wire 11 to the common terminal post 73 on the panel 12, and thence by wire 74, resistor 75, a wire 76, wire 29, and B- terminal

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post 30 to the battery return wire 3, thus energizing the said magnet coils to perform their brake control function, which is the closing of the exhaust ports through which fluid under pressure is released to effect release of the brakes. Connected in parallel with the resistor 75 and subject to the voltage-drop across said resistor is a circuit consisting of a wire 77, a variable resistor or rheostat 78 having a manually operable contact arm 79, a wire 80, the upper winding 81 of relay 13, and wire 76. The contact arm 79 of resistor 78 is positioned manually (as will be explained) to indicate the number of magnet coils (in this case the number of cars on the train, assuming one magnet coil per car), as shown on an escutcheon plate 82. The voltage-drop across the resistor 75, with no faults in the control circuit is sufficient to cause the winding 81 of relay 13 to be energized so as to maintain the relay picked-up when the contact arm 79 of resistor 78 is positioned, as indicated on the escutcheon plate 82, in accordance with the actual number of magnet coils in the circuit. The positioning of the contact arm 79 of variable resistor 78 is such that with no fault in the control circuit, the resistor may be adjusted in correspondence with an addition or subtraction of the number of magnet coils in a circuit, so as to regulate the voltage energizing the winding 81 of relay 13 and limit said voltage to an amount insufficient to cause relay 13 to pick-up, but sufficient enough to maintain the relay 13 picked-up after said relay is picked-up by some other means as will be explained hereinafter. Said adjustment of resistor 78 in accordance with the number of magnet coils is indicated on the calibrated escutcheon plate 82.

If a fault occurs in the circuit energizing magnet coils 4, 5, 6, 7, 8 and 9, such as would cause a reduction from the normal current in the common wire 11 and a corresponding reduction in the voltage-drop across the resistor 75 below that required to energize the winding 81 of relay 13 sufficiently to maintain relay 13 picked-up, relay 13 will drop-out by reason of the concurrent deenergization of the lower winding 60 of relay 13 in a manner presently described. Thus, unless a fault occurs in the control circuit, relay 13 will remain energized and picked-up while the control circuit is energized.

Switch 10 is also effective, when closed, to complete another circuit, which circuit may be traced from the battery supply wire 2, by way of switch 10, wire 72, wire 83, terminal post 84, wire 85, the top winding 86 of relay 14, wire 29, wire 29, and the B— terminal post 30 to the battery return wire 3. This circuit energizes the top winding 86 of relay 14 in a direction opposite that in which the lower winding 26 of relay 14 is energized. The opposing energization of the two windings 86 and 26 will effect movement of the relay 14 to its dropped-out position, in which the contact member 31 is open and the contact member 32 is moved to its lower closed position. When the contact member 31 is opened, the circuit for energizing the lower winding 60 of relay 13 is thus interrupted thereby leaving the previously energized top winding 81 as the only means for maintaining relay 13 picked-up.

The contact member 32 of relay 14 is effective in its down closed position to interrupt the circuit previously described whereby pulsating D. C. voltage is supplied from the cabinet 34 for energizing the relay 15, and instantly thereafter to establish another circuit for energizing the wind-

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ing of relay 15 by way of the B+ wire 22, closed contact member 65 of relay 13, wire 87, contact member 32 in its down closed position, wire 35, closed contact member 46, wire 37, wire 38, resistor 39, wire 40, winding 41 of relay 15, and wire 42 to the B— wire 43. During the short time interval in which the contact member 32 of relay 14 is changing from the upper closed position to its lower closed position, the relay 15 is maintained energized to its picked-up position by the current discharging from condenser 52 through the loop circuit consisting of wire 51, resistor 50, wire 49, wire 38, resistor 39, wire 40, winding 41 of the relay 15, wire 42, and wire 53. Prior to the expiration of the delayed drop-out period of relay 15, the energizing circuit for the winding of relay 15, as previously traced, will have been established by contact member 32 in its lower closed position, thereby keeping the contact members of relay 15 in their respective picked-up positions.

As previously explained, if a fault occurs in the control circuit resulting in the reduction of current in said circuit, the voltage-drop then existing across resistor 75 is insufficient to maintain the relay 13 picked-up and the contact members of said relay are thus restored to their dropped-out or down positions. With contact member 65 in its down position, the circuit previously described for energizing relay 15 is thereby interrupted and thus, after a short time interval (time during which the condenser 52 discharges through the loop circuit previously described) the relay 15 will be deenergized and its contact members will move to their respective down positions. With contact member 48 of relay 15 in its down closed position, a circuit is thus completed from the B+ wire 22, contact member 48, wire 88, the "fault" lamp 17, and wire 89 to the B— wire 43, thereby energizing the lamp 17 and giving a visual indication of fault in the magnet coil or control circuit. With contact member 47 in its down closed position, a circuit is thus completed from the B+ wire 22 by way of wire 57, contact member 47, wire 90, audible warning signal 18, and wire 91 to the B— wire 43, thereby giving an audible warning of a fault in the magnet coil circuit.

If the fault in the magnet coil circuit endures only momentarily, it is undesirable to have this fault indicated. A feature of my invention is to prevent the drop-out of relay 15 (which effect a "fault" indication) unless the fault on the control circuit is prolonged and continued. I obtain this result through the arrangement now to be described.

When the current energizing winding 81 of relay 13 is unable to maintain the relay 13 picked-up by reason of a fault on the control circuit, relay 13 drops out causing contact member 64 to move to its down closed position and contact member 65 to move to its open position. The opening of contact member 65 interrupts the mentioned circuit from the B+ wire 22 for energizing said relay 15, but relay 15 does not immediately drop-out due to the fact that condenser 52 discharges through the winding of relay 15, as previously mentioned, and thereby maintains relay 15 energized for a short time interval sufficient to enable any momentary fault to be removed. However, even though the momentary fault on the control circuit is removed, the winding 81 of relay 13 is unable to cause pick-up of relay 13 when the winding 81 again becomes energized. As previously mentioned, the winding 81 of relay

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13 is ineffective, when energized, to cause the relay 13 to pick-up, although, after the relay is picked-up, winding 81 is effective to maintain the relay picked-up. In order to cause the relay 13 to be picked-up upon termination of a momentary fault, the arrangement including condenser 70 is provided, according to my invention. With contact 64 of relay 13 in its lower closed position, condenser 70 discharges current through the lower winding 60 of relay 13 by way of the loop circuit consisting of condenser 70, wire 59, contact member 64 of relay 13 in its lower closed position, wire 92, resistor 93, wire 94, wire 59, the lower winding 60 of relay 13, wire 61, resistor 62, wire 63, wire 43, and wire 71, thus causing relay 13 to be picked-up. As soon as the relay 13 is picked-up by the current discharging from the condenser 70 through the just described loop circuit, the contact member 64 of relay 13, which is correspondingly shifted to its upper closed position, interrupts said loop circuit and re-establishes the charging circuit previously traced, for condenser 70.

Thus, if the fault is prolonged, relay 13 will continue to be alternately picked-up and dropped-out due to the completion of the condenser discharge circuit for picking up relay 13 as soon as said relay drops out due to the fault.

The discharging time of condenser 70 is regulated by the variable resistor 93. The resistor 93 controls the charging time of said condenser 70 and serves to so limit the amount of recharge of the said condenser each time the contact member 64 of relay 13 is picked-up during the intermittent operation of relay 13, that after the expiration of a certain uniform time the condenser 70 will be discharged sufficiently so as to be unable to effect the pick-up of relay 13, thereby terminating continuous alternate pick-up and drop-out of relay 13.

When the charge of the condenser 70 is ultimately dispensed after a certain length of time during which relay 13 continues to pick-up and drop-out alternately, the relay 13 is caused to drop-out and remain dropped-out to effect a fault indication as previously described, until said fault is corrected. However, if the fault is momentary and corrects itself before condenser 70 is sufficiently discharged, the upper winding 81 of relay 13 becomes effective to maintain the said relay picked-up as previously described, and thus the relay 13 will stay picked-up, and the condenser 70 will be fully recharged. Consequently the "fault" lamp 17 will not be energized as it was when the relay 13 remained deenergized, as previously described, because relay 15 will not be caused to drop-out.

By means of the novel arrangement which I have provided, as above described, a fault indication is thus given only if the fault is prolonged and not if the fault endures only momentarily.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. For use in checking equipment used to check the integrity and lack of integrity of an electrical circuit, the combination of a first means operative responsive to the existence of integrity or lack of integrity of said circuit while said circuit is deenergized, a second means operative responsive to the existence of integrity or lack of integrity of said circuit while said circuit is energized, means responsive to energization and deenergization of said circuit to selectively render either said second means or said first means

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effective, respectively, means operative to cause said second means when effective to be responsive to the lack of integrity of said circuit only when said lack of integrity endures longer than a certain uniform interval of time, and signal means common to both said first means and said second means and controlled alternatively thereby, depending on whether the said circuit is deenergized or energized, for indicating the existence of integrity or lack of integrity of said circuit.

2. For use in a checking equipment used to check the integrity and lack of integrity of an electrical circuit, the combination of a relay having two separate windings, one of said windings being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, a first means for energizing said one winding when said circuit is deenergized and for deenergizing said one winding when said circuit is energized, second means for energizing said other winding above said certain value only so long as the integrity of said circuit is not impaired and for reducing the energization of said other winding to below said certain value upon the impairment of the integrity of said circuit while said circuit is energized, third means for intermittently energizing said one winding over a certain uniform interval of time while said circuit is energized to thereby cause intermittent pick-up and drop-out of said relay while the current energizing said other winding does not exceed said certain value, means responsive to drop-out of said relay only after the expiration of said certain uniform interval of time while said circuit is energized and while the current energizing said other winding does not exceed said certain value, and signal means controlled by the last said means for indicating the existence of integrity or lack of integrity of said circuit.

3. For use in a checking equipment used to check the integrity and lack of integrity of an electrical circuit, the combination of a relay having two separate windings, one of said windings being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, a first means for energizing said one winding when said circuit is deenergized and for deenergizing said one winding when said circuit is energized, second means for energizing said other winding above said certain value only so long as the integrity of said circuit is not impaired and for reducing the energization of said other winding to below said certain value upon the impairment of the integrity of said circuit while said circuit is energized, a condenser, means for first charging said condenser and then discharging said condenser repeatedly through said one winding for intermittently energizing said one winding over a certain uniform interval of time while said circuit is energized to thereby cause intermittent pick-up and drop-out of said relay while the current energizing said other winding does not exceed said certain value, means responsive to drop-out of said relay occurring only after the expiration of said certain uniform interval of time while said circuit is energized and while the current energizing said other winding does not exceed said certain value, and signal means controlled

by the last said means for indicating the existence of integrity or lack of integrity of said circuit.

4. For use in a checking equipment used to check the integrity and lack of integrity of an electrical circuit, the combination of a relay having two separate windings, one of said windings being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, a first means for energizing said one winding when said circuit is deenergized and for deenergizing said one winding when said circuit is energized, second means for energizing said other winding above said certain value only so long as the integrity of said circuit is not impaired and for reducing the energization of said other winding to below said certain value upon the impairment of the integrity of said circuit while said circuit is energized, a condenser, means for first charging said condenser and then discharging said condenser repeatedly through said winding for intermittently energizing said one winding while said circuit is energized to thereby cause intermittent pick-up and drop-out of said relay while the current energizing said other winding does not exceed said certain value, means for limiting the degree of recharge of said condenser during each successive recharge interval thereby to effect depletion of the charge on said condenser at the expiration of a certain uniform interval of time, means responsive to drop-out of said relay occurring after the expiration of said certain uniform interval of time as a result of depletion of the charge on said condenser, and signal means controlled by the last said means for indicating the existence of integrity or lack of integrity of said circuit.

5. For use in a checking equipment used to check the integrity and lack of integrity of a control circuit, the combination of a relay having two separate windings, means effective when said circuit is deenergized for causing one of the windings of said relay to be energized and effective when said circuit is energized for causing said one winding of said relay to be deenergized, said one winding of said relay being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding of said relay being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, first means for energizing said other winding of said relay above said certain value only while said circuit is energized and the integrity of said circuit is not impaired, and for reducing the energization of said other winding to below said certain value upon the impairment of the integrity of said circuit while said circuit is energized, second means for intermittently energizing said one winding of said relay over a certain uniform interval of time while said circuit is energized to thereby cause intermittent pick-up and drop-out of said relay while the said current for energizing said other winding does not exceed said certain value, and for deenergizing said one winding of said relay after said certain uniform time interval when said circuit is energized and said current for energizing said other winding of said relay does not exceed said certain value, and signal means controlled by said relay for indicating the existence of integrity or lack of integrity of said circuit.

6. For use in a checking equipment used to

check the integrity and lack of integrity of an electrical circuit, the combination of a relay having two separate windings, means effective when said circuit is deenergized for causing one of the windings of said relay to be energized, and effective when said circuit is energized for causing said one winding of said relay to be deenergized, said one winding of said relay being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding of said relay being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, first means for energizing said other winding of said relay above said certain value only while said circuit is energized and the integrity of said circuit is not impaired and for reducing the energization of said other winding to below said certain value upon the impairment of integrity of said circuit while said circuit is energized, second means for intermittently energizing said one winding of said relay over a certain uniform interval of time while said circuit is energized to thereby cause pick-up and drop-out of said relay while the said current for energizing said other winding of said relay does not exceed said certain value due to lack of integrity of said circuit for said certain uniform time interval, and for deenergizing said one winding of said relay after said certain uniform time interval when said circuit is energized and said current for energizing said other winding of said relay does not exceed said certain value, electro-responsive means controlled by said relay, and operatively responsive only after the elapse of a second certain uniform interval of time following drop-out of said relay to indicate a lack of integrity of said circuit.

7. For use in a checking equipment used to check the integrity and lack of integrity of an electrical circuit, the combination of a relay having two separate windings, means effective when said circuit is deenergized for causing one of the windings of said relay to be energized, and effective when said circuit is energized for causing said one winding of said relay to be deenergized, said one winding of said relay being effective when energized to cause pick-up of said relay and to maintain said relay picked-up, the other winding of said relay being effective only when energized by a current exceeding a certain value for maintaining the said relay picked-up, first means for energizing said other winding of said relay above said certain value only while said circuit is energized and the integrity of said circuit is not impaired and for reducing the energization of said other winding to below said certain value upon the impairment of integrity of said circuit while said circuit is energized, second means for intermittently energizing said one winding of said relay over a certain uniform interval of time while said circuit is energized to thereby cause pick-up and drop-out of said relay while the said current for energizing said other winding of said relay does not exceed said certain value due to lack of integrity of said circuit for said certain uniform time interval, and for deenergizing said one winding of said relay after said certain uniform time interval when said circuit is energized and said current for energizing said other winding of said relay does not exceed said certain value, electro-responsive means operatively unresponsive to intermittent drop-out of said relay occurring during the said certain uniform interval of time and operatively responsive only to drop-out of said relay occurring

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at the expiration of said certain uniform interval of time, and signal means controlled by said electro-responsive means to indicate integrity and lack of integrity of said circuit.

8. Circuit checking equipment comprising electro-responsive means operatively responsive to reduction of the normal current in the circuit resulting from impairment of the integrity of the circuit, means effective upon such operative response of said electro-responsive means for causing intermittent restoration of said electro-responsive means to the normal condition thereof over a certain period of time, so long as the impairment of the integrity of the circuit continues, relay means controlled by said electro-responsive means, means for preventing a change in the position of said relay means under the con-

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trol of said electro-responsive means until after said certain period of time has expired, and signal means controlled by said relay means for indicating integrity and lack of integrity of the circuit.

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