(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 967 833 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.12.1999 Bulletin 1999/52

(51) Int Cl.[6]: **H04R 27/00**

(21) Application number: **99305005.3**

(22) Date of filing: **25.06.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **27.06.1998 GB 9813882**

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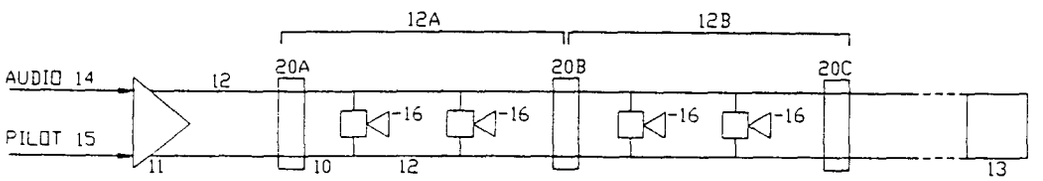
(54) PA system having zone isolator circuits

(57) A public address network using a single pair of signal wires (12) split in to sections using isolator circuits (20) which detect short circuit faults and open circuit faults and isolate if a fault is detected. In a fault tolerant mode an audio signal (14) and a pilot signal (15) for powering the isolators (20) are supplied from both ends of the signal wires (12).

FIG.1



EP 0 967 833 A2

Description

[0001] The present invention relates in general to a public address system and in particular, but not exclusively, to a public address system used as a voice alarm speaker network in conjunction with a fire or safety alarm system.

[0002] Typically, a public address system comprises a plurality of speakers positioned at convenient locations around building or other site, each coupled to a central control unit including an audio amplifier for driving a audio signal to the speaker units. It is desired to minimise the amount of wiring in a system, in order to minimise cost and complexity and to improve long term reliability. Ideally, it is desired to use a single pair of signal wires coupled to each speaker unit, with the speaker units typically being coupled across the signal wires in parallel. Using a single pair of signal wires minimises cabling costs and aids discrete installation. However, this arrangement has minimal redundancy and a fault such as a short circuit may occur at any point along the signal wires, leading to a malfunction of the system. A short circuit fault generally means that the system must be shut down in order to avoid damage to sensitive components, such as the audio amplifier. An open circuit fault, for example due to an accidental break in the signal wires, can often be tolerated, but loud speakers positioned after the break do not receive an audio signal.

[0003] It is an aim of the present invention to provide a public address system having greater fault tolerance, whilst requiring minimal wiring.

[0004] It is an aim of at least preferred embodiments of the present invention to provide a fault tolerant public address system which maintains operation despite a short circuit fault or a open circuit fault occurring on a single pair of signal wires.

[0005] According to the present invention there is provided an isolator circuit for use with signal wires, comprising: fault detection means for detecting a fault condition on the signal wires; and interrupt means for interrupting the signal wires, the interrupt means being responsive to the fault detection means.

[0006] Preferably, the isolator circuit is locatable in use in series at a predetermined position along the signal wires. Preferably, the signal wires comprise a pair of signal wires suitable for delivering an audio signal to an audio output unit such as a loud speaker unit. The loud speaker unit is preferably part of a public address system, ideally a voice alarm system for use with a fire or other alarm condition detecting system.

[0007] Preferably, the fault detection means comprises switch means for switching to a fault detected state when a predetermined fault condition is detected on the signal wires. Preferably, the switch means is a latched or gated switch. Preferably, the fault detection means detects a short circuit fault condition on the signal wires, preferably by distinguishing between a normal high resistance load and a fault condition low resistance load. Preferably, the fault detection means is an overcurrent tripout switch. the overcurrent tripout switch preferably determines a short circuit fault condition when a load current on the signal wires exceeds a predetermined limit.

[0008] Preferably, the interrupt means is arranged to operatively interrupt at least one of the signal wires in response to a fault condition being detected by the fault detecting means. The interrupt means may take any suitable form, but conveniently comprises a relay. Preferably, the relay is arranged to interrupt one of the signal wires and, when closed, to complete a signal path from an input of the isolator circuit to an output of the isolator circuit. Preferably, the relay has contacts which are normally open, and which are held closed in normal operation to complete the signal path. Preferably, the relay is driven by a constant current source, which operates in response to the fault detecting means.

[0009] Preferably, the isolator circuit further comprises filter means for filtering a non-audio pilot signal carried on the signal wires from an audio signal carried on the signal wires. Preferably, the pilot signal is used to power the isolator circuit. Conveniently, the pilot signal is a supersonic signal or a subsonic signal, and ideally is a direct current signal.

[0010] Preferably, the fault detection means determines a fault condition when the pilot signal is not present. In the preferred arrangement the normally open relay is held closed by the pilot signal, and will interrupt the signal path when the pilot signal is not present because no power is then supplied to the isolator circuit.

[0011] According to a second aspect of the present invention, there is provided an isolator for receiving a non-audio pilot signal carried on an audio signal wire, the isolator circuit for interrupting a signal path along the signal wire when the pilot signal is not present.

[0012] Preferably, the isolator circuit draws power solely from the pilot signal to thereby complete the signal path when the pilot signal is present.

[0013] Preferably, the isolator circuit is locatable with a first signal wire coupled to an input thereof and a second signal wire coupled to an output thereof, the isolator circuit for completing a signal path between the first and second signal wires. Preferably, the first and the second signal wires operatively deliver an audio signal to one or more loud speaker units. In this arrangement, the isolator circuit preferably detects a fault on either the input or the output side thereof. That is, the fault detecting means requires a high resistance signal path on both the input side and the output side of the isolator circuit in order to complete the signal path. Preferably, the isolator circuit interrupts the signal path if a short circuit fault condition is determined on either the input side or the output side of the isolator circuit. In this way, sensitive components such as an audio amplifier, a booster unit, or a speaker unit coupled to one side of the isolator are protected from a short circuit fault occurring on the other side of isolator.

[0014] Preferably, the isolator circuit derives power from a pilot signal available at either side of the isolator circuit. Preferably, the filter means comprises an OR gate for selecting a pilot signal present at either the input side or the output side of the isolator circuit, or both. Preferably, the filter means comprises a low pass filter for filtering a direct current pilot signal from an alternating current audio signal.

[0015] According to a further aspect of the present invention there is provided a public address network, comprising an audio signal driver for driving an audio signal onto a pair of signal wires for delivery to one or more loud speaker units; and a pilot signal driver for driving a pilot signal onto the signal wires for delivery to one or more isolator circuits.

[0016] Preferably, the network comprises at least one isolator circuit as described above. Preferably, the or each isolator circuit is arranged to operatively isolate a section or zone of the signal wire.

[0017] Preferably, the network comprises a driver unit comprising the audio driver and the pilot signal driver; a plurality of loud speaker units coupled in parallel across the signal wires; and at least one isolator circuit for dividing the signal wires into a plurality of sequential sections.

[0018] Preferably, the or each loud speaker unit produces an audible output in response to the audio signal. Preferably, the or each loud speaker unit comprises means for filtering the audio signal from the signal wires conveniently being in the form of a band pass filter. Where the pilot signal is a direct current signal, the loud speaker filter conveniently comprises an AC only filter such as a capacitor.

[0019] The isolator circuits are preferably arranged to detect a fault condition in at least one adjacent signal wire section, and preferably in either of two adjacent sequential sections. Preferably, the isolator circuit interrupts the signal path as a failsafe condition and completes the signal path only if the pilot signal is present and no fault condition is detected.

[0020] Preferably, the network comprises a monitor circuit for determining that the pilot signal is present on the signal wires. Preferably, the monitor circuit is an end of line circuit arranged to terminate the sequential sections of signal wires. That is, the end of line monitor circuit determines that the pilot signal has successfully been driven along the entire length of the signal wires and is present at all parts of the desired signal path. When the pilot signal is present, the monitor circuit determines a normal operating condition. Preferably, the monitor circuit provides status output information, such as a green LED, to indicate a normal operating condition.

[0021] Preferably, the network further comprises a fault control circuit, conveniently arranged in the signal path after the driver circuits. Preferably, the signal wires are physically arranged to form a circular loop such that the end of line monitor and the fault control circuit may be arranged in a single control housing.

[0022] The fault control circuit preferably comprises a fault monitor for detecting when an earth fault is present, and preferably providing operator feed back such as by illuminating an LED.

[0023] Preferably, the fault control circuit comprises a fault type detector for providing operator feed back, such as by illuminating LEDs, in response to a detected short circuit or open circuit fault condition.

[0024] Preferably, the fault control circuit comprises a short circuit detector for, conveniently, detecting the current drawn by the load on the signal wires, the short circuit detector for entering an overcurrent tripout state when the load current exceeds a predetermined limit.

[0025] Preferably, an open circuit fault is detected by the end of line monitor circuit, i.e. because the pilot signal does not reach the monitor circuit, and a short circuit fault detected by the short circuit detector, i.e. because the load current exceeds a predetermined limit.

[0026] Preferably, when either fault condition is detected, the pilot signal is interrupted, thereby causing each isolator circuit to interrupt the signal path. That is, the network is temporarily shut down in order avoid damage to any sensitive components. Preferably, a delay circuit is provided to re-start the network after a predetermined delay, preferably of the order of one to ten seconds.

[0027] It is desired to restart the network after a fault condition has been detected, and for as much of the network as possible to continue functioning. That is, it is desired for the network to function reliably even though a fault condition has occurred.

[0028] Preferably, when the network operates after a fault condition, the audio signal and the pilot signal are driven to both ends of the signal wires simultaneously.

[0029] According to a further aspect of the present invention there is provided a public address network wherein, in a normal operating condition, audio and other signals are driven on to one end of a series signal path, and, in a fault condition, the signals are driven onto both ends of the series signal path.

[0030] Preferably, in the fault-tolerant operating condition, the pilot signal is received by a first isolator unit in the signal path and the isolator unit completes the signal path if no short circuit fault is detected on either side thereof. The pilot signal then reaches the second isolator circuit in the series which, if a short circuit condition is detected on one side thereof, will not complete the signal path beyond that isolator circuit. That is, in the fault-tolerant operating condition the signal path is completed up to, and terminated by, an isolator unit having the short circuit condition in a section of signal path adjacent thereto. The network functions correctly up to the fault detecting isolator circuit without causing damage to any sensitive components. Where the audio and pilot signals are driven from both ends of the signal path, the majority of the network can be completed with only a short section containing the fault condition being isolat-

ed. Advantageously, the network still operates and continues to provide, for example, a voice alarm message to occupants of a building where an alarm condition such as a fire has been detected.

[0031] Further, where the audio signal is driven from both ends of the signal path, it will still reach all parts of the network even if a open circuit condition occurs. That is, the audio signal will travel along the signal path from both directions up to the position of the open circuit fault.

[0032] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic diagram showing a preferred network topography;

Figure 2 is a schematic block diagram of an isolator;

Figure 3 is a more detailed schematic block diagram of an isolator circuit;

Figure 4 is a circuit diagram for a preferred isolator circuit;

Figure 5 is a schematic diagram of a preferred network; and

Figure 6 is a schematic block diagram of a preferred control circuit.

[0033] The preferred embodiment of the present invention will be described with reference to a public address network for producing an audible signal from a plurality of loud speaker units. As an example, such a public address network can be used to warn of an alarm condition and give information to the occupants of a building.

[0034] Referring to Figure 1, a preferred schematic layout is shown for a network 10 comprising a control station 11 having an amplifier for driving an audio signal 14 and a pilot signal 15 on to signal wires 12. The signal wires 12 are divided into sections 12a, 12b, etc., by isolators 20. Each section is provided with one or more loud speaker units 16 or other devices.

[0035] In a preferred normal operating condition, the pilot signal 15 is detected by each isolator unit 20 which, in response, completes the signal path between relevant sections e.g. 12a, 12b of the signal wires. A successful operating condition is determined when the pilot signal 15 reaches an end of line monitor 13. In this normal condition, the audio signal 14 is supplied to each of the speaker units 16 arranged in parallel across the signal wires 12 such that, for example, an alarm message is heard simultaneously throughout a building.

[0036] The operation of each isolator unit 20 will now be described in more detail. Generally, each isolator unit 20 is of identical construction.

[0037] Referring to Figure 2, a basic structure of a preferred isolator unit is shown in block diagram form. The isolator unit 20 comprises a relay 21 whose contacts are arranged to lie in a signal path between an input coupled to a first signal wire section 12a and an output coupled to a second signal wire section 12b. The signal wires 12a and 12b form adjacent sections to the isolator unit 20.

[0038] The relay 21 operates in accordance with a control signal from a relay driver circuit 22 which is coupled to a short circuit detector unit 23.

[0039] In a first preferred embodiment, the short circuit detector 23 comprises a voltage sensor for determining the load current drawn by an output section of the isolator, i.e. on the signal wires 12b. In a second embodiment, the short circuit detector is arranged to sense voltage developed across both the output load 12b and the input load 12a, such that the isolator circuit may operate bidirectionally.

[0040] In a normal operating condition, no short circuit condition will be detected and the driver 22 will operate to close the contacts of relay 21, thereby completing the signal path between the input 12a and the output 12b. However when a short circuit fault is detected by the control station 11, the pilot signal is interrupted thus removing power supply from the isolators, the relay 21 deenergises the contacts of the relay open, thereby interrupting the signal path.

[0041] Referring now to Figure 3, a more detailed block diagram of the preferred isolator unit 20 is shown.

[0042] In the preferred embodiment, the signal wires 12 carry both an audio signal 14 and a pilot signal 15. The pilot signal is preferably a non-audio signal such as a subsonic or supersonic signal, and ideally a direct current signal. As shown in Figure 3, each isolator unit comprises means for detecting the pilot signal 15, suitably a low pass filter 24. The low pass filter 24 recovers the direct current component from the signals received at the input 12a to produce a direct current power supply, suitably of around 50 volts DC. In a normal operating condition, the active current source (or constant current generator) 221 supplies a predetermined constant current through a relay driver 222 to the coil of a relay 21 to keep the normally open contacts thereof closed and thereby complete the signal path. Conveniently, the constant current generator 221 provides a current of about 10 milliamps thereby underrunning the coil of relay 21. Advantageously, less power is dissipated and relay life expectancy is improved despite the relay coil being powered for most of the time in a normal operating condition.

[0043] Where the pilot signal 15 is not present at the input 12a to the isolator 20, no power supply is provided through the low pass filter 24 and the contacts of relay 21 remain open to interrupt the signal path through the isolator.

[0044] When the short circuit detector 23 detects a short circuit on the output line 12b, the relay driver 222

is switched to divert current from the coil of relay 21, thereby opening the contacts of the relay and interrupting the signal power through the isolator.

[0045] Referring now to Figure 4, a bi-directional isolator circuit 20 is shown.

[0046] The DC pilot signal 15 can be obtained from the first signal wire input 12a through a first low pass filter comprising inductor LI and capacitor C2, or from the second signal wire input 12b through a second low pass filter comprising a second inductor L2 and a second capacitor C3. The DC pilot signal is supplied to power the remainder of the isolator circuit through a diode OR gate formed from diodes D1 and D2. The inductors L1 and L2 preferably have an inductance of approximately 90H, i.e. a relatively large value, to minimise loading of the isolator circuit on the audio components of the network.

[0047] As shown in Figure 4, the short circuit detector 23 comprises an AND gate formed of diodes D4 and D6 coupled to either side of the isolator 12a and 12b. Therefore, a single short circuit detector can be used, comprising zener diode Z1, bias resister R1 and power transistor T1. The relay 21 is closed only if the short circuit detector 23 detects a high resistance on both sides of the isolator 20, and, otherwise, the relay remains open.

[0048] Referring now to Figures 1 and 5, the preferred network will be described in more detail.

[0049] As shown in Figure 5, the audio signal 14 is driven onto the signal wire loop 12 through a transformer TX1. Typically, the transformer TX1 is a 100V line transformer taking an audio signal input from an audio amplifier 114 and providing this to both ends of the signal line loop 12.

[0050] A pilot signal driver 115 is used to superimpose the pilot signal, in this example a DC signal of about 65 volts, onto the loop 12 alongside the audio signal 14. Each loudspeaker unit 16 on the loop 12 filters out the pilot signal 15, such as by using a decoupling capacitor, to leave only the audio signal 14. Therefore, the pilot signal 15 does not affect the audio signal 14.

[0051] In a normal operating condition, the pilot signal 15 travels from one end only all the way along the signal line loop 12 to reach an end of line monitor 13 which produces a normal condition signal and operator feedback, such as a green LED.

[0052] When an open circuit fault occurs on the signal loop 12, the pilot signal does not reach the end of line monitor 13 and an open circuit fault condition is detected. A control circuit 14 provides operator feedback, such as a red LED, and closes line relays RLA1 and RLA2. As shown in Figure 5, closing relays RLA1 and RLA2 connects both ends of the loop 12 (shown as A and A', and B and B', respectively) such that the pilot signal 15 is now supplied to both ends of the loop 12. The network is therefore able to detect an open circuit fault and maintain full operation.

[0053] Referring now to Figure 6, the control circuit 14 comprises a global overcurrent trip detector 141 for detecting a short circuit on the network. If a short circuit is detected by the overcurrent trip circuit 141 or if the pilot signal does not reach the end of line circuit 13, the control circuit 14 causes the network to be shutdown, thereby avoiding possible damage to sensitive components such as the audio amplifier 114. The pilot signal 15 no longer reaches any of the isolators 20, each of which thereby isolate respective sections of the signal wire loop 12.

[0054] After a predetermined delay, reboot circuit 143 causes the pilot signal 115 and the audio signal 114 to be reapplied to the signal loop 12. The isolators 20 will each in turn assess adjacent sections of the signal loop 12 for the short circuit fault, and reconnect the signal path only if the short circuit fault does not occur in the adjacent line sections. For example, referring again to Figure 1, isolator 20b tests for a short circuit in sections 12a and 12b and will connect the signal path 12a to 12b only if no short circuit is detected.

[0055] As discussed above in relation to Figure 5, line relay control circuit 142 will, in this fault condition, close line relays RLA1 and RLA2 such that the pilot signal 15 is driven from both ends of the loop 12. In this configuration, the pilot signal 15 and the audio signal 14 thereby reach all parts of the signal loop 12, except for the section containing the short circuit fault which is isolated by isolator units 20 at either side thereof.

[0056] A public address network has been described which detects and tolerates open circuit and short circuit fault conditions safely and economically, and which maintains operation of the network despite such fault conditions. Minimal additional circuitry is required, and, advantageously, only a single pair of signal wires are required.

[0057] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0058] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0059] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0060] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel

one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An isolator circuit (20) for use with signal wires (12) of a public address network, the isolator circuit comprising:

   fault detection means (23) for detecting a fault condition on the signal wires (12); and

   interrupt means (21) for interrupting at least one of the signal wires (12), the interrupt means (21) being responsive to the fault detection means (23).

2. An isolator circuit as claimed in claim 1, wherein the isolator circuit is locatable in use in series at a predtermined position along the signal wires (12).

3. An isolator circuit as claimed in claim 1 or 2, wherein the isolator circuit (20) is suitable for use with a pair of signal wires (12) for delivering an audio signal to an audio output unit (16).

4. An isolator circuit as claimed in any of claims 1 to 3, wherein the fault detection means (23) is arranged to detect at least one of a short circuit fault or an open circuit fault in the signal wires (12).

5. An isolator circuit as claimed in any of claims 1 to 4, wherein the fault detection means (23) detects a short circuit fault condition on the signal wires (12) by distinguishing between a normal high resistance load and a fault condition low resistance load on the signal wires.

6. An isolator circuit as claimed in any of claims 1 to 5, wherein the isolator circuit (20) is arranged to be powered by a pilot signal (15) carried by the signal wires (12).

7. An isolator circuit as claimed in claim 6, wherein the fault detection means (23,222) determines a fault condition when the pilot signal (15) is not present, and the interrupt means (21) interrupts the signal wire (12) in response thereto.

8. A public address network comprising a driver unit (11) for driving an audio signal (14) on to a pair of signal wires (12) for delivery to one or more audio output units (16), and for driving a pilot signal (15) on to the signal wires (12) for delivery to one or more isolator circuits (20), each isolator circuit (20) being arranged to operatively isolate a section of the signal wires (12).

9. A method of operating a public address network having a series signal path including a pair of signal wires (12) coupled to one or more audio output units (16) and one or more isolators (20) for isolating sections of the signal wires (12), comprising the steps of:

   driving an audio signal (14) on to the signal wires (12) for delivery to the audio output units (16);

   driving a pilot signal (15) on to the signal wires (12) for delivery to the isolators (20);

   detecting the pilot signal at a first end of the series signal path using an end of line detector (13);

   if the pilot signal (15) is not present at the end of line detector (13), then driving the audio signal (14) and the pilot signal (15) from both ends of the audio signal path.

10. A method as claimed in claim 9, further comprising the step of:

    driving the audio signal (14) and the pilot signal (15) for powering the isolators (20) onto a second end of the signal wires (12) remote from the first end; and

    if the pilot signal (15) is not present at the end of line detector (13), then removing the audio signal (14) and the pilot signal (15) from the first end, and then driving the audio signal (14) and the pilot signal (15) onto both the first and second ends of the signal wires (12).

FIG.1

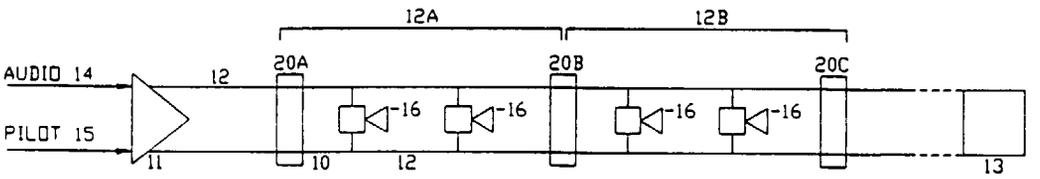


FIG.2

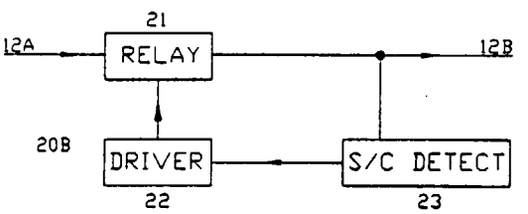
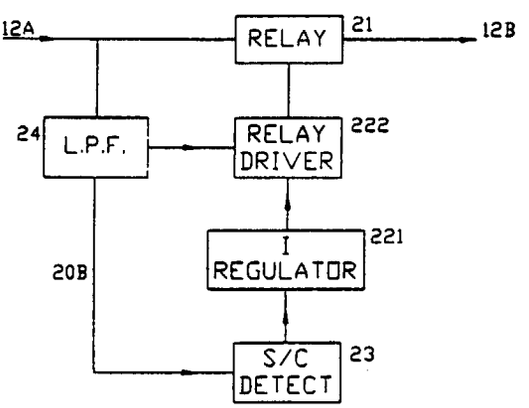


FIG.3



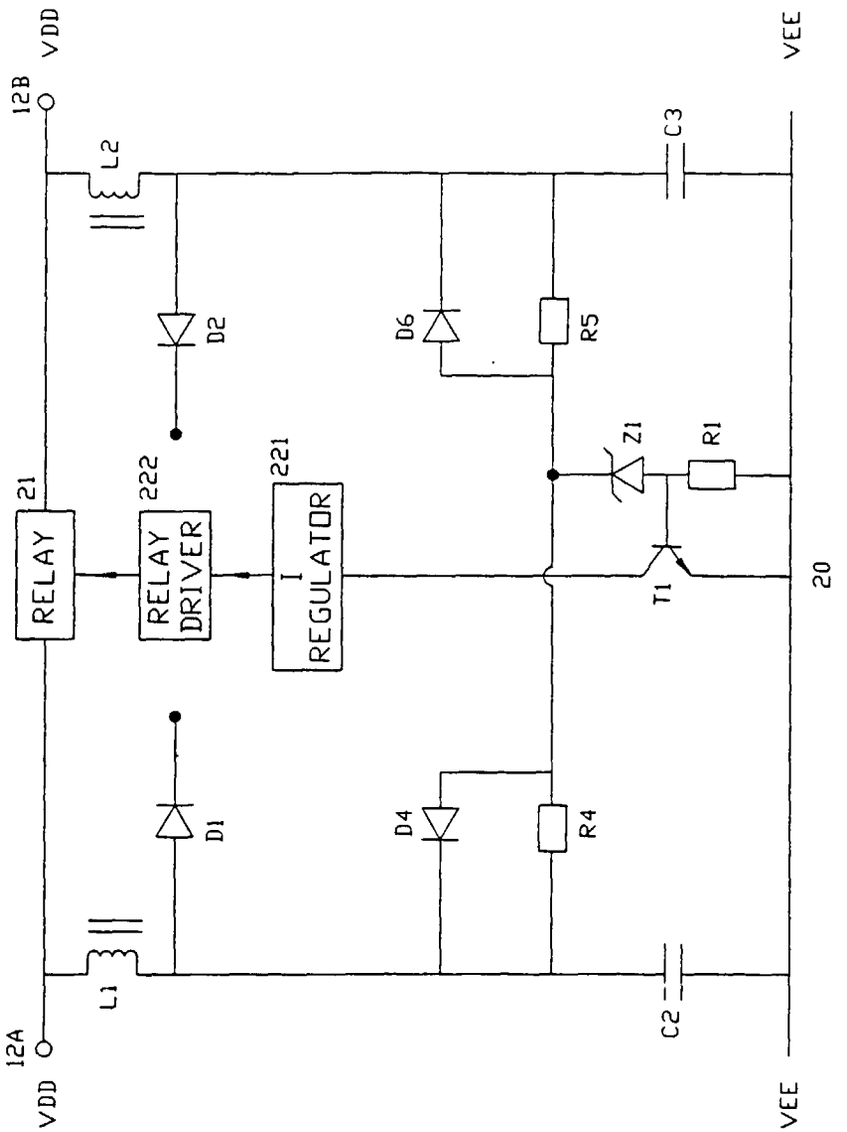

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FIG.4

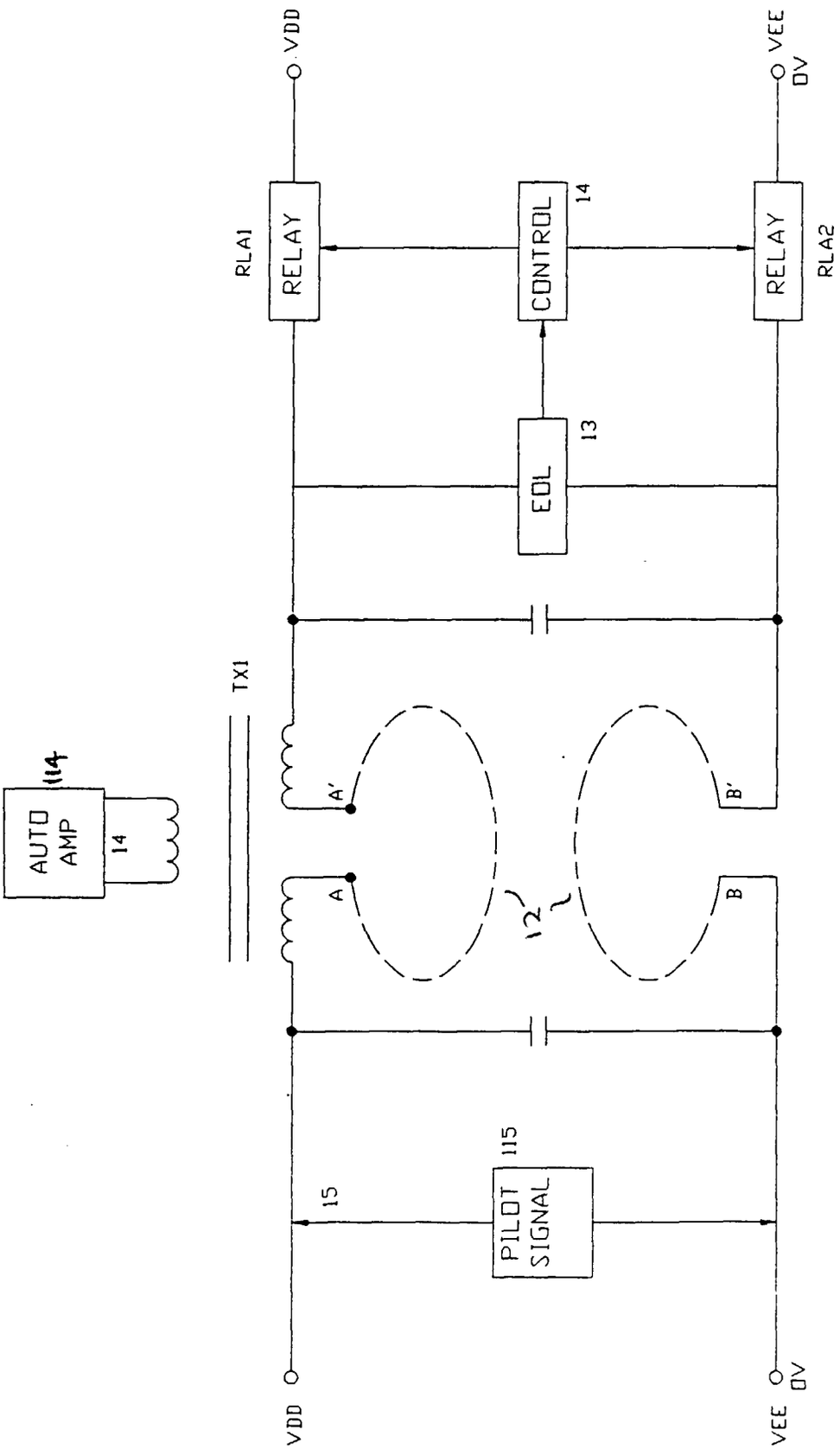
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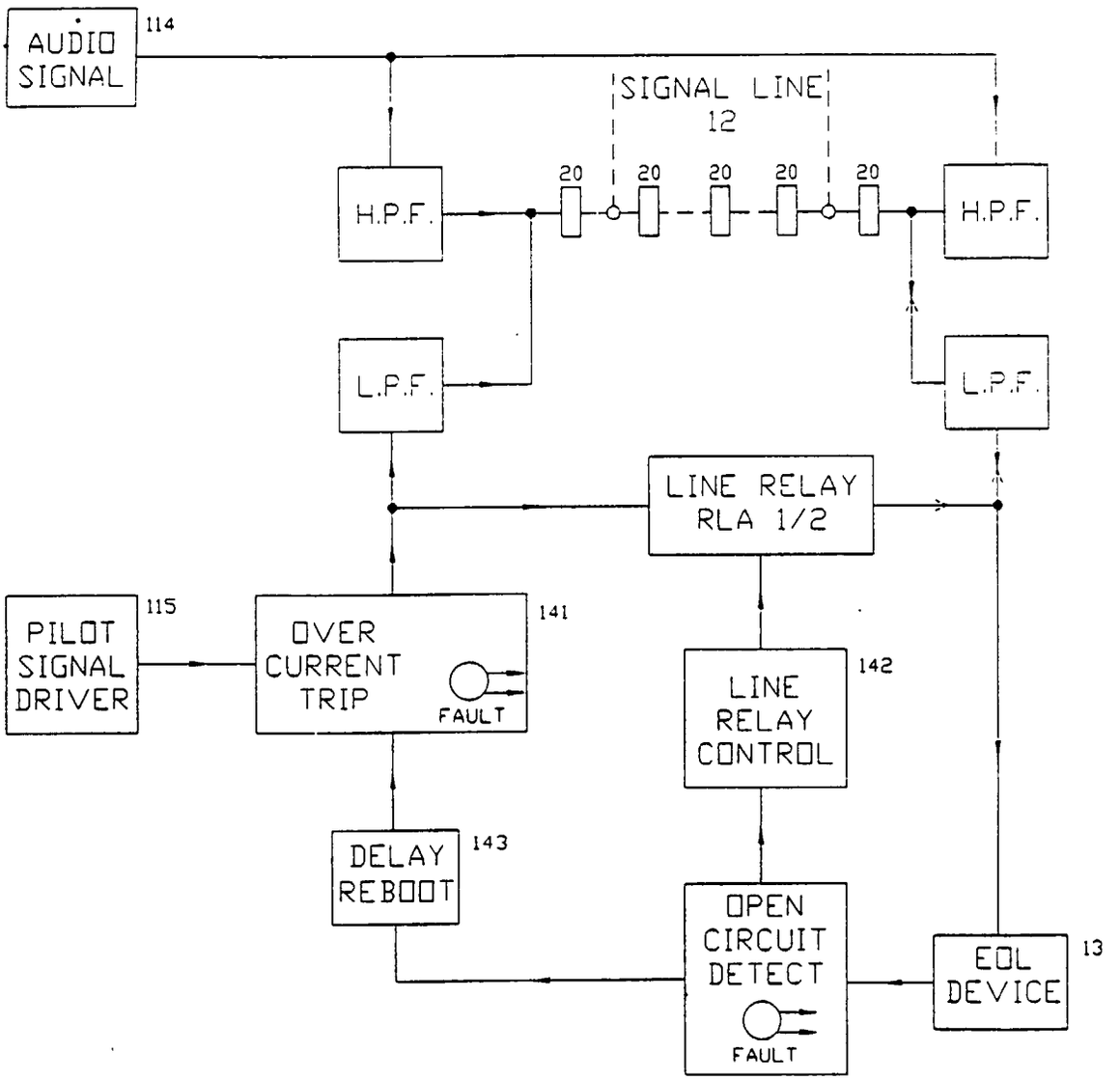
FIG.5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143
OPEN CIRCUIT DETECT
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13

FIG.6