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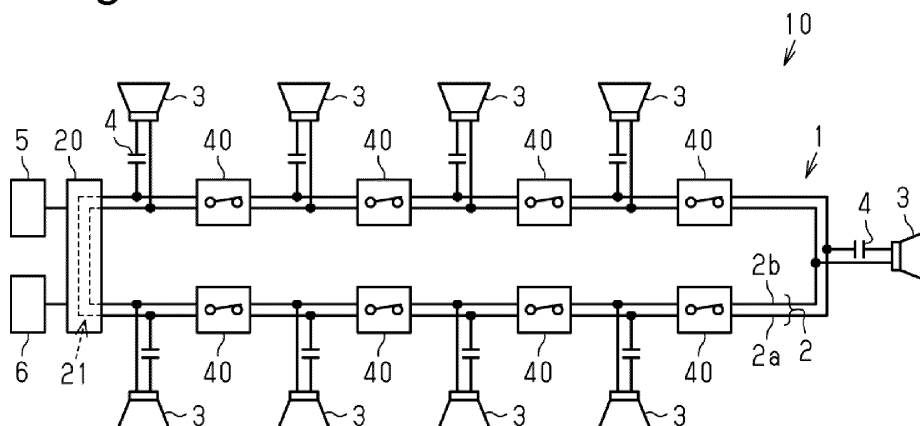
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(54) **BROADCASTING SYSTEM**

(57) A broadcasting system (10) is provided with one loop (1) designed to transmit a signal to a speaker (3) and constituted by a plurality of signal lines (2), one or a plurality of isolators (40) arranged between the signal lines (2) constituting the loop (1), and a broadcast output device (20) for outputting an output signal to the loop (1). The broadcast output device (20) forms the output signal outputted to the loop (1) by superimposing an input signal

and a direct-current voltage one on top of another. The isolator (40) operates on the basis of the output signal, detects shorting of the signal line (2) connected to the isolator (40), connects the plurality of signal lines (2) connected to the isolator (40) when there is no shorting, and leaves the plurality of signal lines (2) connected to the isolator (40) unconnected when shorting is detected.

Fig.1



Description

[0001] The present invention relates to a broadcasting system configured to transmit a signal to signal lines connected to speakers.

[0002] In a known technique, when one or more of signal lines becomes abnormal in a broadcasting system, a broadcasting signal is transmitted to other signal line(s) having no abnormality in the broadcasting system.

[0003] Patent Document 1 describes an example of a technique that isolates a signal line when the signal line is broken or is short-circuited.

[0004] Patent Document 1: Japanese National Phase Laid-Open Patent Publication No. 2014-509813

[0005] The technique described in Patent Document 1 uses a communication device such as a modem. This hinders application of this technique to a conventional broadcasting system.

[0006] It is an objective of the present invention to provide a broadcasting system that effectively isolates a short-circuited portion when a signal line is short-circuited.

(1) A broadcasting system according to one aspect of the present invention is configured to transmit a signal to speakers. The broadcasting system includes a single loop configured by multiple signal lines, to which at least one of the speakers is configured to be connected, one or more isolators arranged between the signal lines configuring the loop, and a broadcast output device that transmits an output signal to the loop. The broadcast output device superimposes an input signal on a direct current voltage to generate the output signal, which is transmitted to the loop. Each of the isolators is actuated based on the output signal to detect a short circuit of the signal lines connected to the isolator. When the short circuit is not formed, the isolator connects the signal lines connected to the isolator to each other. When the short circuit is formed, the isolator disconnects the signal lines connected to the isolator from each other.

With this configuration, the isolator is actuated by power of the output signal to detect a short circuit. When a short circuit is formed, the signal lines connected to the isolator are disconnected from each other. This prevents continuous transmission of the output signal to the short-circuited wires. Thus, when the loop is short-circuited, the short-circuited portion is effectively isolated.

(2) In the broadcasting system described above, the broadcast output device includes a first terminal and a second terminal that are connected to the signal lines of the loop, a first switch arranged on an internal signal line that connects the first terminal to the second terminal in the broadcast output device, a second switch arranged between the first switch and the second terminal, a first short circuit detector that de-

fects a short circuit in a portion located toward the first terminal from the first switch, and a second short circuit detector that detects a short circuit in a portion located toward the second terminal from the second switch. The first switch disconnects the first terminal from the second switch when the first short circuit detector detects the short circuit, and connects the first terminal to the second switch when the first short circuit detector does not detect the short circuit. The second switch disconnects the second terminal from the first switch when the second short circuit detector detects the short circuit, and connects the second terminal to the first switch when the second short circuit detector does not detect the short circuit. With this configuration, when a short circuit is detected in the signal lines connected to the broadcast output device, transmission of the output signal to the short-circuited portion is limited.

(3) In the broadcasting system described above, each of the isolators includes a third terminal and a fourth terminal, a separation switch arranged on an internal signal line that connects the third terminal to the fourth terminal, a third short circuit detector that detects a short circuit in a portion located toward the third terminal from the separation switch, and a fourth short circuit detector that detects a short circuit in a portion located toward the fourth terminal from the separation switch. The separation switch disconnects the third terminal from the fourth terminal when at least one of the third short circuit detector or the fourth short circuit detector detects a short circuit, and connects the third terminal to the fourth terminal when none of the third short circuit detector and the fourth short circuit detector detects a short circuit. With this configuration, when the signal lines connected to the isolator are short-circuited, transmission of the output signal to the short-circuited portion is limited.

(4) In the broadcasting system described above, the separation switch disconnects the third terminal from the fourth terminal when the output signal does not reach the isolator.

With this configuration, before activation of the broadcasting system, the third terminal is disconnected from the fourth terminal. When the output signal is input to the isolator, the isolator is actuated. This configuration hinders current from flowing to the short-circuited portion when the broadcasting system is activated.

(5) The broadcasting system described above further includes a branch isolator connected between the loop and a branch signal line branching from the loop. The branch isolator includes a first loop terminal and a second loop terminal that are connected to the signal lines of the loop, a branch terminal connected to the branch signal line, a first separation switch arranged between the first loop terminal and a branch portion of the branch signal line, a second

separation switch arranged between the second loop terminal and the branch portion of the branch signal line, a fifth short circuit detector that detects a short circuit in a portion located toward the first loop terminal, and a sixth short circuit detector that detects a short circuit in a portion located toward the second loop terminal. The first separation switch disconnects the first loop terminal from the branch portion of the branch signal line when the fifth short circuit detector detects the short circuit, and connects the first loop terminal to the branch portion of the branch signal line when the fifth short circuit detector does not detect the short circuit. The second separation switch disconnects the second loop terminal from the branch portion of the branch signal line when the sixth short circuit detector detects the short circuit, and connects the second loop terminal to the branch portion of the branch signal line when the sixth short circuit detector does not detect the short circuit. With this configuration, when a short circuit is detected in the signal lines connected to the branch isolator, transmission of the output signal to the short-circuited portion is limited.

(6) In the broadcasting system described above, the branch isolator includes a branch short circuit detector that detects a short circuit of the branch signal line. When the branch short circuit detector detects the short circuit, the first separation switch disconnects the first loop terminal from the branch portion of the branch signal line, and the second separation switch disconnects the second loop terminal from the branch portion of the branch signal line. With this configuration, when a short circuit is detected in the branch signal line, the branch signal line is isolated from the loop. Thus, transmission of the output signal to the short-circuited portion is limited.

(7) In the broadcasting system described above, the branch isolator includes a direct current blocking filter arranged on an internal branch signal line to block a direct current component. The internal branch signal line connects the branch portion to the branch terminal. With this configuration, direct current components are blocked in the branch signal line. This allows the branch signal line to be connected to a speaker that does not include a capacitor for blocking direct current components.

(8) In the broadcasting system described above, the broadcast output device outputs a pilot alternating current signal for detecting breakage of the branch signal line. When the pilot alternating current signal is received, the branch isolator detects breakage of the branch signal line. With this configuration, erroneous detections are reduced when detecting breakage of the branch signal line.

(9) In the broadcasting system described above, the branch isolator further includes a power supply voltage generation circuit that generates a power supply voltage based on an output signal that is output from

the broadcast output device through the signal lines. When the power supply voltage is not generated, the first separation switch disconnects the first loop terminal from the branch portion of the branch signal line. When the power supply voltage is not generated, the second separation switch disconnects the second loop terminal from the branch portion of the branch signal line.

[0007] In this configuration, the power supply voltage is generated based on the output signal. This eliminates the need for an external power supply. In addition, input of the output signal to the branch isolator allows for detection of a short circuit. Thus, when the broadcasting system is activated, current is hindered from flowing to the short-circuited portion.

[0008] The broadcasting system effectively isolates a short-circuited portion.

[0009]

Fig. 1 is a schematic diagram showing a first embodiment of a broadcasting system.

Fig. 2 is a circuit diagram of a broadcast output device.

Fig. 3 is a chart showing operation of the broadcast output device.

Fig. 4 is a circuit diagram of an isolator.

Fig. 5 is a chart showing operation of the isolator.

Fig. 6 is a schematic diagram showing operation of the broadcasting system when activated.

Fig. 7 is a schematic diagram showing operation of the broadcasting system when activated.

Fig. 8 is a schematic diagram showing operation of the broadcasting system when activated.

Fig. 9 is a schematic diagram showing operation of the broadcasting system when activated.

Fig. 10 is a schematic diagram of the broadcasting system when a loop is short-circuited.

Fig. 11 is a flowchart of a breakage detection process.

Fig. 12 is a schematic diagram of the broadcasting system when the loop is broken.

Fig. 13 is a schematic diagram of the broadcasting system showing a flow of an output signal when the loop is broken.

Fig. 14 is a schematic diagram showing a second embodiment of a broadcasting system.

Fig. 15 is a circuit diagram of a branch isolator.

Fig. 16 is a chart showing operation of the branch isolator.

Fig. 17 is a schematic diagram showing operation of the branch isolator when activated.

Fig. 18 is a schematic diagram showing operation of the branch isolator when activated.

First Embodiment

[0010] A first embodiment of a broadcast output device

and a broadcasting system will now be described with reference to Figs. 1 to 13.

[0011] A broadcasting system 10 transmits a signal to speakers 3 through signal lines 2. The broadcasting system 10 is, for example, installed inside a building and transmits audio information to the speakers 3 installed in rooms. The audio information is not particularly limited. The audio information includes, for example, communication information for notifying the public or particular people, music sound information, disaster information, and emergency evacuation information. The broadcasting system 10 has a role in transmitting disaster information and emergency evacuation information when a disaster occurs. If the broadcasting system 10 has an abnormality and the broadcasting area is limited, the broadcasting system 10 cannot play a sufficient role of emergency notification. It is desirable that the broadcasting system 10 be capable of limiting broadcast interference caused by an abnormality. The technique is related to limitation of broadcast interference. The broadcast interference refers to inability to transmit the audio information to some or all of the speakers 3 when the broadcasting system 10 has a partial abnormality. The broadcasting system 10 of the present embodiment will now be described.

[0012] The broadcasting system 10 includes at least one broadcast output device 20 and multiple signal lines 2 connected to the broadcast output device 20. The signal lines 2 and an internal signal line 21, which will be described later, configure a single loop 1. The broadcasting system 10 includes one or more isolators 40 connected to the signal lines 2. The isolators 40 connect the two signal lines 2, which are components of the loop 1.

[0013] The speakers 3 are connected to the signal lines 2 through direct current blocking filters 4. The direct current blocking filters 4 are, for example, capacitors. The signal lines 2 include two wires. More specifically, the signal lines 2 include a first wire 2a and a second wire 2b. The first wire 2a has a higher potential than the second wire 2b. The second wire 2b has a lower potential than the first wire 2a. The first wire 2a and the second wire 2b are insulated from ground.

[0014] The broadcast output device 20 transmits an output signal to the loop 1 in two directions. The broadcast output device 20 includes a signal line (hereafter referred to as "internal signal line 21") configuring a portion of the loop 1. In the description hereafter, the portion of the loop 1 excluding the internal signal line 21 of the broadcast output device 20 is referred to as a loop body 1m. The broadcast output device 20 includes two terminals (hereafter referred to as "first terminal 31" and "second terminal 32") connected to the signal lines 2 of the loop body 1m. The first terminal 31 and the second terminal 32 are connected to the internal signal line 21 in the broadcast output device 20.

[0015] Preferably, the broadcast output device 20 includes a power circuit 23, a ground fault detector 24, and a controller 25. The power circuit 23 and the controller

25 may be configured to be external devices connected from the outside of the broadcast output device 20. The ground fault detector 24 may be omitted.

[0016] The power circuit 23 generates a direct current voltage having a first potential and a direct current voltage having a second potential that is lower than the first potential based on an external power supply 5. The first potential direct current voltage is input to a first wire 21a of the internal signal line 21. The second potential direct current voltage is input to a second wire 21b of the internal signal line 21. The internal signal line 21 and the power circuit 23 are connected through an alternating current blocking filter 26, which cuts off alternating current components. The alternating current blocking filter 26 blocks alternating current components in the output signal (refer to the following description) transmitted to the internal signal line 21 from entering the power circuit 23 to limit an abnormal operation of the power circuit 23.

[0017] The controller 25 controls a loop connection switch 28 (refer to the following description) and an indicator (not shown). When receiving various signals (first to third abnormality notification signals, which will be described later), the controller 25 transmits an indication instruction signal to the indicator. The indicator is actuated in a predetermined indication mode (e.g., illumination of multiple lamps) in accordance with the indication instruction signal of the controller 25. A person controlling the broadcasting system 10 acknowledges the abnormality of the broadcasting system 10 from the indication mode of the indicator.

[0018] The ground fault detector 24 detects a short circuit of the first wire 21a with ground and a short circuit of the second wire 21b with ground. When at least one of the short circuits is detected, the ground fault detector 24 transmits the first abnormality notification signal, which indicates occurrence of a ground fault, to the controller 25.

[0019] The broadcast output device 20 is connected to an input device 6. The input device 6 inputs a predetermined input signal into the broadcast output device 20. The input signal includes an audio signal corresponding to the above-described audio information and a mechanical signal such as a tone signal. An example of the mechanical signal is a pilot alternating current signal, which will be described later. The pilot alternating current signal has a frequency outside an audible range or proximate to the limits of the audible range. The pilot alternating current signal includes, for example, a 40-kHz signal or a 20-kHz signal.

[0020] The input signal is input to the internal signal line 21 through a noise cut filter 27. The input signal includes a first input signal transmitted to the first wire 21a and a second input signal transmitted to the second wire 21b. For example, the first input signal includes alternating current components, and the second input signal does not include alternating current components.

[0021] In the internal signal line 21, the input signal is superimposed on direct current voltage. More specifical-

ly, in the internal signal line 21, the first input signal is superimposed on the first potential direct current voltage, and the second input signal is superimposed on the second potential direct current voltage, so that output signals are generated. The output signals are transmitted in the internal signal line 21 in two directions, namely, a first direction D1 and a second direction D2 opposite to the first direction D1. The output signal in the first direction D1 is output from the first terminal 31. The output signal in the second direction D2 is output from the second terminal 32.

[0022] The broadcast output device 20 further includes a first switch 33, a second switch 36, a first short circuit detector 34, and a second short circuit detector 37. The broadcast output device 20 further includes the loop connection switch 28. The first switch 33, the second switch 36, and the loop connection switch 28 are arranged on the internal signal line 21.

[0023] The loop connection switch 28 is arranged between the first terminal 31 and the second terminal 32 in the internal signal line 21. The loop connection switch 28 is switched "on" to connect the first terminal 31 and the second terminal 32 and is switched "off" to disconnect the first terminal 31 from the second terminal 32 (state that interrupts transmission of signal) in the internal signal line 21. Switching the loop connection switch 28 on and off closes and opens the loop 1. More specifically, the loop connection switch 28 includes a switch 28a that connects or disconnects the first wires 21a and 21a of the internal signal line 21 and a switch 28b that connects or disconnects the second wires 21b and 21b of the internal signal line 21 (refer to Fig. 2).

[0024] A breakage detector 29 is arranged on the internal signal line 21 between the first terminal 31 and the loop connection switch 28. The breakage detector 29 detects whether the loop 1 is broken. The breakage detector 29 is actuated to detect breakage in the loop 1 in a predetermined step of a "breakage detection process" executed by the controller 25 and described later. The term "breakage" refers to a state in which at least one of the first wire 2a and the second wire 2b of the signal lines 2 configuring the loop 1 is broken. In the description hereafter, such breakage is referred to as "the broken loop." The breakage detector 29 detects a potential difference between opposite ends of a resistor RD connected between the first wire 2a and the second wire 2b to determine whether the broken loop is present. When determining that the broken loop is present, the breakage detector 29 transmits a signal indicating the broken loop (hereafter referred to as "third abnormality notification signal") to the controller 25.

[0025] As shown in Fig. 2, the first switch 33 and the second switch 36 are arranged on the internal signal line 21. The second switch 36 is arranged between the first switch 33 and the second terminal 32. That is, the first switch 33 is located closer to the first terminal 31 than the second switch 36. The second switch 36 is located closer to the second terminal 32 than the first switch 33.

The first switch 33 and the second switch 36 are connected by intermediate wires 22, which are components of the internal signal line 21. The loop connection switch 28 and the breakage detector 29, which are described above, are arranged between the first switch 33 and the first terminal 31.

[0026] The first switch 33 connects the first terminal 31 to the second switch 36 or disconnects the first terminal 31 from the second switch 36 in the internal signal line 21. More specifically, the first switch 33 is switched "on" to connect the intermediate wire 22 and the wire located toward the first terminal 31 and switched "off" to disconnect the intermediate wire 22 from the wire located toward the first terminal 31 in the first wire 21a of the internal signal line 21. When the first short circuit detector 34 detects a short circuit, which will be described later, the first switch 33 is switched "off." When the first short circuit detector 34 does not detect a short circuit, which will be described later, the first switch 33 is switched "on."

[0027] The first short circuit detector 34 detects whether a short circuit is formed in the signal lines 2 at the side of the first switch 33 in the first direction D1. The term "short circuit" refers to a state in which the first wire 2a and the second wire 2b of the signal lines 2 are connected. The first short circuit detector 34 includes a first switch controller 35 and a resistor RA connected to the first wire 21a in parallel to the first switch 33.

[0028] The first switch controller 35 determines whether the potential of the first wire 21a between the first switch 33 and the first terminal 31 (potential at the first terminal 31) is inside a specified range (for example, range that is greater than or equal to second potential (V) and less than or equal to predetermined potential X that is lower than first potential). The specified range indicates a potential range in which a short circuit is formed in the signal lines 2. When the potential at the first terminal 31 is inside the specified range, the first switch controller 35 determines that the short circuit is formed. When the detected potential is inside the specified range (i.e., short circuit is formed), the first switch controller 35 switches the first switch 33 off and transmits the second abnormality notification signal to the controller 25. When the detected potential is outside the specified range (i.e., short circuit is not formed), the first switch controller 35 switches the first switch 33 on.

[0029] The second switch 36 has a structure similar to that of the first switch 33. More specifically, in the internal signal line 21, the second switch 36 is switched "off" to disconnect the second terminal 32 from the first switch 33 when the second short circuit detector 37, which will be described later, detects a short circuit, and is switched "on" to connect the second terminal 32 and the first switch 33 when the second short circuit detector 37 does not detect a short circuit.

[0030] The second short circuit detector 37 detects whether a short circuit is formed in the signal lines 2 at the side of the second switch 36 in the second direction D2. The second short circuit detector 37 includes a sec-

ond switch controller 38 and a resistor RA connected to the first wire 21a in parallel to the second switch 36.

[0031] The second switch controller 38 determines whether the potential of the first wire 21a between the second switch 36 and the second terminal 32 (potential at the second terminal 32) is inside a specified range. The specified range indicates a potential range in which a short circuit is formed in the signal lines 2. When the potential at the second terminal 32 is inside the specified range, the second switch controller 38 determines that the short circuit is formed. When the detected potential is inside the specified range (i.e., short circuit is formed), the second switch controller 38 switches the second switch 36 off and transmits the second abnormality notification signal to the controller 25. When the detected potential is outside the specified range (i.e., short circuit is not formed), the second switch controller 38 switches the second switch 36 on.

[0032] The operation of the broadcast output device 20 will now be described.

[0033] When the broadcast output device 20 is not supplied with power from the external power supply 5, the first switch 33 and the second switch 36 are switched off, and the loop connection switch 28 is also switched off. When the broadcast output device 20 is supplied with power, the loop connection switch 28 is switched on. The power circuit 23 inputs direct current voltage into the internal signal line 21. As a result, current flows to the resistor RA that is connected in parallel to the first switch 33. When a short circuit is formed in the signal lines 2 at a side of the first switch 33 toward the first terminal 31, the potential at the first terminal 31 is decreased to be inside the specified range. The first switch controller 35 causes the first switch 33 to remain off. When a short circuit is not formed in the signal lines 2 at the side of the first switch 33 toward the first terminal 31, the potential at the first terminal 31 is outside the specified range, and the first switch 33 is switched on. In this state, a direct current voltage is transmitted from the first switch 33 to the signal lines 2 in the first direction D1. When the input signal is input to the broadcast output device 20, the output signal is generated and output in the first direction D1.

[0034] The second switch 36 operates in the same manner as the first switch 33. When a short circuit is not formed in the signal lines 2 at a side toward the second terminal 32, the potential at the second terminal 32 is outside the specified range, and the second switch 36 is switched on. The direct current voltage is transmitted from the second switch 36 to the signal lines 2 in the second direction D2. When the input signal is input to the broadcast output device 20, the output signal is generated and output in the second direction D2.

[0035] Output modes of the broadcast output device 20 will now be described with reference to Fig. 3.

(a) When the potential at the side of the first switch 33 toward the first terminal 31 is not inside the specified range (i.e., short circuit is not formed) and the

potential at the side of the second switch 36 toward the second terminal 32 is not inside the specified range (i.e., short circuit is not formed), the output signals are output in the first direction D1 and the second direction D2, that is, two directions.

(b) When the potential at the side of the first switch 33 toward the first terminal 31 is not inside the specified range (i.e., short circuit is not formed) and the potential at the side of the second switch 36 toward the second terminal 32 is inside the specified range (i.e., short circuit is formed), the output signal is output in the first direction D1.

(c) When the potential at the side of the first switch 33 toward the first terminal 31 is inside the specified range (i.e., short circuit is formed) and the potential at the side of the second switch 36 toward the second terminal 32 is not inside the specified range (i.e., short circuit is not formed), the output signal is output in the second direction D2.

(d) When the potential at the side of the first switch 33 toward the first terminal 31 is inside the specified range (i.e., short circuit is formed) and the potential at the side of the second switch 36 toward the second terminal 32 is inside the specified range (i.e., short circuit is formed), the output signals are not output in any of the first direction D1 and the second direction D2.

[0036] The isolator 40 will now be described with reference to Fig. 4. As described above, the isolator 40 connects the two signal lines 2, which configure the loop 1. The isolator 40 includes two terminals (hereafter referred to as "third terminal 42" and "fourth terminal 43") connected to the signal lines 2. The isolator 40 includes a signal line (hereafter referred to as "internal signal line 41") that connects the third terminal 42 and the fourth terminal 43 in the isolator 40. The internal signal line 41 includes a first wire 41a and a second wire 41b.

[0037] The isolator 40 includes a separation switch 44, a third short circuit detector 45, and a fourth short circuit detector 47. Preferably, the isolator 40 includes a power supply voltage generation circuit 49 that generates a power supply voltage.

[0038] The separation switch 44 is arranged on the first wire 41a of the internal signal line 41. The separation switch 44 is switched "on" to connect the third terminal 42 and the fourth terminal 43 and is switched "off" to disconnect the third terminal 42 from the fourth terminal 43 in the internal signal line 41. The separation switch 44 is switched "off" when at least one of the third short circuit detector 45 or the fourth short circuit detector 47 detects a short circuit. The separation switch 44 is switched "on" when none of the third short circuit detector 45 and the fourth short circuit detector 47 detects a short circuit (refer to Fig. 5).

[0039] The third short circuit detector 45 detects whether a short circuit is formed in a portion located toward the third terminal 42 from the separation switch 44. The third

short circuit detector 45 includes a third switch controller 46 and a resistor RB connected to the first wire 41a in parallel to the separation switch 44. The third switch controller 46 determines whether the potential of the first wire 41a between the separation switch 44 and the third terminal 42 (potential at the third terminal 42) is inside a specified range. The specified range indicates a potential range in which a short circuit is formed in the signal lines 2. When the potential at the side of the separation switch 44 toward the third terminal 42 is inside the specified range, the third switch controller 46 determines that the short circuit is formed.

[0040] The fourth short circuit detector 47 detects whether a short circuit is formed in a portion located toward the fourth terminal 43 from the separation switch 44. The fourth short circuit detector 47 has the same configuration as the third short circuit detector 45 except the following points. The fourth short circuit detector 47 includes a fourth switch controller 48 and the resistor RB connected to the first wire 41a in parallel to the separation switch 44. The resistor RB is shared by the third short circuit detector 45 and the fourth short circuit detector 47. When the potential at the side of the separation switch 44 toward the fourth terminal 43 is inside the specified range, the fourth switch controller 48 determines that the short circuit is formed.

[0041] The power supply voltage generation circuit 49 generates a power supply voltage based on an output signal transmitted through the signal lines 2. The power supply voltage generated by the power supply voltage generation circuit 49 is supplied to the third short circuit detector 45 and the fourth short circuit detector 47 in the isolator 40. The power supply voltage generation circuit 49 includes two input portions 49a and 49b. The input portion 49a, which is one of the two input portions, is connected to the first wire 41a between the separation switch 44 and the third terminal 42. The input portion 49b, which is the other input portion, is connected to the first wire 41a between the separation switch 44 and the fourth terminal 43. As described above, when the power supply voltage generation circuit 49 includes the two input portions 49a and 49b, the power supply voltage is generated regardless of a direction in which the output signal is transmitted.

[0042] Operations of the separation switch 44 of the isolator 40 will now be described with reference to Fig. 5.

[0043] In Fig. 5, (a) to (d) show operations when the output signal is transmitted to the isolator 40 in at least one of the two directions. In these cases, the power supply voltage is generated, so that the separation switch 44 operates.

[0044] In Fig. 5, (e) shows operation when the output signal is not transmitted to the isolator 40 in any of the two directions. In this case, the power supply voltage is not generated, so that the switch does not operate and the separation switch 44 remains off.

(a) When the potential at the side of the separation

switch 44 toward the third terminal 42 is not inside the specified range (i.e., short circuit is not formed) and the potential at the side of the separation switch 44 toward the fourth terminal 43 is not inside the specified range (i.e., short circuit is not formed), the separation switch 44 is switched on. In this case, the two signal lines 2 connected to the isolator 40 are connected to each other.

(b) When the potential at the side of the separation switch 44 toward the third terminal 42 is not inside the specified range (i.e., short circuit is not formed) and the potential at the side of the separation switch 44 toward the fourth terminal 43 is inside the specified range (i.e., short circuit is formed), the separation switch 44 is switched off. In this case, the two signal lines 2 connected to the isolators 40 are not connected to each other.

(c) When the potential at the side toward the third terminal 42 from the separation switch 44 is inside the specified range (i.e., short circuit is formed) and the potential at the side toward the fourth terminal 43 from the separation switch 44 is not inside the specified range (i.e., short circuit is not formed), the separation switch 44 is switched off. In this case, the two signal lines 2 connected to the isolators 40 are not connected to each other.

(d) When the potential at the side of the separation switch 44 toward the third terminal 42 is inside the specified range (i.e., short circuit is formed) and the potential at the side of the separation switch 44 toward the fourth terminal 43 is inside the specified range (i.e., short circuit is formed), the separation switch 44 is switched off. In this case, the two signal lines 2 connected to the isolators 40 are not connected to each other.

(e) When the output signal is not transmitted to the isolator 40, the power supply voltage is not generated, and the separation switch 44 remains off. In this case, the two signal lines 2 connected to the isolators 40 are not connected to each other.

[0045] Operation of the isolators 40 when the broadcasting system 10 is activated will now be described with reference to Figs. 6 to 10. In this example, a short circuit is formed in the signal lines 2 between the second isolator 40 and the third isolator 40 from the broadcast output device 20 in the first direction D1.

[0046] Before activation, the broadcast output device 20 and the isolators 40 are switched "off." When the broadcast output device 20 is supplied with power from the external power supply 5 in accordance with activation, the loop connection switch 28 of the broadcast output device 20 is switched "on." The first switch 33 and the second switch 36 of the broadcast output device 20 are "off," and the separation switches 44 of the isolators 40 are "off."

[0047] The first potential direct current voltage is transmitted to the first wire 2a of the signal lines 2. The direct

current voltage is transmitted in the first direction D1 and the second direction D2. First, a switch group arranged in the first direction D1 from the broadcast output device 20 will be described.

[0048] As shown in Fig. 6, when the direct current voltage is transmitted in the first direction D1, current flows to the resistors RA and RB, which are connected in parallel to the respective switches. In this example, since the signal lines 2 are short-circuited, the current flows from the first wire 2a to the second wire 2b. More specifically, at this stage, the current flows to the first wire 2a through the resistors RA and RB and a short-circuited portion SC (see broken line). As a result, the potential at the side of the first switch 33 toward the first terminal 31 has a value outside the specified range (value greater than the above-described predetermined potential X, which is greater than second potential). The operation of the first short circuit detector 34 causes the first switch 33 of the broadcast output device 20 to be switched "on."

[0049] As shown in Fig. 7, when the first switch 33 of the broadcast output device 20 is switched "on," the direct current voltage is transmitted to the isolator 40 located adjacent to the broadcast output device 20. As a result, the power supply voltage generation circuit 49 of the isolator 40 is actuated to generate the power supply voltage. This actuates the third short circuit detector 45 and the fourth short circuit detector 47. At this stage, the current flows to the first wire 2a through the resistors RB and the short-circuited portion SC (see broken line). As a result, the potential at the side of the separation switch 44 toward the third terminal 42 and the potential at the side of the separation switch 44 toward the fourth terminal 43 have a value outside the specified range (value greater than above-described predetermined potential X, which is greater than second potential). The operation of the third short circuit detector 45 and the fourth short circuit detector 47 causes the separation switch 44 to be switched "on."

[0050] As shown in Fig. 8, when the separation switch 44 of the first the isolator 40 is switched "on," the direct current voltage is transmitted to the second isolator 40, which is adjacent to the first isolator 40 in the first direction D1. As a result, the power supply voltage generation circuit 49 of the isolator 40 is actuated to generate the power supply voltage. This actuates the third short circuit detector 45 and the fourth short circuit detector 47. At this stage, the current flows to the first wire 2a through the one resistor RB and the short-circuited portion SC (see broken line). In this state, one of the potential at the side of the separation switch 44 toward the third terminal 42 and the potential at the side of the separation switch 44 toward the fourth terminal 43 (potential at the side closer to the short-circuited portion SC) has a value inside the specified range (value proximate to second potential). Thus, the third short circuit detector 45 or the fourth short circuit detector 47 determines that a short circuit is formed, and the separation switch 44 remains "off."

[0051] As described above, when the separation

switch 44 of the second isolator 40 remains "off," the direct current voltage supplied in the first direction D1 is not transmitted to the isolators 40 that are arranged in the first direction D1 from the second the isolator 40. In addition, the current flows to the short-circuited portion SC of the loop 1 through at least one resistor RB. Thus, the direct current voltage is not directly applied to the short-circuited portion SC in the first direction D1.

[0052] Next, the operation of a switch group arranged in the second direction D2 will be described with reference to Fig. 9.

[0053] When the direct current voltage is transmitted in the second direction D2, current flows to the resistors RA and RB, which are connected in parallel to the respective switches. Then, in the same manner as when the direct current voltage is transmitted in the first direction D1, the second switch 36 of the broadcast output device 20 and the separation switches 44 of the isolators 40 are switched "on" in the arranged order in the second direction D2.

[0054] When the separation switch 44 of the isolator 40 that is the second one from the short-circuited portion SC of the loop 1 upstream in the second direction D2 is switched "on," the direct current voltage is transmitted to the isolator 40 located adjacent to the second isolator 40 in the second direction D2. As a result, the power supply voltage generation circuit 49 of the isolator 40 located adjacent to the short-circuited portion SC is actuated to generate the power supply voltage. This actuates the third short circuit detector 45 and the fourth short circuit detector 47. At this stage, the current flows to the first wire 2a through one resistor RB and the short-circuited portion SC. In this state, one of the potential at the side of the separation switch 44 toward the third terminal 42 and the potential at the side of the separation switch 44 toward the fourth terminal 43 (potential at the side closer to the short-circuited portion SC) has a value inside the specified range (value proximate to second potential). Thus, the third short circuit detector 45 or the fourth short circuit detector 47 determines that a short circuit is formed and keeps the separation switch 44 "off."

[0055] As described above, when the separation switch 44 of the isolator 40 that is the first one from the short-circuited portion SC of the loop 1 upstream in the second direction D2 remains "off," the direct current voltage supplied in the second direction D2 is not transmitted to the isolators 40 that are arranged in the second direction D2 from the first isolator 40. In addition, the current flows to the short-circuited portion SC of the loop 1 through at least one resistor RB. This hinders direct application of the direct current voltage to the short-circuited portion SC in the second direction D2.

[0056] The operations of the isolators 40 described above switch the separation switches 44 of the isolators 40 that sandwich the short-circuited portion SC of the loop 1 "off."

[0057] As shown in Fig. 10, the short-circuited portion SC of the loop 1 is substantially isolated from the range

of transmission of the output signal in the broadcasting system 10. As a result, the direct current voltage is not directly applied to the short-circuited portion SC of the loop 1. This hinders overcurrent from flowing to the short-circuited portion SC.

[0058] In the description with reference to Figs. 6 to 10, the short-circuited portion SC of the loop 1 is isolated when the broadcasting system 10 is activated. However, in addition to the time of activation, isolation is executed at a time other than activation.

[0059] During operation of the broadcasting system 10, the signal lines 2 of the loop 1 may be damaged and short-circuited by fire or other incidents. While being supplied with power, the broadcast output device 20 and the isolators 40 perform detection for a short circuit as described above. When the broadcast output device 20 and the isolators 40 detect a short circuit, the switch of the device that detects the short circuit is switched "off," so that the short-circuited portion SC is isolated. Thus, as long as power is supplied, the broadcasting system 10 of the present embodiment performs constant detection for a short circuit. When a short circuit is detected, the short-circuited portion SC is automatically isolated.

[0060] A first operation of the isolator 40 will now be described.

[0061] The isolator 40 detects a short circuit at opposite sides of the separation switch 44. In addition, as described above, the broadcast output device 20 detects a short circuit at opposite sides of the first switch 33 and the second switch 36. In this configuration, each of the signal lines 2 is arranged in the loop 1 between two switches. In each of the signal lines 2, a short circuit is detected based on output signals that are input in the two directions (first direction D1 and second direction D2). When the signal lines 2 is short circuited, the short circuit is detected at the opposite sides of the short-circuited portion SC of the signal lines 2, and the switches at opposite sides of the signal lines 2 are switched off. Thus, the signal lines 2 including the short-circuited portion SC are isolated from the loop 1.

[0062] A second operation of the isolator 40 will now be described.

[0063] Before activation of the broadcasting system 10, a power supply voltage is not generated in the separation switch 44 of the isolator 40. Thus, the third terminal 42 is disconnected from the fourth terminal 43. When the broadcasting system 10 is activated, an output signal is output from the broadcast output device 20, and the power supply voltage is generated in the isolator 40 based on the output signal, so that the separation switch 44 becomes operable. When the third short circuit detector 45 and the fourth short circuit detector 47 do not detect a short circuit, the separation switch 44 connects the third terminal 42 and the fourth terminal 43. In accordance with the operation described above, when activated, starting from the broadcast output device 20, the isolators 40 are sequentially activated from ones closer to the broadcast output device 20. Also, detection for a

short circuit of the signal lines 2 is sequentially performed from positions closer to the broadcast output device 20. When a short circuit is detected, the signal lines 2 having the short circuit are isolated. This hinders overcurrent from flowing to the short-circuited portion SC during activation.

[0064] A breakage detection process will now be described with reference to Figs. 11 and 12.

[0065] The breakage detection process detects whether the loop 1 is broken. The breakage detection process is cyclically executed by the controller 25. For example, the controller 25 executes the breakage detection process at an interval of several dozen seconds. In the breakage detection process, the controller 25 executes steps S1 to S4 described below.

[0066] In step S1, the controller 25 switches the loop connection switch 28 "off." As a result, the output signal is transmitted in only the second direction D2. The output signal is output from the second terminal 32 and is transmitted to the first terminal 31 through the loop 1. In the description hereafter, the output signal that is output from the broadcast output device 20 and returned to the broadcast output device 20 is referred to as "the return signal." The breakage detector 29 detects whether "the return signal" is present.

[0067] As shown in Fig. 12, when the signal lines 2 have breakage, the breakage detector 29 does not detect "the return signal." The breakage detector 29 transmits a signal indicating presence or absence of "the return signal" to the controller 25.

[0068] In step S2, the controller 25 determines whether "the return signal" is present based on the detection result of the breakage detector 29 for "the return signal." When "the return signal" is absent (when the loop 1 is broken), the controller 25 proceeds to step S3 and transmits the third abnormality notification signal, which indicates the broken loop, to the indicator. Subsequently, in step S4, in step S4, the loop connection switch 28 is switched "on," and the breakage detection process is terminated. In step S2, when "the return signal" is present (when the loop 1 is not broken), the controller 25 proceeds to step S4 to switch the loop connection switch 28 "on" and terminates the breakage detection process.

[0069] The operation of the broadcasting system 10 when the loop 1 is broken will now be described with reference to Fig. 13. As described above, the broadcast output device 20 outputs the output signals in the first direction D1 and the second direction D2. Therefore, when the loop 1 is broken, the output signal is transmitted in the first direction D1 to a line LA between the broadcast output device 20 and a broken portion, and the output signal is transmitted in the second direction D2 to the other line LB in the loop 1. Thus, the output signal is transmitted to each of the lines LA and LB. When the loop 1 is broken at two locations, the output signal is not transmitted between the two broken portions OA. The output signal is transmitted to the portion excluding the two broken portions OA. The broadcast output device 20

configured to output the output signals in two directions reduces a portion that does not receive the output signals as compared to a broadcast output device configured to output an output signal in only one direction.

[0070] The advantages of the broadcast output device 20 and the broadcasting system 10 will now be described below.

(1) The broadcast output device 20 outputs the output signals in the first direction D1 and the second direction D2 in the loop 1. With this configuration, signals are transmitted from the broadcast output device 20 to the broken portion OA in two directions. This reduces the range of the loop 1 to which the signals are not transmitted when the loop 1 is partially broken. In addition, the broadcast output device 20 eliminates the need for a communication device for obtaining this advantage.

(2) The broadcast output device 20 outputs the output signals in the first direction D1 and the second direction D2 at predetermined times (e.g., cyclically). Whether the loop 1 has an abnormality is determined based on whether the broadcast output device 20 detects "the return signal" returned through the loop 1. With this configuration, whether the loop 1 has an abnormality (in the present embodiment, breakage) is simply detected.

(3) The broadcast output device 20 superimposes an input signal on a direct current voltage to generate an output signal transmitted to the loop 1. The isolator 40 is actuated based on the output signal to detect a short circuit of the signal lines 2 connected to the isolator 40. When a short circuit is not formed, the two signal lines 2 connected to the isolator 40 are connected to each other. When a short circuit is formed, the two signal lines 2 connected to the isolator 40 are disconnected from each other. With this configuration, the isolator 40 is actuated by power of the output signal to detect a short circuit. This eliminates the need for an external power supply that actuates the isolator 40. When a short circuit is formed, the two signal lines 2 connected to the isolator 40 are disconnected from each other. This prevents continuous transmission of the output signal to the short-circuited wires. Thus, when the loop 1 is short-circuited, the short-circuited portion is effectively isolated.

(4) The first switch 33 of the broadcast output device 20 disconnects the first terminal 31 from the second switch 36 when the first short circuit detector 34 detects a short circuit, and connects the first terminal 31 to the second switch 36 when the first short circuit detector 34 does not detect a short circuit. The second switch 36 of the broadcast output device 20 disconnects the second terminal 32 from the first switch 33 when the second short circuit detector 37 detects a short circuit, and connects the second terminal 32 to the first switch 33 when the second short circuit

detector 37 does not detect a short circuit. With this configuration, when a short circuit is formed in the signal lines 2, which are connected to the broadcast output device 20, transmission of the output signal to the short-circuited portion SC is limited.

(5) When at least one of the third short circuit detector 45 and the fourth short circuit detector 47 detects a short circuit, the separation switch 44 of the isolator 40 disconnects the third terminal 42 from the fourth terminal 43. When none of the third short circuit detector 45 and the fourth short circuit detector 47 detects a short circuit, the separation switch 44 connects the third terminal 42 to the fourth terminal 43. With this configuration, when a short circuit is formed in the signal lines 2 connected to the isolator 40, transmission of the output signal to the short-circuited portion SC is limited.

(6) In the isolator 40, the separation switch 44 disconnects the third terminal 42 from the fourth terminal 43 when the output signal does not reach the isolator 40.

[0071] With this configuration, before activation of the broadcasting system 10, the separation switch 44 is "off." Input of the output signal to the isolator 40 actuates the isolator 40. This configuration hinders current from flowing to the short-circuited portion SC when the broadcasting system 10 is activated.

30 Second Embodiment

[0072] A second embodiment of a broadcasting system 11 will now be described with reference to Figs. 14 to 18.

[0073] As shown in Fig. 14, the broadcasting system 11 of the second embodiment includes a single loop 1 and branch signal lines 7 branched from the loop 1. The branch signal lines 7 and the signal lines 2 configuring the loop 1 are connected by branch isolators 50. The broadcasting system 11 of the second embodiment differs from the first embodiment in two points. That is, the broadcasting system 11 includes the branch signal lines 7, and the broadcasting system 11 includes the branch isolators 50. Detection of an abnormality of the branch signal line 7 will be described below. The same reference numerals are given to those components that are the same components described in the first embodiment.

[0074] Fig. 15 is a circuit diagram of the branch isolator 50.

[0075] The branch isolator 50 connects the branch signal line 7 and the signal lines 2, which configure the loop 1. The branch isolators 50 includes two terminals (hereafter referred to as "first loop terminal 52" and "second loop terminal 53") that are connected to the signal lines 2 configuring the loop 1 and a terminal (hereafter referred to as "branch terminal 54") that is connected to the branch signal line 7. The branch isolator 50 includes a signal line (hereafter referred to as "internal signal line 51") that con-

nects the first loop terminal 52 and the second loop terminal 53 in the branch isolator 50. The internal signal line 51 includes a first wire 51a and a second wire 51b. The branch isolator 50 further includes a signal line (hereafter referred to as "internal branch signal line 61") that connects the branch terminal 54 and the internal signal line 51. The internal branch signal line 61 includes a first wire 61a and a second wire 61b. In the description hereafter, portions connecting the internal signal line 51 and the internal branch signal line 61 are referred to as "branch portion 56." Preferably, the branch isolator 50 further includes a branch end terminal 55 connected to an end of the branch signal line 7.

[0076] A direct current blocking filter 62 is arranged on the first wire 61a of the internal branch signal line 61 to block direct current components. The direct current blocking filter 62 blocks direct current components of the output signal and allows alternating current components to pass through. The direct current blocking filter 62 allows a signal at a frequency in an audible range and a range proximate to the audible range. More specifically, only alternating current is transmitted to the branch signal line 7. This allows the branch signal line 7 to be connected to a speaker 3 that does not include a direct current blocking filter.

[0077] In addition, the branch isolator 50 includes a first separation switch 63, a second separation switch 66, a fifth short circuit detector 64, and a sixth short circuit detector 67. Preferably, the branch isolator 50 includes a power supply voltage generation circuit 71. Preferably, the branch isolator 50 includes a branch short circuit detector 72 that detects current in the branch signal line 7, a pilot alternating current detector 73 that detects the pilot alternating current signal, which will be described later, and a branch voltage detector 74 that detects a voltage difference between a first wire 7a and a second wire 7b of the branch signal line 7.

[0078] The first separation switch 63 and the second separation switch 66 are arranged on the first wire 51a of the internal signal line 51. The first separation switch 63 is arranged between the first loop terminal 52 and the branch portion 56. The second separation switch 66 is arranged between the second loop terminal 53 and the branch portion 56. That is, the first separation switch 63 and the second separation switch 66 are located at opposite sides of the branch portion 56.

[0079] The first separation switch 63 is switched "on" to connect the first loop terminal 52 to the branch portion 56 and is switched "off" to disconnect the first loop terminal 52 from the branch portion 56. The second separation switch 66 is switched "on" to connect the second loop terminal 53 to the branch portion 56 and is switched "off" to disconnect the second loop terminal 53 from the branch portion 56.

[0080] When the branch short circuit detector 72, which will be described later, detects a short circuit, the first separation switch 63 is switched "off" regardless of the detection state of the fifth short circuit detector 64. When

the branch short circuit detector 72, which will be described later, does not detect a short circuit and the fifth short circuit detector 64, which will be described later, detects a short circuit, the first separation switch 63 is switched "off." When the branch short circuit detector 72, which will be described later, does not detect a short circuit and the fifth short circuit detector 64, which will be described later, does not detect a short circuit, the first separation switch 63 is switched "on."

[0081] When the branch short circuit detector 72, which will be described later, detects a short circuit, the second separation switch 66 is switched "off" regardless of the detection state of the sixth short circuit detector 67. When the branch short circuit detector 72, which will be described later, does not detect a short circuit and the sixth short circuit detector 67 detects a short circuit, the second separation switch 66 is switched "off." When the branch short circuit detector 72, which will be described later, does not detect a short circuit and the sixth short circuit detector 67 does not detect a short circuit, the second separation switch 66 is switched "on."

[0082] The fifth short circuit detector 64 detects whether a short circuit is formed in a portion located toward the first loop terminal 52 from the first separation switch 63.

[0083] The fifth short circuit detector 64 includes a fifth switch controller 65 and a resistor RC that is connected to the first wire 51a in parallel to the first separation switch 63. The fifth switch controller 65 determines whether the potential of the first wire 51a between the first separation switch 63 and the first loop terminal 52 (potential at the first loop terminal 52) is inside a specified range. The specified range indicates a potential range in which a short circuit is formed in the signal lines 2. When the potential at the first loop terminal 52 is inside the specified range, the fifth switch controller 65 determines that a short circuit is formed.

[0084] The sixth short circuit detector 67 detects whether a short circuit is formed in a portion located toward the second loop terminal 53 from the second separation switch 66. The sixth short circuit detector 67 includes a sixth switch controller 68 and a resistor RC that is connected to the first wire 51a in parallel to the second separation switch 66. The sixth switch controller 68 determines whether the potential of the first wire 51a between the second separation switch 66 and the second loop terminal 53 (potential at the second loop terminal 53) is inside a specified range. The specified range indicates a potential range in which a short circuit is formed in the signal lines 2. When the potential at the second loop terminal 53 is inside the specified range, the sixth switch controller 68 determines that a short circuit is formed.

[0085] The power supply voltage generation circuit 71 has substantially the same configuration as that described in the first embodiment. More specifically, the power supply voltage generation circuit 71 generates a power supply voltage based on an output signal transmitted through the signal lines 2. The power supply volt-

age generated by the power supply voltage generation circuit 71 is supplied to the fifth short circuit detector 64, the sixth short circuit detector 67, the branch short circuit detector 72, the pilot alternating current detector 73, and the branch voltage detector 74 in the branch isolator 50. The power supply voltage generation circuit 71 includes two input portions. One of the input portions is denoted by 71a and connected to the first wire 51a between the first separation switch 63 and the first loop terminal 52. The other input portion is denoted by 71b and connected to the first wire 51a between the second separation switch 66 and the second loop terminal 53. As described above, when the power supply voltage generation circuit 71 includes the two input portions 71a and 71b, the power supply voltage generation circuit 71 generates the power supply voltage regardless of a direction in which the output signal is transmitted.

[0086] The branch short circuit detector 72 detects current in the internal branch signal line 61 and determines whether the current is inside a specified range. The specified range indicates a range of current when the branch signal line 7 is short-circuited. When the current in the branch signal line 7 is inside the specified range, the branch short circuit detector 72 determines that a short circuit is formed. When a short circuit is detected, the branch short circuit detector 72 switches the first separation switch 63 and the second separation switch 66 "off."

[0087] The pilot alternating current detector 73 detects the pilot alternating current signal. When detecting the pilot alternating current signal, the pilot alternating current detector 73 notifies the branch voltage detector 74 that the pilot alternating current signal is detected.

[0088] When the pilot alternating current detector 73 detects a pilot alternating current, the branch voltage detector 74 detects a potential difference between the first wire 7a and the second wire 7b at the end of the branch signal line 7 and determines whether the potential difference is inside a specified range. The specified range indicates a range of voltage when the branch signal line 7 is broken. When the potential difference is inside the specified range, the branch voltage detector 74 determines that the branch signal line 7 is broken. When detecting breakage, the branch voltage detector 74 shows a predetermined visible indication (e.g., illumination of lamp) indicating that breakage is detected. Also, when detecting breakage, the branch voltage detector 74 switches only one of the first separation switch 63 and the second separation switch 66 "off."

[0089] The operation of the branch isolator 50 will now be described with reference to Fig. 16.

[0090] In Fig. 16, (a) to (e) show cases in which the output signal is transmitted to the branch isolator 50 in at least one of the two directions. In these cases, the power supply voltage is generated, so that the switches operate. Among (a) to (e) shown in Fig. 16, (a) to (d) show operations of the first separation switch 63 and the second separation switch 66 when the current in the

branch signal line 7 is not inside the specified range (i.e., short circuit is not formed). Among (a) to (e) shown in Fig. 16, (e) shows operations of the first separation switch 63 and the second separation switch 66 when the current in the branch signal line 7 is inside the specified range (i.e., short circuit is formed). In Fig. 16, (f) shows a case in which the output signals are not transmitted to the branch isolators 50 in any one of the two directions. In this case, the power supply voltage is not generated, so that the switches do not operate and remain off.

[0091] In the states of (a) to (d), a precondition is that the current in the branch signal line 7 is not inside the specified range (i.e., the branch signal line 7 is not short-circuited).

(a) In the precondition, when the potential at a side of the first separation switch 63 toward the first loop terminal 52 is not inside the specified range (i.e., short circuit is not formed), the first separation switch 63 is switched on. In addition, in the precondition, when the potential at a side of the second separation switch 66 toward the second loop terminal 53 is not inside the specified range (i.e., short circuit is not formed), the second separation switch 66 is switched on. In this case, the two signal lines 2 connected to the branch isolator 50 are connected, and the two signal lines 2 are connected to the branch signal line 7. As a result, the branch signal line 7 is connected to the loop 1 by the first loop terminal 52 and the second loop terminal 53 ("two connections").

(b) In the precondition, when the potential at the side of the first separation switch 63 toward the first loop terminal 52 is not inside the specified range (i.e., short circuit is not formed), the first separation switch 63 is switched on. In addition, in the precondition, when the potential at the side of the second separation switch 66 toward the second loop terminal 53 is inside the specified range (i.e., short circuit is formed), the second separation switch 66 is switched on. In this case, of the two signal lines 2 connected to the branch isolator 50, the signal line 2 located toward the first loop terminal 52 is connected to the branch signal line 7, and the signal line 2 located toward the second loop terminal 53 is not connected to the branch signal line 7. As a result, the branch signal line 7 is connected to the loop 1 by the first loop terminal 52 ("single connection").

(c) In the precondition, when the potential at a side of the first separation switch 63 toward the first loop terminal 52 is inside the specified range (i.e., short circuit is formed), the first separation switch 63 is switched off. In addition, in the precondition, when the potential at a side of the second separation switch 66 toward the second loop terminal 53 is not inside the specified range (i.e., short circuit is not formed), the second separation switch 66 is switched on. In this case, of the two signal lines 2 connected to the branch isolator 50, the signal line 2 located toward

the first loop terminal 52 is not connected to the branch signal line 7, and the signal line 2 located toward the second loop terminal 53 is connected to the branch signal line 7. As a result, the branch signal line 7 is connected to the loop 1 by the second loop terminal 53 ("single connection").

(d) In the precondition, when the potential at a side of the first separation switch 63 toward the first loop terminal 52 is inside the specified range (i.e., short circuit is formed), the first separation switch 63 is switched off. In addition, in the precondition, when the potential at the side of the second separation switch 66 toward the second loop terminal 53 is inside the specified range (i.e., short circuit is formed), the second separation switch 66 is switched off. In this case, of the two signal lines 2 connected to the branch isolator 50, the signal line 2 located toward the first loop terminal 52 is not connected to the branch signal line 7, and the signal line 2 located toward the second loop terminal 53 is not connected to the branch signal line 7. The branch signal line 7 is isolated from the loop 1 ("isolation").

(e) When the current in the branch signal lines 7 is inside the specified range (i.e., the branch signal line 7 is short-circuited), the first separation switch 63 and the second separation switch 66 are switched off regardless of values of the potential at a side of the first separation switch 63 toward the first loop terminal 52 and the potential at the side of the second separation switch 66 toward the second loop terminal 53. As a result, the branch signal line 7 is isolated from the loop 1 ("isolation").

(f) When the output signal is not transmitted to the branch isolator 50, the power supply voltage is not generated, and the first separation switch 63 and the second separation switch 66 remain off. In this case, the two signal lines 2 connected to the branch isolator 50 are disconnected from each other.

[0092] The operation of the branch isolator 50 when the broadcasting system 11 is activated will now be described with reference to Figs. 17 and 18. In this example, a short circuit is formed in the signal lines 2 at the side of the branch isolators 50 in the first direction D1.

[0093] Before activation, the broadcast output device 20, the isolators 40, and the branch isolators 50 are "off." When activated, the controller 25 switches the loop connection switch 28 of the broadcast output device 20 "on." The controller 25 outputs an output signal on which the pilot alternating current signal is superimposed from the broadcast output device 20. The pilot alternating current signal is generated, for example, in the input device 6. The pilot alternating current signal is used to check whether the branch signal line 7 is broken.

[0094] Immediately after activation, in the same manner as the first embodiment, a direct current voltage is transmitted in the first direction D1 and the second direction D2. For each of the isolators 40 configuring the loop

1, a short circuit is sequentially detected in the first direction D1. When a short circuit of an isolator 40 is not detected, the separation switch 44 of the isolator 40 is switched "on," and the direct current voltage is transmitted to the adjacent isolator 40. In the same manner, for each of the isolators 40 configuring the loop 1, detection for a short circuit is sequentially performed in the second direction D2.

[0095] When the separation switch 44 of the isolator 40 that is first from the branch isolator 50 in the direction opposite to the first direction D1 is switched "on," the direct current voltage is transmitted to the branch isolator 50. As a result, the power supply voltage generation circuit 71 of the branch isolator 50 is actuated to generate the power supply voltage. This actuates the fifth short circuit detector 64, the sixth short circuit detector 67, the branch short circuit detector 72, the branch voltage detector 74, and the pilot alternating current detector 73.

[0096] As shown in Fig. 17, when the direct current voltage is transmitted to the branch isolator 50, the direct current voltage is applied to the branch signal line 7. Since the internal branch signal line 61 is provided with the direct current blocking filter 62, only alternating current components of the output signal are transmitted to the branch signal line 7. The pilot alternating current detector 73 detects the pilot alternating current signal. Based on this detection, the branch voltage detector 74 starts the detection for breakage in the branch signal line 7. When the branch voltage detector 74 detects breakage, for example, an indicator lamp of the branch isolator 50 is illuminated. Thus, notification of breakage is issued. In addition, when the breakage is detected, the branch voltage detector 74 switches only one of the first separation switch 63 and the second separation switch 66 "off." This allows the broadcast output device 20 to detect that the branch signal line 7 is broken (refer to "the breakage detection process" described later).

[0097] In addition, when the direct current voltage is transmitted to the branch isolator 50, the branch short circuit detector 72 starts the detection for a short circuit in the branch signal line 7. When the branch short circuit detector 72 detects a short circuit, the first separation switch 63 and the second separation switch 66 remain "off" as described above. Priority is given to a switch instruction based on "short circuit detection" of the branch short circuit detector 72 over a switch instruction based on "short circuit detection" of the fifth short circuit detector 64 and a switch instruction based on "short circuit detection" of the sixth short circuit detector 67.

[0098] When the direct current voltage is transmitted to the branch isolators 50, the current flows to the first wire 2a through the short-circuited portion SC via the two resistors RC and RC of the branch isolator 50. In this example, since a short circuit is formed in the signal lines 2 at the side of the branch isolator 50 in the first direction D1, the potential at the side of the second separation switch 66 toward the second loop terminal 53 has a value inside the specified range (value proximate to second

potential). Thus, the sixth short circuit detector 67 determines that a short circuit is formed and keeps the second separation switch 66 "off." As described above, when the second separation switch 66 remains "off," the direct current voltage supplied in the first direction D1 is not transmitted to the isolators 40 that are arranged in the first direction D1 from the branch isolator 50. The current flows to the short-circuited portion SC of the loop 1 through at least the two resistors RC and RC (see broken line). This hinders direct application of the direct current voltage to the short-circuited portion SC in the first direction D1.

[0099] The fifth short circuit detector 64 does not detect a short circuit and switches the first separation switch 63 "on." As a result, the branch signal line 7 is connected to the loop 1 by the first loop terminal 52. Thus, alternating current of the output signal is transmitted to the branch signal line 7 (refer to Fig. 18).

[0100] The operation of the switch group of the loop 1 arranged in the second direction D2 corresponds to the operation of the switch group of the loop 1 arranged in the second direction D2 that is described in the first embodiment. Therefore, in this example, the separation switch 44 of the isolator 40 adjacent to the branch isolator 50 in the first direction D1 remains off.

[0101] The operations of the isolators 40 described above switch the second separation switch 66 of the branch isolator 50 and the separation switch 44 of the isolator 40 that sandwich the short-circuited portion SC of the loop 1 "off." As a result, the short-circuited portion SC of the loop 1 is substantially isolated from the range in which the output signal is transmitted in the broadcasting system 11. Thus, the direct current voltage is not directly applied to the short-circuited portion SC of the loop 1. This hinders overcurrent from flowing to the short-circuited portion SC.

[0102] In the above description, when the broadcasting system 11 is activated, the short-circuited portion SC of the loop 1 is isolated by operation of the switches. However, in addition to the time of activation, isolation is executed at a time other than activation. This point is the same as the first embodiment.

[0103] The breakage detection process will now be described.

[0104] The steps of the breakage detection process are the same as those in the first embodiment. In this example, the branch signal line 7 is broken. The operation of the breakage detection process will be described. The flowchart is the same as the flowchart shown in Fig. 11.

[0105] In step S1, the controller 25 switches the loop connection switch 28 "off." As a result, the output signal is transmitted in only the second direction D2. The output signal is output from the second terminal 32 and is transmitted to the first terminal 31 through the loop 1.

[0106] When the branch signal line 7 is broken, "the return signal" is not detected. This is because, as described above, when breakage is detected in the branch signal line 7, one of the first separation switch 63 and the

second separation switch 66 of the branch isolator 50 is switched "off."

[0107] In step S2, the controller 25 determines whether "the return signal" is present based on the detection result of the breakage detector 29 for "the return signal." When "the return signal" is absent (when the loop 1 or the branch signal line 7 is broken), the controller 25 proceeds to step S3 and transmits the third abnormality notification signal, which indicates the broken loop, to the indicator. When "the return signal" is present (when the loop 1 and the branch signal line 7 are not broken), the controller 25 proceeds to step S4 to switch the loop connection switch 28 "on" and terminates the breakage detection process. Thus, the breakage of the branch signal line 7 is detected through the same process as the breakage detection process of the first embodiment.

[0108] The advantages of the broadcast output device 20 and the broadcasting system 11 will now be described below.

(1) The first separation switch 63 of the branch isolator 50 disconnects the first loop terminal 52 from the branch portion 56 when the fifth short circuit detector 64 detects a short circuit, and connects the first loop terminal 52 to the branch portion 56 when the fifth short circuit detector 64 does not detect a short circuit. The second separation switch 66 of the branch isolators 50 disconnects the second loop terminal 53 from the branch portion 56 when the sixth short circuit detector 67 detects a short circuit, and connects the second loop terminal 53 to the branch portion 56 when the sixth short circuit detector 67 does not detect a short circuit. With this configuration, when a short circuit is formed in the signal lines 2 connected to the branch isolator 50, transmission of the output signal to the short-circuited portion SC is limited.

(2) When the branch short circuit detector 72 of the branch isolator 50 detects a short circuit of the branch signal line 7, the first separation switch 63 disconnects the first loop terminal 52 from the branch portion 56 of the branch signal line 7, and the second separation switch 66 also disconnects the second loop terminal 53 from the branch portion 56 of the branch signal line 7. With this configuration, when a short circuit is detected in the branch signal line 7, the branch signal line 7 is isolated from the loop 1. Thus, transmission of the output signal to the short-circuited portion SC is limited.

(3) The branch isolator 50 includes the direct current blocking filter 62, which is arranged on the internal branch signal line 61 to block direct current components. With this configuration, direct current components are blocked in the branch signal line 7. This allows the branch signal line 7 to be connected to a speaker 3 that does not include a capacitor for blocking direct current components.

(4) The broadcast output device 20 outputs the pilot

alternating current signal for detecting breakage in the branch signal line 7. When receiving the pilot alternating current signal, the branch isolator 50 detects that the branch signal line 7 is broken. When no signal is input to the branch signal line 7, breakage in the branch signal line 7 cannot be accurately detected. This is because the potential difference slightly differs between when no signal is input to the branch signal line 7 and when the branch signal line 7 is broken. In this regard, with this configuration, when the pilot alternating current signal is received, breakage is detected in the branch signal line 7. This reduces erroneous detections when detecting breakage in the branch signal line 7.

(5) The branch isolator 50 further includes the power supply voltage generation circuit 71. The first separation switch 63 disconnects the first loop terminal 52 from the branch portion 56 of the branch signal line 7 (the first separation switch 63 is "off") when the power supply voltage is not generated, and the second separation switch 66 disconnects the second loop terminal 53 from the branch portion 56 of the branch signal line 7 (the second separation switch 66 is "off") when the power supply voltage is not generated.

In this configuration, the power supply voltage is generated based on the output signal. This eliminates the need for an external power supply that actuates the branch isolator 50. Before activation of the broadcasting system 11, the first separation switch 63 and the second separation switch 66 are switched "off." Input of the output signal to the branch isolator 50 allows the branch isolator 50 to detect a short circuit. Thus, when the broadcasting system 11 is activated, current is hindered from flowing to the short-circuited portion SC.

(6) The broadcast output device 20 outputs the output signal in one of the first direction D1 and the second direction D2. Whether the loop 1 has an abnormality is determined based on whether the broadcast output device 20 detects "the return signal" returned through the loop 1. With this configuration, whether the loop 1 has an abnormality (in the present embodiment, the branch signal line 7 is broken) is simply detected.

Modified Examples

[0109] The configurations of the broadcast output device 20 and the broadcasting systems 10 and 11 are not limited to those described in the embodiments. For example, the embodiments may be changed in any manner.

[0110] In the first embodiment, the pilot alternating current signal is generated in the input device 6. Instead, the pilot alternating current signal may be generated in the broadcast output device 20.

[0111] In the embodiment, the signal lines 2 include two wires. However, the configuration of the signal lines

2 is not limited to such a configuration. The signal lines 2 may include one conductive wire. The signal lines 2 may include a coaxial cable.

DESCRIPTION OF THE REFERENCE NUMERALS

[0112] D1) first direction, D2) second direction, LA) line, LB) line, OA) broken portion, RA) resistor, RB) resistor, RC) resistor, RD) resistor, SC) short-circuited portion, 1) loop, 1m) loop body, 2) signal line, 2a) first wire, 2b) second wire, 3) speaker, 4) direct current blocking filter, 5) external power supply, 6) input device, 7) branch signal line, 7a) first wire, 7b) second wire, 10) broadcasting system, 11) broadcasting system, 20) broadcast output device, 21) internal signal line, 21a) first wire, 21b) second wire, 22) intermediate wire, 23) power circuit, 24) ground fault detector, 25) controller, 26) alternating current blocking filter, 27) noise cut filter, 28) loop connection switch, 28a) switch, 28b) switch, 29) breakage detector, 30) first terminal, 31) second terminal, 32) first switch, 33) first short circuit detector, 34) first switch controller, 35) second switch, 36) second short circuit detector, 37) second switch controller, 38) second switch controller, 39) isolator, 40) internal signal line, 40a) first wire, 40b) second wire, 41) third terminal, 42) fourth terminal, 43) separation switch, 44) third short circuit detector, 45) third switch controller, 46) fourth short circuit detector, 47) fourth switch controller, 48) power supply voltage generation circuit, 48a) input portion, 48b) input portion, 49) branch isolator, 50) internal signal line, 50a) first wire, 50b) second wire, 51) first loop terminal, 52) second loop terminal, 53) branch terminal, 54) branch end terminal, 55) branch portion, 56) internal branch signal line, 56a) first wire, 56b) second wire, 57) direct current blocking filter, 58) first separation switch, 59) fifth short circuit detector, 60) fifth switch controller, 61) second separation switch, 62) sixth short-circuit detector, 63) sixth switch controller, 64) power supply voltage generation circuit, 64a) input portion, 64b) input portion, 65) branch short circuit detector, 66) pilot alternating current detector, 67) branch voltage detector

Claims

1. A broadcasting system configured to transmit signals to speakers, the broadcasting system comprising:

a single loop configured by multiple signal lines, to which at least one of the speakers is configured to be connected;
one or more isolators arranged between the signal lines configuring the loop; and
a broadcast output device configured to transmit an output signal to the loop, the broadcasting system being **characterized in that:**

the broadcast output device is configured

- to superimpose an input signal on a direct current voltage to generate the output signal, which is transmitted to the loop, each of the isolators is actuated based on the output signal to detect a short circuit of the signal lines connected to the isolator, when the short circuit is not formed, each of the isolators connects the signal lines connected to the isolator to each other, and when the short circuit is formed, each of the isolators disconnects the signal lines connected to the isolator from each other.
2. The broadcasting system according to claim 1, wherein the broadcast output device includes
- a first terminal and a second terminal that are connected to the signal lines of the loop,
 - a first switch arranged on an internal signal line that connects the first terminal to the second terminal in the broadcast output device,
 - a second switch arranged between the first switch and the second terminal,
 - a first short circuit detector configured to detect a short circuit in a portion located toward the first terminal from the first switch, and
 - a second short circuit detector configured to detect a short circuit in a portion located toward the second terminal from the second switch,
- the first switch disconnects the first terminal from the second switch when the first short circuit detector detects the short circuit, and connects the first terminal to the second switch when the first short circuit detector does not detect the short circuit, and the second switch disconnects the second terminal from the first switch when the second short circuit detector detects the short circuit, and connects the second terminal to the first switch when the second short circuit detector does not detect the short circuit.
3. The broadcasting system according to claim 1 or 2, wherein each of the isolators includes
- a third terminal and a fourth terminal,
 - a separation switch arranged on an internal signal line that connects the third terminal to the fourth terminal,
 - a third short circuit detector that detects a short circuit in a portion located toward the third terminal from the separation switch, and
 - a fourth short circuit detector that detects a short circuit in a portion located toward the fourth terminal from the separation switch, and
- the separation switch disconnects the third terminal
- from the fourth terminal when at least one of the third short circuit detector or the fourth short circuit detector detects a short circuit, and connects the third terminal to the fourth terminal when none of the third short circuit detector and the fourth short circuit detector detects a short circuit.
4. The broadcasting system according to claim 3, wherein the separation switch disconnects the third terminal from the fourth terminal when the output signal does not reach the isolator.
5. The broadcasting system according to any one of claims 1 to 4, further comprising:
- a branch isolator connected between the loop and a branch signal line branching from the loop, wherein the branch isolator includes
 - a first loop terminal and a second loop terminal that are connected to the signal lines of the loop,
 - a branch terminal connected to the branch signal line,
 - a first separation switch arranged between the first loop terminal and a branch portion of the branch signal line,
 - a second separation switch arranged between the second loop terminal and the branch portion of the branch signal line,
 - a fifth short circuit detector that detects a short circuit in a portion located toward the first loop terminal, and
 - a sixth short circuit detector that detects a short circuit in a portion located toward the second loop terminal,
- the first separation switch disconnects the first loop terminal from the branch portion of the branch signal line when the fifth short circuit detector detects the short circuit, and connects the first loop terminal to the branch portion of the branch signal line when the fifth short circuit detector does not detect the short circuit, and the second separation switch disconnects the second loop terminal from the branch portion of the branch signal line when the sixth short circuit detector detects the short circuit, and connects the second loop terminal to the branch portion of the branch signal line when the sixth short circuit detector does not detect the short circuit.
6. The broadcasting system according to claim 5, wherein the branch isolator includes a branch short circuit detector that detects a short circuit of the branch signal line, and

when the branch short circuit detector detects the short circuit, the first separation switch disconnects the first loop terminal from the branch portion of the branch signal line, and the second separation switch disconnects the second loop terminal from the branch portion of the branch signal line. 5

7. The broadcasting system according to claim 5 or 6, wherein
the branch isolator includes a direct current blocking filter arranged on an internal branch signal line to block a direct current component, and
the internal branch signal line connects the branch portion to the branch terminal. 10
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8. The broadcasting system according to any one of claims 5 to 7, wherein
the broadcast output device outputs a pilot alternating current signal for detecting breakage of the branch signal line, and 20
when the pilot alternating current signal is received, the branch isolator detects breakage of the branch signal line.
9. The broadcasting system according to any one of claims 5 to 8, wherein 25
the branch isolator further includes a power supply voltage generation circuit that generates a power supply voltage based on an output signal that is output from the broadcast output device through the signal lines, 30
when the power supply voltage is not generated, the first separation switch disconnects the first loop terminal from the branch portion of the branch signal line, and 35
when the power supply voltage is not generated, the second separation switch disconnects the second loop terminal from the branch portion of the branch signal line. 40
45
50
55

Fig.1

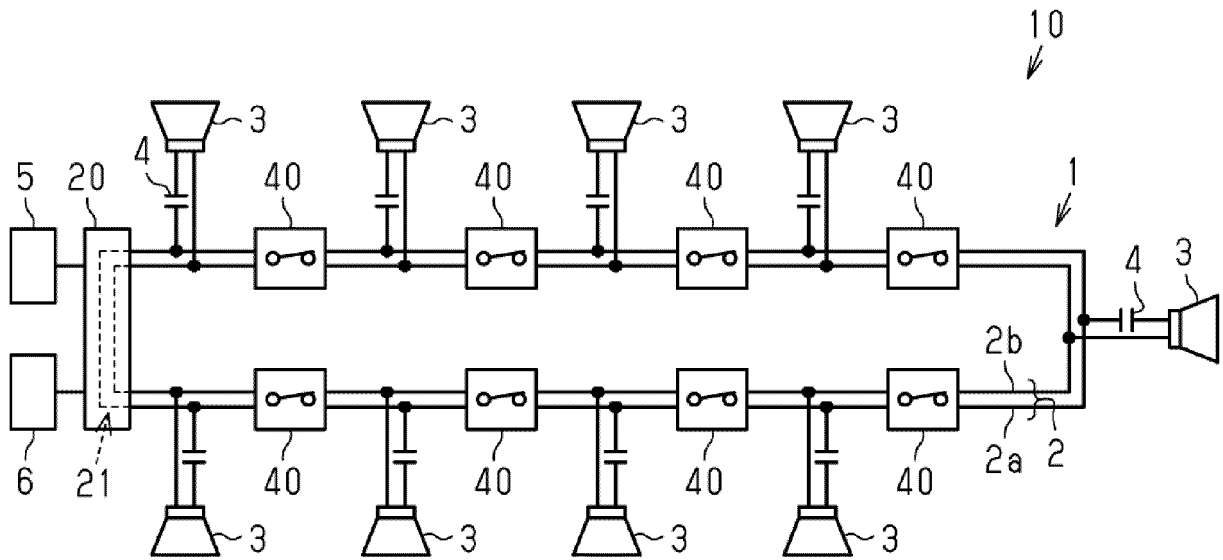


Fig.2

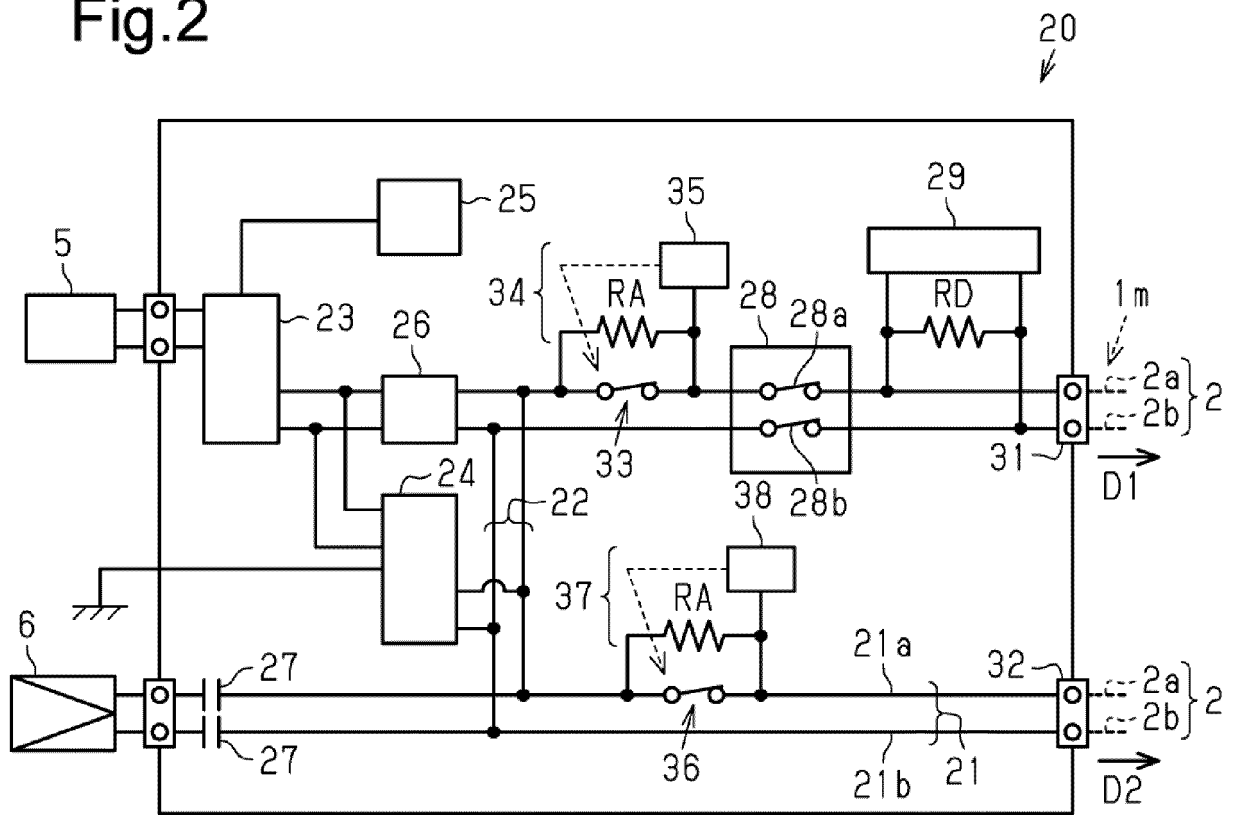


Fig.3

	(a)	(b)	(c)	(d)
Potential at 1st terminal is outside specified range	YES (No short circuit)	YES (No short circuit)	NO (Short circuit)	NO (Short circuit)
Potential at 2nd terminal is outside specified range	YES (No short circuit)	NO (Short circuit)	YES (No short circuit)	NO (Short circuit)
1st Switch State	ON	ON	OFF	OFF
2nd Switch State	ON	OFF	ON	OFF
Output State	Output in two directions	Output in 1st direction	Output in 2nd direction	Not output in any direction

Fig.4

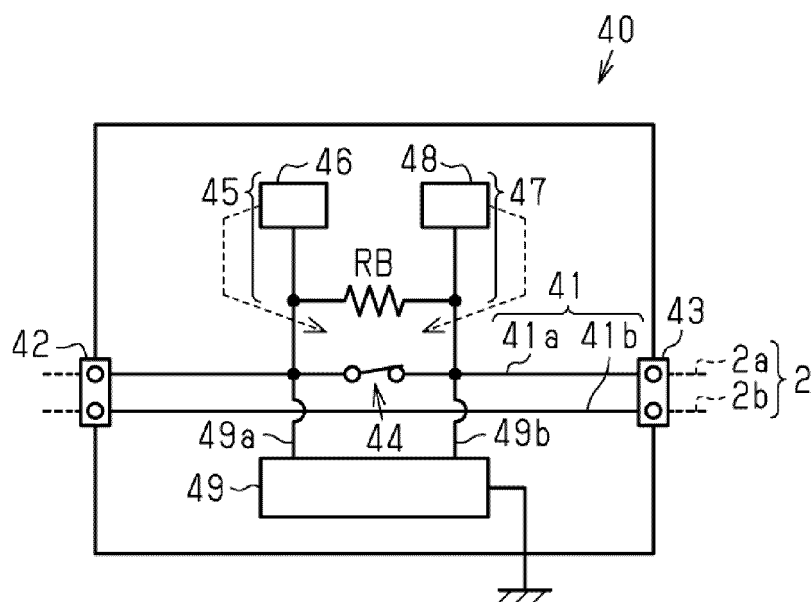


Fig.5

	(a)	(b)	(c)	(d)	(e)
Input of Output Signal	YES				NO
Potential at 3rd terminal is outside specified range	YES (No short circuit)	YES (No short circuit)	NO (Short circuit)	NO (Short circuit)	—
Potential at 4th terminal is outside specified range	YES (No short circuit)	NO (Short circuit)	YES (No short circuit)	NO (Short circuit)	—
Separation Switch State	ON	OFF			OFF

Fig.6

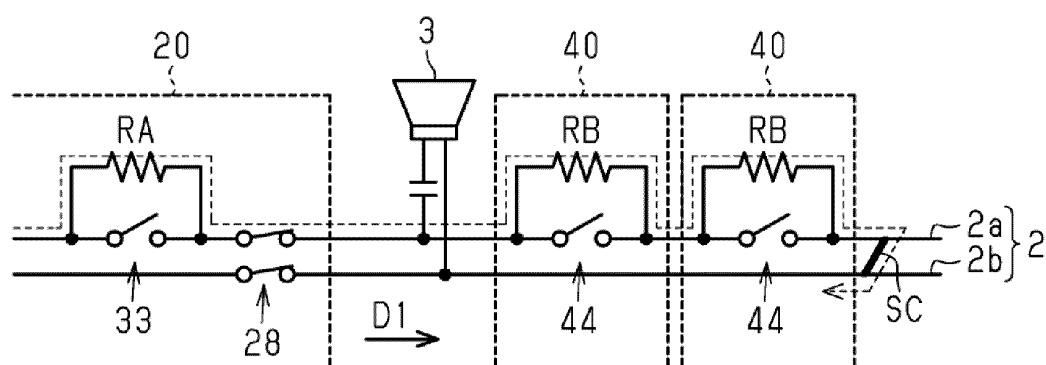


Fig.7

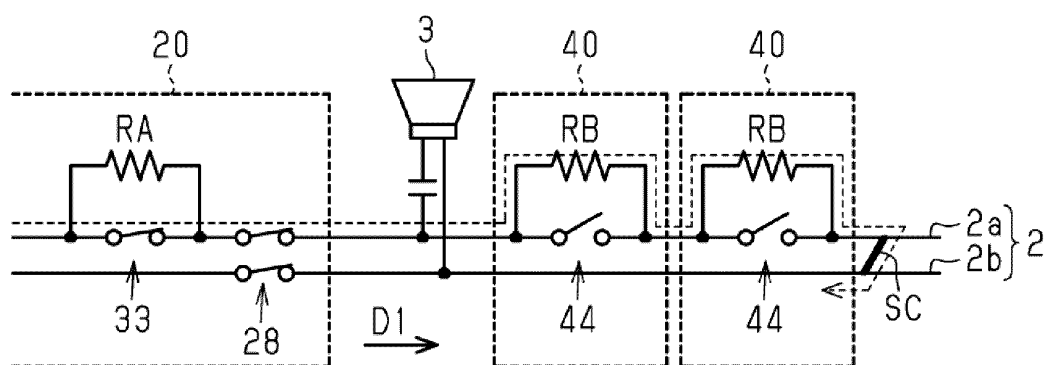


Fig.8

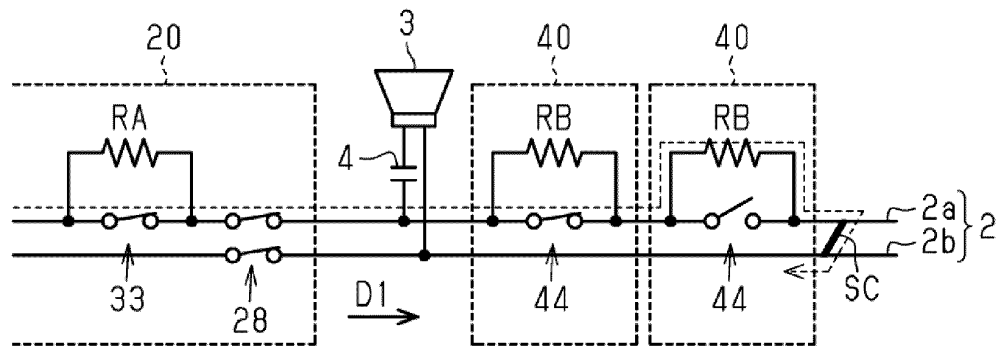


Fig.9

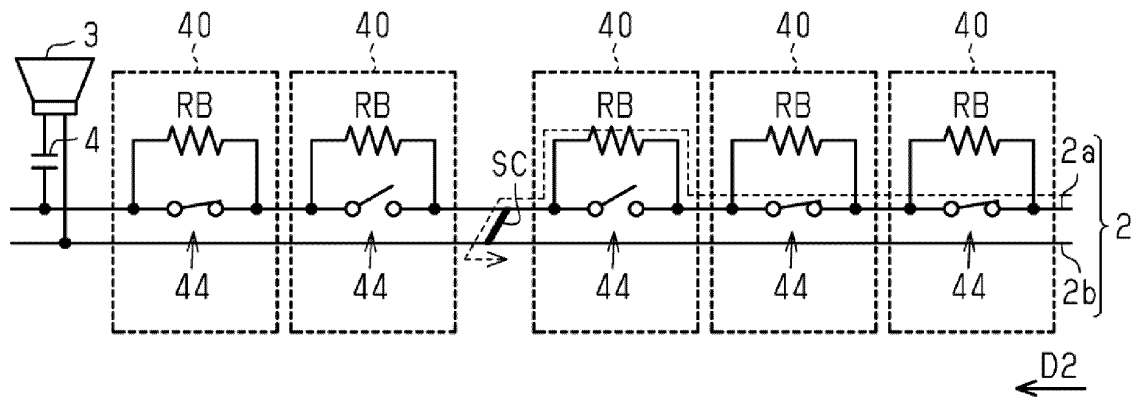


Fig.10

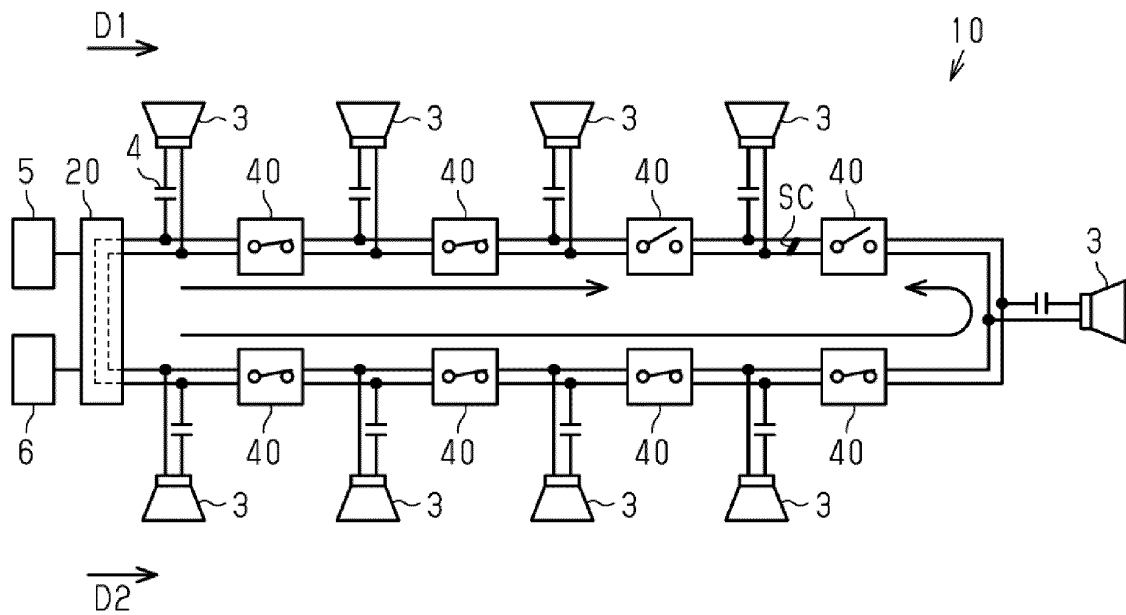


Fig.11

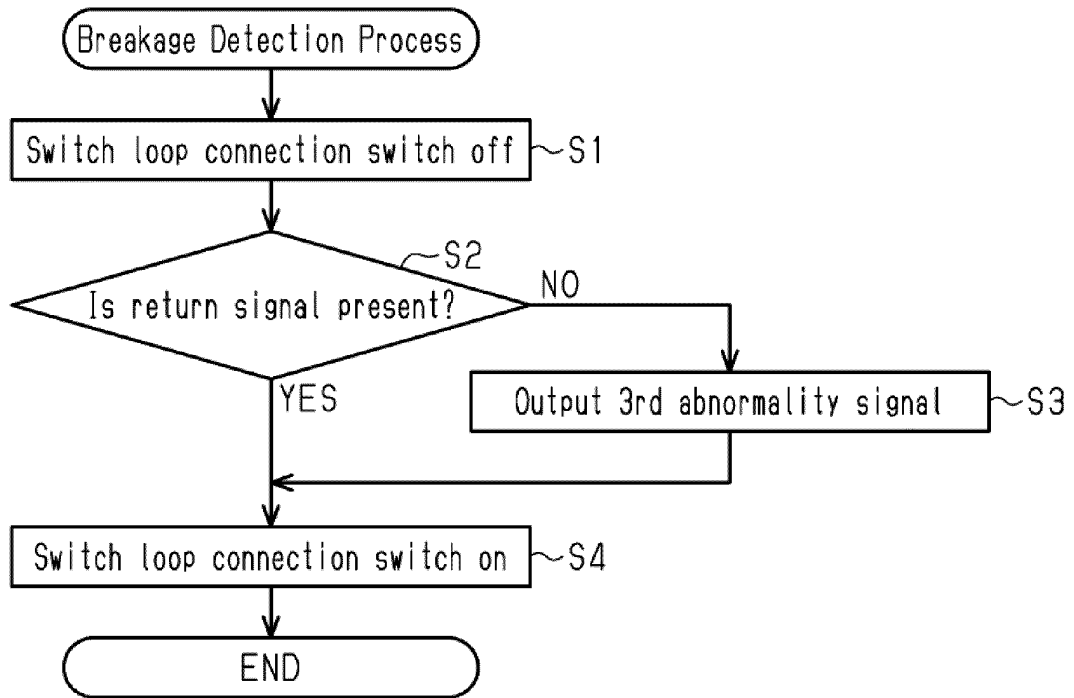


Fig.12

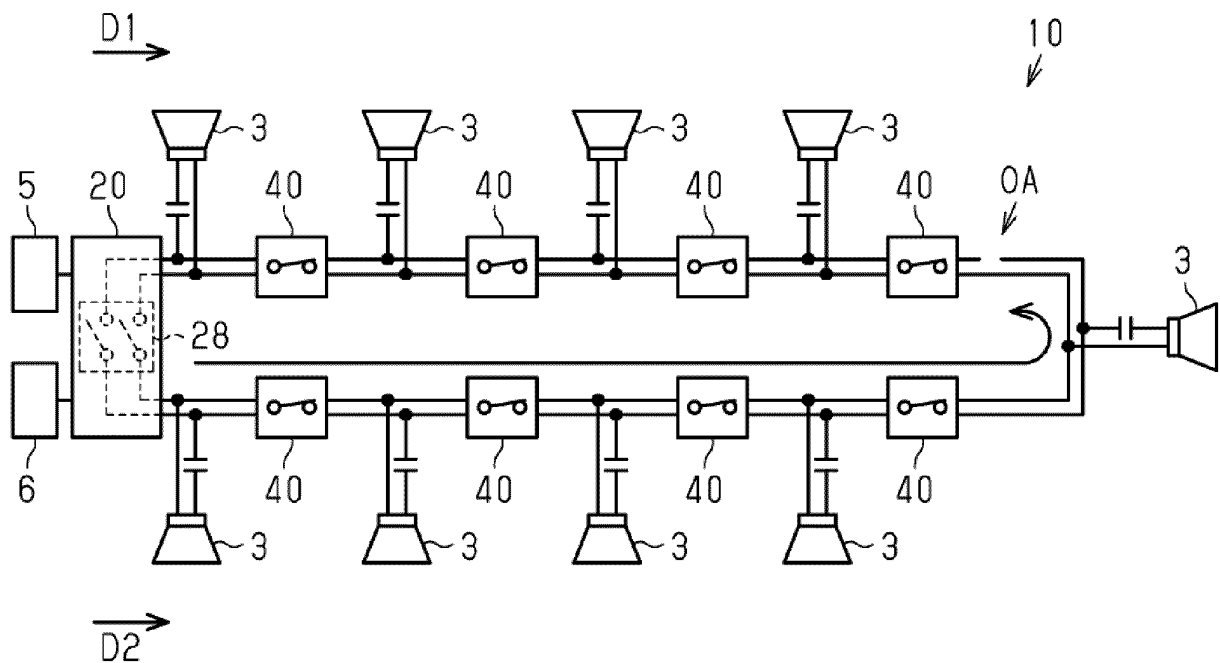


Fig.13

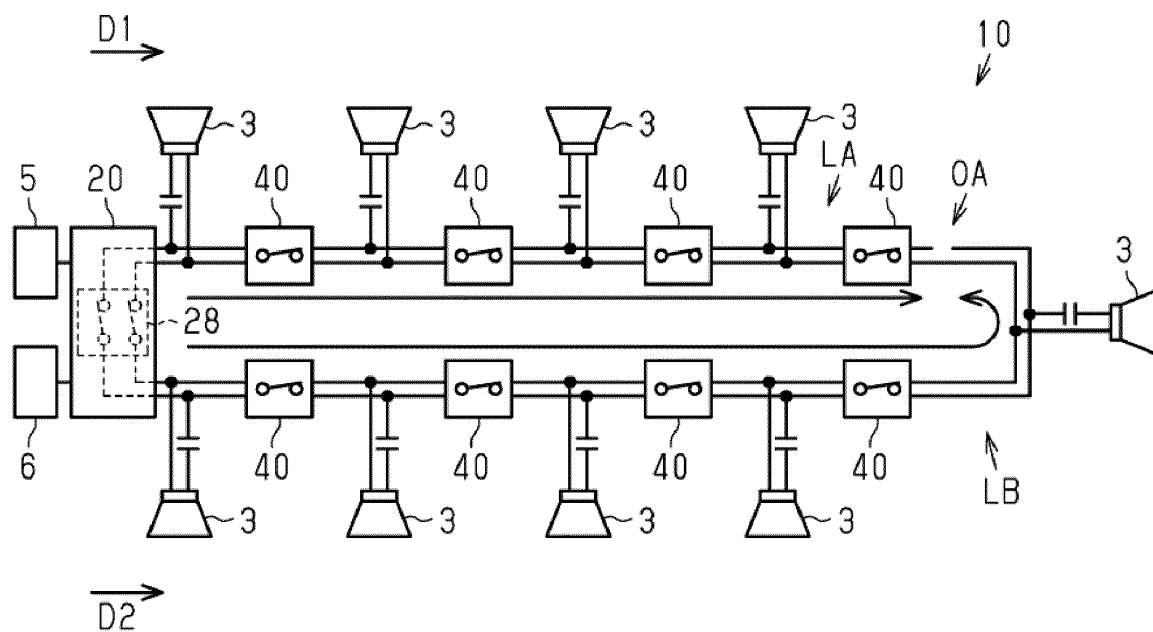


Fig.14

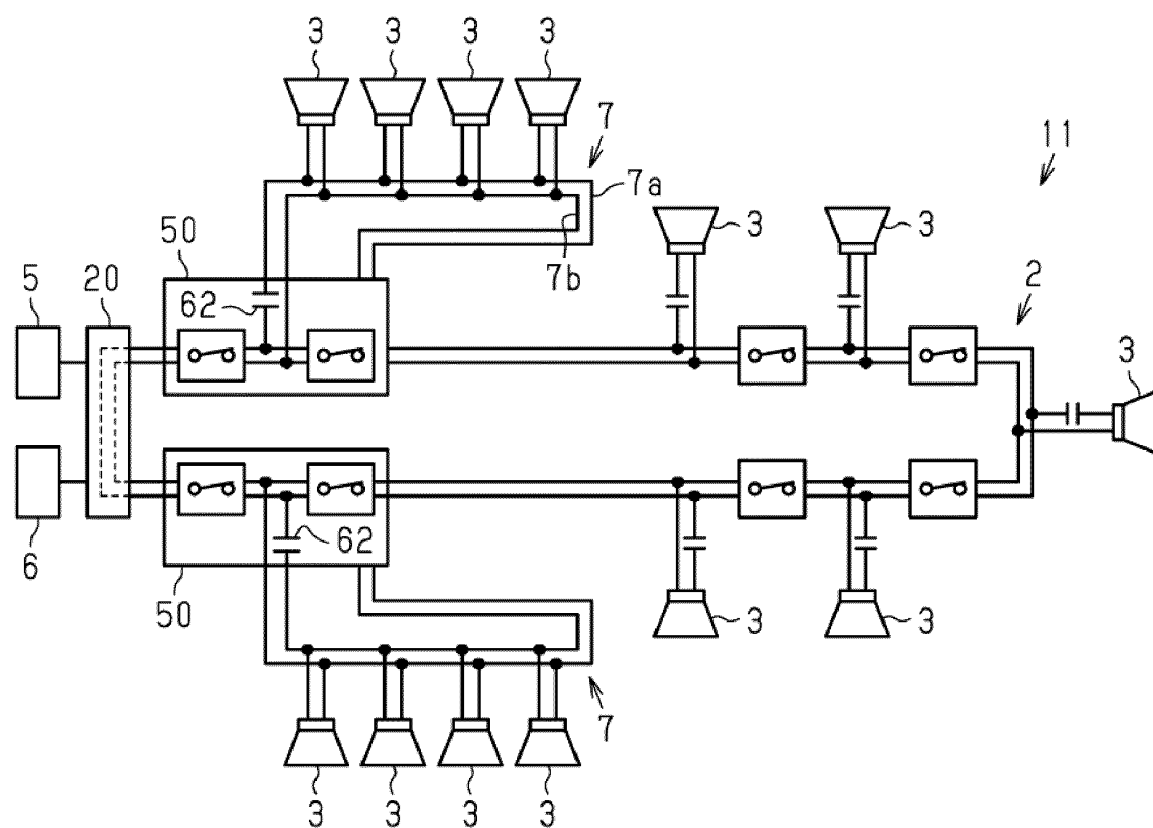


Fig.15

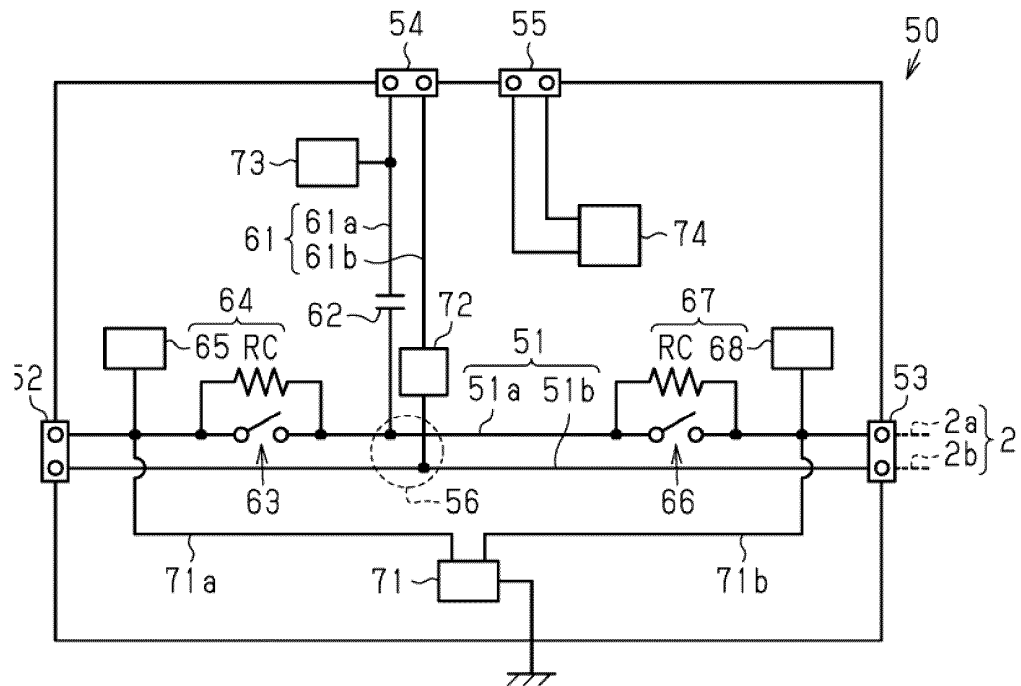


Fig.16

	(a)	(b)	(c)	(d)	(e)	(f)
Input of Output Signal	YES					NO
Current in internal branch signal line is outside specified range	YES (No short circuit)				NO (Short circuit)	
Potential at 1st loop terminal is outside specified range	YES (No short circuit)	YES (No short circuit)	NO (Short circuit)	NO (Short circuit)	—	—
Potential at 2nd loop terminal is outside specified range	YES (No short circuit)	NO (Short circuit)	YES (No short circuit)	NO (Short circuit)	—	—
1st Separation Switch State	ON	ON	OFF	OFF	OFF	OFF
2nd Separation Switch State	ON	OFF	ON	OFF	OFF	OFF
Branch Signal Line	Two Connections	Single Connection	Single Connection	Isolation	Isolation	—

Fig.17

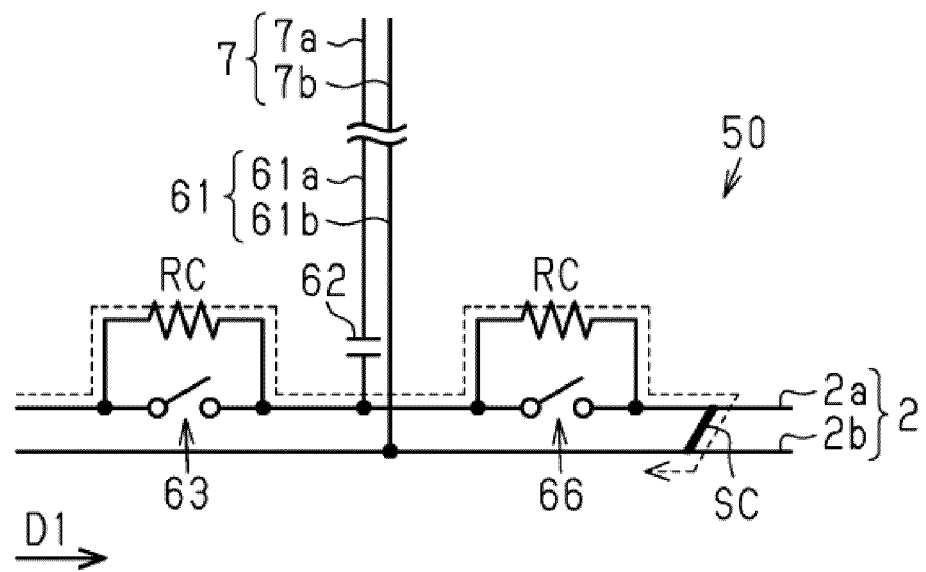
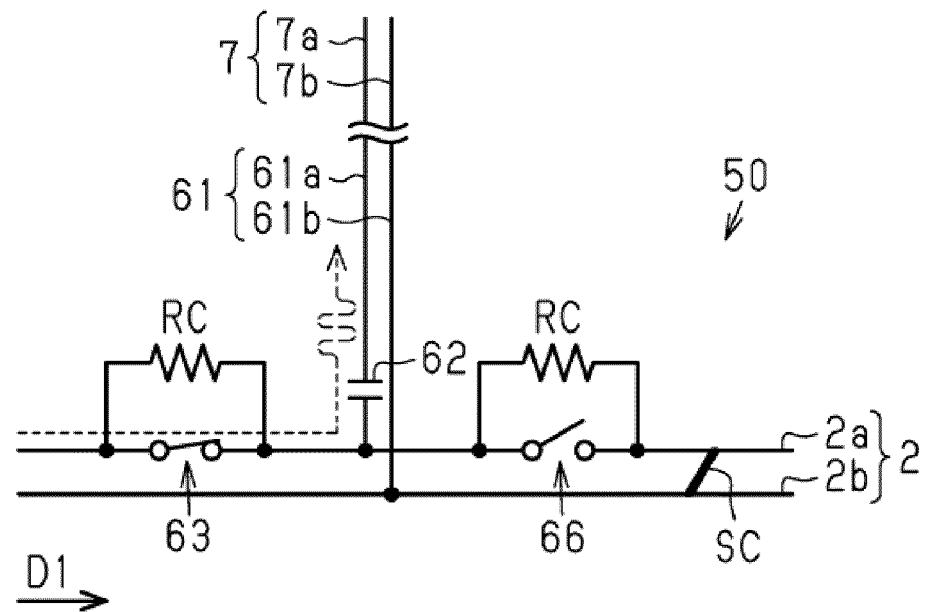


Fig.18



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/046142

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. H04R27/00 (2006.01) i, H04H20/12 (2008.01) i, H04H20/61 (2008.01) i,
H04R3/12 (2006.01) i, H04R29/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. H04R27/00, H04H20/12, H04H20/61, H04R3/12, H04R29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 6033397 B2 (TOA CORP.) 30 November 2016,	1
A	paragraphs [0012]-[0030], fig. 1-5 & WO 2014/013530 A1, paragraphs [0012]-[0030], fig. 1-5	2-9
A	JP 09-070099 A (TOA CORP.) 11 March 1997, paragraphs [0034]-[0050], fig. 1 (Family: none)	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
12.03.2018

Date of mailing of the international search report
20.03.2018

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Patent documents cited in the description

- JP 2014509813 A [0004]