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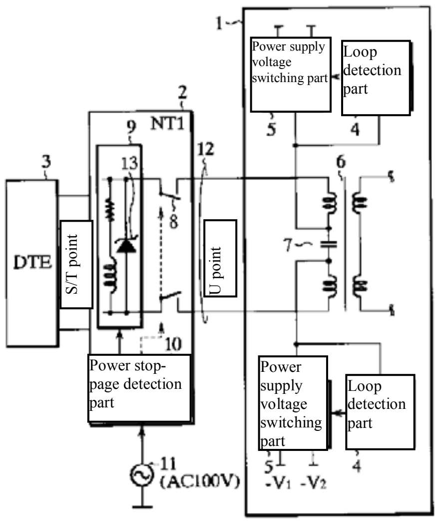
(54) (TITLE OF THE INVENTION) Power Supply Circuit

(57) (ABSTRACT)
(PROBLEM) To provide a power supply circuit that switches power supply voltage and supplies the desired power while ensuring safety.
(MEANS FOR SOLVING) A loop detection part 4 is provided that detects a DC loop based on current that flows to a constant-current circuit, the voltage at two terminals of the constant-current circuit, or the line voltage of the digital subscriber line, when local power supply to a network terminal device 2 to which a subscriber terminal 3 is connected is stopped, a contact breaker point 8 is turned ON by a stoppage detection part 10, and a DC loop is formed via a phantom power supply part 9 on the side of the power supply circuit 1; and a power supply voltage switching part 5 is provided that supplies power to a digital subscriber line 12 at a low voltage V_2 of −48 V during local power supply to the network terminal device 2 and switches to a high voltage V_1 of −120 V which is supplied to the digital subscriber line 12 when the DC loop formed due to stoppage of local power supply is detected by the loop detection part 4.

Explanatory diagram describing the principle of the present invention.



(SCOPE OF PATENT CLAIMS)

(CLAIM 1) A power supply circuit whereby station power supply is carried out via a digital subscriber line when local power supply is stopped to a network terminal device to which a subscriber terminal is connected;

said power supply circuit characterized in that it is provided with a loop detection part that supplies low-voltage power supply to said digital subscriber line and detects a direct current loop formed by stoppage of local power supply to the network terminal device; and

a power supply voltage switching part that switches to high voltage power supply when a direct current loop of said network terminal device is detected by said loop detection part.

(CLAIM 2) The power supply circuit according to Claim 1, characterized in that said loop detection part is constituted by a current detection part that performs low voltage power supply to said digital subscriber line and detects current running in a direct current loop formed upon stoppage of the local power supply of said network terminal device.

(CLAIM 3) The power supply circuit according to Claim 1, wherein said loop detection part has a configuration whereby low-voltage power is supplied via a constant-current circuit to said digital subscriber line that is connected to said network terminal device and detects a direct current loop formed by stoppage of the local power supply of said network terminal device due to the current flowing in said constant-current circuit.

(CLAIM 4) The power supply circuit according to Claim 1, characterized in that said loop detection part has a configuration whereby low-voltage power is supplied via a constant-current circuit to said digital subscriber line that is connected to said network terminal device, and detects a direct current loop formed by stoppage of the local power supply of said network terminal device due to the voltage between the two terminals of said constant-current circuit.

(CLAIM 5) The power supply circuit according to Claim 1, characterized in that said loop detection part has a configuration whereby low-voltage power is supplied via a constant-current circuit to said digital subscriber line that is connected to said network terminal device, and detects a direct current loop formed by stoppage of the local power supply of said network terminal device by detecting a drop in line voltage of said digital subscriber line.

(CLAIM 6) The power supply circuit according to any of Claims 1 to 5, characterized by having first and second current detection parts that detect current flowing respectively in the tip line and ring line of said digital subscriber line and a power supply voltage switching part that detects the difference in currents detected by said first and second current detection parts, determines that a ground or contact fault has occurred when said difference exceeds a set value, and switches the power supply voltage that supplies power to said digital subscriber line to a low voltage.

(CLAIM 7) The power supply circuit according to any of Claims 1 to 6, characterized by having first and second current detection parts that detect current flowing respectively in the tip line and ring line of said digital subscriber line and a power supply voltage switching part that detects the difference in currents detected by said first and second current detection parts, switches the power supply voltage supplied to said digital subscriber line to low voltage when said difference exceeds a first set value, and blocks the power supply voltage to said digital subscriber line when the difference in currents detected by said first and second current detection parts exceeds a second set value when switched to said low voltage.

(CLAIM 8) The power supply circuit according to any of Claims 2 to 5, characterized by having first and second constant-current circuits that supply constant current respectively to the tip line and ring line of said digital subscriber line, first and second voltage detection parts that detect the voltages at the two terminals of said first and second constant-current circuits, and a power supply voltage switching part that detects the difference in detected voltages from said first and second voltage detection parts, determines that a ground or contact fault has occurred when said difference exceeds a set value, and switches the power supply voltage supplied to said digital subscriber line to a low voltage.

(CLAIM 9) The power supply circuit according to any of Claims 2 to 5 or 8, characterized by having first and second constant-current circuits that supply constant current respectively to the tip line and ring line of said digital subscriber line, first and second voltage detection parts that detect the voltages at the two terminals of said first and second constant-current circuits, and a supply voltage switching part that detects the difference in detected voltages from said first and second voltage detection parts, switches the voltage supplied to said digital subscriber line to a low voltage when said difference exceeds a first set value, and blocks the voltage supplied to said digital subscriber line when the difference in the voltages detected by said first and second voltage detection parts exceeds a second set value when switched to said low voltage.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(Technological Field of the Invention) The present invention relates to a power supply circuit that switches the power supply voltage. Subscriber terminals that are connected to digital subscriber lines receive power supply from commercial power sources in the homes of subscribers, and systems are known in which station power supply is carried out to allow minimal restricted communication during power outages. With these types of power supply systems, it is necessary to ensure safety.

(0002)

(Prior Art) Fig. 11 is an explanatory diagram of a conventional example, wherein 101 is a power supply circuit for a switching station, 102 is a network terminal device (NT1) (or digital service unit (DSU)), 103 is a subscriber terminal (DTE), 104 is a digital subscriber line consisting of a tip (TIP) line and ring (RING) line, 105 is a power supply source that allows constant current power supply, 106 is a transformer, 107 is a capacitor, 108 is a transformer, 109 is a capacitor, 110 is a full wave rectification circuit, 111 is a commercial alternating current power source (AC100 V), and 112 is a phantom power supply part. The U and S/T points represent reference points in the ISDN.

(0003) The transformers 106 and 108 are transformers used for communication, and the capacitors 107 and 109 that are linked between the coils are used for blocking direct current. The power supply circuit 101 of each switching station has a power supply power source 105 and supplies power to the network terminal device 102 via the digital subscriber line 104. The power supply voltage mediated by the coil of the transformer 108 and the digital subscriber line 104 is added to the phantom power supply part 112 via the full wave rectification circuit 110, and the power supply from the power supply circuit 101 serves as the station power supply that is supplied from the phantom power supply part 112 to the subscriber terminal 103 when the commercial AC power source 111 is shut down.

(0004) When the commercial AC power source 111 is functioning normally, for example, an AC current of 100 V is rectified in the phantom power supply part 112 and is converted to a prescribed voltage, for example, a DC voltage of 40 V, for use as the local power supply that is supplied to the subscriber terminal 103. Switching to the aforementioned station power supply occurs with shutdown of the commercial AC power supply, and power sufficient to allow minimal communication on the digital subscriber terminal 103 is thus supplied.

(0005)

(Problems to be Solved by the Invention) The voltage of station power supply for analog subscriber lines is generally −48 V. However, in regard to the voltage for a station power supply for a digital subscriber line 104, in order to provide the prescribed power to the subscriber terminal 103, for example, the line voltage is taken to be about 120 V for the power supply power source 105 of the power supply circuit 101. In addition, because the digital subscriber line 104 runs into the home of the consumer, it is desirable to ensure safety by decreasing the line voltage of the digital subscriber line 104 in the home of the subscriber.

(0006) During station power supply, the line impedance of the digital subscriber line 104 in the network terminal device 102 becomes small, and the line voltage is sufficiently reduced. However, during local power supply, the line impedance of the digital subscriber line 104 is large, and thus the line voltage is, for example, 85 to 105 V. This type of voltage has been problematic in terms of safety when applied as the line voltage for the digital subscriber line 104 that runs into the homes of subscribers. An object of the present invention is to supply a prescribed power level while maintaining safety by applying a low voltage during local power supply and a high voltage during station power supply.

(0007)

(Means for Solving the Problems) The power supply circuit of the present invention is described in reference to Fig. 1. (1) When the local power supply to the network terminal device 2 to which the digital subscriber line 3 is connected is shut down, low-voltage power is supplied to the digital subscriber line 12 in the power supply circuit whereby station power supply occurs via the digital subscriber line 12, and a loop detection part 4 is provided that detects the DC loop formed by stoppage of local power supply for the network terminal device, and a power supply voltage switching part 5 is provided that switches to a high-voltage power supply when the DC loop of the network terminal device 2 is detected by the loop detection part 4. For example, the power supply voltage switching part 5 is switched to $V_2 = -48$ V and power is supplied during local power supply, whereas switching to $V_1 = -120$ V occurs and power is supplied during stoppage of the commercial AC power source.

(0008) (2) A configuration may be used in which the loop detection part 4 supplies low-voltage power to the digital subscriber line 12, and is constituted by a current detection part that detects current flowing to the DC loop formed as a result of stoppage of the local power supply of the network terminal device 2. The network terminal device 2 detects stoppage of power from the commercial AC power supply 11 via the power stoppage detection part 10, the contact breaker point 8 is turned ON, and a DC loop is formed via the phantom power supply part 9. Consequently, the DC loop is detected by the loop detection part 4 of the power supply circuit 1 that supplies low-voltage power to the digital subscriber line 12, and the supply is switched to high-voltage power supply by the power supply voltage switching part 5.

(0009) (3) A configuration may also be used in which the loop detection part 4 supplies low-voltage power via the constant-current circuit to the digital subscriber line 12 connected to the network terminal device 2, and the DC loop formed due to stoppage of local power supply of the network terminal device 2 is detected based on the current flowing to the constant-current circuit.

(0010) (4) A configuration may also be used in which the loop detection part 4 supplies low-voltage power via a constant-current circuit to the digital subscriber line 12 connected to the network terminal device 2, and the DC loop formed due to stoppage of the local power supply of the network terminal device 2 is detected based on the voltage at the two terminals of the constant-current circuit.

(0011) (5) A configuration may also be used in which the loop detection part 4 supplies low-voltage power via a constant-current circuit to the digital subscriber line 12 connected to the network terminal device 2, and the DC loop formed by stoppage of the local power supply of the network terminal device 2 is detected based on the decrease in line voltage of the digital subscriber line 12.

(0012) (6) First and second current detection parts may be provided that detect respective currents flowing in the RING line and TIP line of the digital subscriber line 12, and a power supply voltage switching part 5 may be provided that detects the difference in detected current in the first and second current detection parts, determines that there has been a ground or contact fault when this differential exceeds a set value, and switches the power supply voltage supplied to the digital subscriber line 12 to a low voltage.

(0013) (7) First and second current detection parts may be provided that detect respective currents flowing in the RING line and TIP line of the digital subscriber line 12, and a power supply voltage switching part 5 may be provided that detects the difference in detected current in the first and second current detection parts, switches the power supply voltage supplied to the digital subscriber line 12 to low voltage when the difference exceeds a first set value, and blocks the power supply voltage of the digital subscriber line 12 when the difference between the first and second current detection parts exceeds a second set value when switched to this low voltage.

(0014) (8) First and second constant-current circuits may be provided that supply respective constant currents to the RING line and TIP line of the digital subscriber line 12; first and second voltage detection parts may be provided that detect voltages at the two terminals of the first and second constant-current circuits; and a power supply voltage switching part may be provided that detects the difference in detected voltage in the first and second voltage detection parts, determines that a ground or contact fault has occurred when this difference exceeds a set value, and switches the power supply supplied to the digital subscriber line 12 to a low voltage.

(0015) (9) First and second constant-current circuits may be provided that supply constant current respectively to the TIP line and RING line of the digital subscriber line 12; first and second voltage detection parts may be provided that detect the voltages at the two terminals of said first and second constant-current circuits; and a supply voltage switching part may be provided that detects the difference in detected voltages from said first and second voltage detection parts, switches the voltage supplied to said digital subscriber line 12 to a low voltage when said difference exceeds a first set value, and blocks the voltage supplied to said digital subscriber line 12 when the difference in the voltages detected by said first and second voltage detection parts exceeds a second set value when switched to the low voltage.

(0016)
(Embodiments of the Invention) Fig. 1 is an explanatory diagram that describes the principle of the present invention. 1 denotes a power supply circuit for a switching station, 2 denotes a network terminal device (NT1), 3 denotes a subscriber terminal (DTE), 4 denotes a loop detection part, 5 denotes a power supply voltage switching part, 6 denotes a communications transformer, 7 denotes a capacitor for DC blocking, 8 denotes a contact breaker point for forming a DC loop, 9 denotes a phantom power supply part, 10 denotes a power stoppage detection part, 11 denotes a commercial AC power source, 12 denotes a digital subscriber line, and 13 denotes a zener diode used for protection.
(0017) The network terminal device 2 contains transformers and the like for communication, as with conventional examples, but these are not included in the diagram. In addition, power is supplied to the subscriber terminal 3 from a phantom power supply part 9. In addition, with the contact breaker point 8 ON, a DC loop is formed with the power supply circuit 1 via the inner part of the phantom power supply part 9 when power stoppage of the commercial AC power source 11 has been detected by the power stoppage detection part 10. A DC circuit is shown based on resistance and inductance for the interior of the phantom power supply part 9, and the zener diode 12 is used for protection from over-voltage.
(0018) With the power supply circuit 1, a power supply voltage switching part 5 that switches the high-voltage V_1 of −120 V and low voltage V_2 of −48 V and a loop detection part 4 that detects the DC loop of the network terminal device 2 are provided, and the power supply voltage switching part 5 supplies power to the digital subscriber line 12 with the low voltage V_2 supplied at −48 V when no DC loop is detected from the loop detection part 4, specifically, when local power supply is occurring. Consequently, when leak current or the like is negligible in the digital subscriber line 12 that runs into the home of the subscriber, a 48 V line voltage or voltage to ground is produced, and thus safety can be ensured.
(0019) When the contact breaker point 8 is turned ON due to detection of stoppage of the commercial AC power supply 11, specifically, due to stoppage of the local power supply to the network terminal device 2, a DC loop is formed, and current is supplied to the digital subscriber line 12 that is being supplied with low-voltage power V_2 of −48 V. This is detected by the loop detection part 4, and the power supply voltage switching part 5 is controlled and is switched to the high voltage power supply V_1 of −120 V. By this means, it is possible to supply the desired current from the power supply circuit 1 of the switching station to the network terminal device 2.
(0020) Consequently, when local power supply is occurring, low voltage is supplied to the digital subscriber line 12, and thus safety can be improved. In addition, when local power supply is stopped, high-voltage is supplied to the digital subscriber line 12, thereby allowing the desired power to be supplied from the station. In addition, the voltage to ground or line voltage of the digital subscriber line 12 that leads into the home of the subscriber in this case drops to less than 80 V due to the decrease in voltage of the digital subscriber line 12 resulting from the power supply current.
(0021) Fig. 2 is an essential explanatory view of a first embodiment of the present invention. The same symbols as in Fig. 1 denote the same parts. 21a and 21b denote constant-current circuits, 22a and 22b denote current detection parts, and 23a and 23b denote contact breaker points. Diagrams of the power stoppage detection part or the communication trunk of the network terminal device 2 and other such components are not presented. A situation similar to that shown in Fig. 1 occurs at the point when a DC loop is formed with respect to the power supply circuit 1, with the contact breaker point 8 ON resulting from detection of a local power supply stoppage due to stoppage of the commercial AC power supply 11.
(0022) The constant-current circuits 21a and 21b of the power supply circuit 1 have a configuration whereby control occurs so that a constant current is supplied during station power supply to the network terminal device 2 via the digital subscriber line 12. The constant current supply can utilize various configurations that are already known. The current detection parts 22a and 22b supply low voltage power of $V_2 = -48$ V to the digital subscriber line 12, and the loop current flowing at the time of DC loop formation of the network terminal device 2 is detected. The contact breaker points 23a and 23b turn ON, and the voltage is switched from low voltage power supply to high voltage power supply.
(0023) When the commercial AC power supply 11 is restored, local power supply is restarted, the contact breaker point 8 is turned ON, and current flows to the constant-current circuits 21a, 21b of the power supply circuit 1. Consequently, the contact breaker points 23a, 23b turn OFF, the high voltage power supply is switched to low voltage power supply, and the current detection parts 22a and 22b return to their initial states. Specifically, the current detection parts 22a, 22b correspond to the loop detection part 4 in Fig. 1, and the constant-current circuits 21a, 21b and the contact breaker points 23a, 23b correspond to the power supply voltage switching part 5 of Fig. 1. The contact breaker points 8, 23a and 23b can be configured with FETs and other transistors, relays, photocouplers, and the like.
(0024) Fig. 3 is a circuit diagram showing the essential parts of the first embodiment of the present invention, and shows constant-current circuits 21a, 21b, the current detection parts 22a, 22b and the contact breaker points 23a, 23b of Fig. 2 as circuits. 24a and 24b denote transistors, 25a and 25b denote operational amplifiers, 26a and 26b denote photocouplers, 27a and 27b denote phototransistors, 28a and 28b denote light-emitting diodes, and R1 to R7 denote resistors.
(0025) The constant-current circuits 21a and 21b in Fig. 2 are composed of transistors 24a, 24b and operational amplifiers 25a, 25b. The current detection parts 22a, 22b are composed of resistors R2, R6 and light-emitting diodes 28a, 28b. The contact breaker points 23a, 23b are composed of phototransistors 27a, 27b of photocouplers 26a, 26b.
(0026) When the commercial AC power supply 11 is operating normally, and the local power supply is being supplied to the network terminal device 2, the contact breaker point 8 is OFF, and low voltage V_2 of −48 V is applied to the digital subscriber line 12 via the resistors R2, R6 and the light-emitting diodes 28a, 28b of the photocouplers 26a, 26b. However, no current flows because a DC loop is not formed in the network terminal device 2, and the light-emitting diodes 28a and 28b do not light. Consequently, the phototransistors 27a and 27b are in an OFF state. Specifically, contact breaker points 23a and 23b in Fig. 2 are in an OFF state, and low voltage is supplied to the digital subscriber line 12. The voltage to ground or the line voltage of the digital subscriber line 12 that runs into the home of the subscriber is thus at approximately 48 V, allowing safety to be ensured.

(0027) When the commercial AC power source 11 is stopped and the local power supply is stopped, the contact breaker point 8 turns ON and a DC loop is formed via the phantom power supply part 9. Current thus flows to the light-emitting diodes 28a and 28b of the photocouplers 26a and 26b, the diodes light, and the phototransistors 27a and 27b are thus turned ON. Consequently, high voltage V_1 of −120 V is supplied to the digital subscriber line 12, and the current of the station power supply in this case is controlled at a constant current by the constant-current circuit consisting of the transistors 24a, 24b and the operational amplifiers 25a, 25b. In this case, the voltage to ground or the line voltage of the digital subscriber line 12 that runs into the home of the subscriber can be decreased so that it is less than 80 V, including the voltage drop of the digital subscriber line 12 and the voltage drop of the transistors 24a, 24b (constant-current circuit).

(0028) In addition, a series circuit is formed with the resistor R2 and light-emitting diode 28a parallel to the series circuit of the transistor 24a, the resistor R1 and the phototransistor 27a. Similarly, a series circuit formed from the resistor R6 and the light-emitting diode 28b is connected in parallel with the series circuit of the transistor 24b, the resistor R5 and the phototransistor 27b. Thus, when a DC loop is formed during supply of high-voltage power, a configuration can be produced where current flows continually to the light-emitting diodes 28a, 28b, so that the ON condition of the phototransistors 27a, 27b is maintained.

(0029) When stoppage of the commercial AC power supply 11 is restored and local power supply is reinitiated, the contact breaker point 8 turns OFF and current to the digital subscriber line 12 decreases to zero. Consequently, emission of the light-emitting diodes 28a, 28b of the photocouplers 26a, 26b stops, and the phototransistors 27a, 27b assume an OFF condition. Switching is thus carried out to change the power supply voltage from a high voltage V_1 of −120 V to a low voltage V_2 of −48 V.

(0030) Fig. 4 is an explanatory diagram of the essential components of a second embodiment of the present invention. In the embodiment of Fig. 2, a case is presented that involves a configuration in which loop current flowing to both the TIP line and RING line of the digital subscriber line 12 is detected, and the DC loop of the network terminal device 2 can be detected based on detection of current flowing only to the RING line.

(0031) Consequently, this corresponds to a configuration for the second embodiment in which the current detection part 22b and the contact breaker point 23b are omitted in the first embodiment. During local power supply to the network terminal device 2, the contact breaker point 23a is switched to a low voltage V_2 of −48 V, and low voltage is supplied to the digital subscriber line 12 via the constant-current circuits 21a, 21b, but the contact breaker point 8 of the network terminal device 2 is OFF, so current does not flow to the constant-current circuits 21a, 21b.

(0032) The current detection part 22a is controlled so that the contact breaker point 23a is switched to the high voltage V_1 of −120 V when current flowing to the constant-current circuit 21a is detected, and current does not flow to the digital subscriber line 12 during local current supply, so a low voltage power supply condition is produced. Next, upon shut-down of local power supply, the contact breaker point 8 is turned ON, and a DC loop is formed, so that current flows to the digital subscriber line 12 via the constant-current circuits 21a, 21b. When this current is detected by the current detection part 22a, the contact breaker point 23a is switched to the high voltage V_1 of −120 V. High voltage is thus applied to the digital subscriber line 12, and the desired power is supplied to the network terminal device 2.

(0033) Fig. 5 is an explanatory diagram of the essential components of a third embodiment of the present invention. The same symbols in Fig. 2 and Fig. 4 denote the same parts. 31a and 31b are voltage detectors and 32 is a contact breaker point. In this embodiment, the voltages at both terminals of the constant-current circuits 21a and 21b are detected by the voltage detection parts 31a and 31b, the DC loop of the network terminal device 2 is detected, and thus the contact breaker point 8 is OFF during local power supply of the network terminal device 2. Thus, a DC loop is not formed from the side of the power supply circuit 1, and current does not flow to the digital subscriber line 12 via the constant-current circuits 21a, 21b. The voltages at both terminals of the constant-current circuits 21a, 21b are thus 0 or values close to zero.

(0034) Consequently, in this state, the contact breaker point 32 is switched to the low voltage V_2 of −48 V, and low voltage power supply is supplied to the digital subscriber line 12. The contact breaker point 8 is thus turned ON as a result of shut-down of local power supply to the network terminal device 2, and a DC loop is formed from the standpoint of the power supply circuit 1. Consequently, current flows to the digital subscriber line 12 via the constant-current circuit 21a, 21b, and a voltage is seen on both terminals of the constant-current circuits 21a, 21b.

(0035) When the voltage is at or above a set value, the voltage detection parts 31a, 31b detect loops, the contact breaker point 32 is switched to the high voltage V_1 of −120 V, and supply of high voltage to the digital subscriber line 12 is performed. As a result, the power supply voltage of the digital subscriber line 12 during local power supply is low, which improves safety, whereas the power supply voltage is high during local power supply stoppage, which allows the desired power to be supplied.

(0036) The contact breaker point 8 turns OFF as a result of restarting of the local power supply, and, after the current that flows to the digital subscriber line 12 goes to zero, the voltage at the two terminals of the constant-current circuits 21a, 21b becomes zero or a value close to zero. Consequently, the voltage detection parts 31a, 31b control the contact breaker point 32 so that it is switched from the high voltage V_1 of −120 V to the low voltage V_2 of −48 V.

(0037) Fig. 6 is an explanatory diagram of the essential components of a fourth embodiment of the present invention. The same symbols as in Fig. 5 denote the same parts. 34 denotes a

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