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(54) **Power supply device for cold-cathode discharge lamps**

(57) A power supply device (1) for cold-cathode discharge lamps, constituted by a unit (2) for conversion from alternating-current mains voltage to direct current with voltage reduction, and by a distribution unit (12) which supplies power to one or more inverters (16) suit-

able to convert from low-voltage DC to high-voltage AC one or more cold-cathode discharge lamps (13). Appropriate devices (28) are also provided for diagnostics, programming, functional testing, any ground leakage, and identification of failure of the individual lamp.

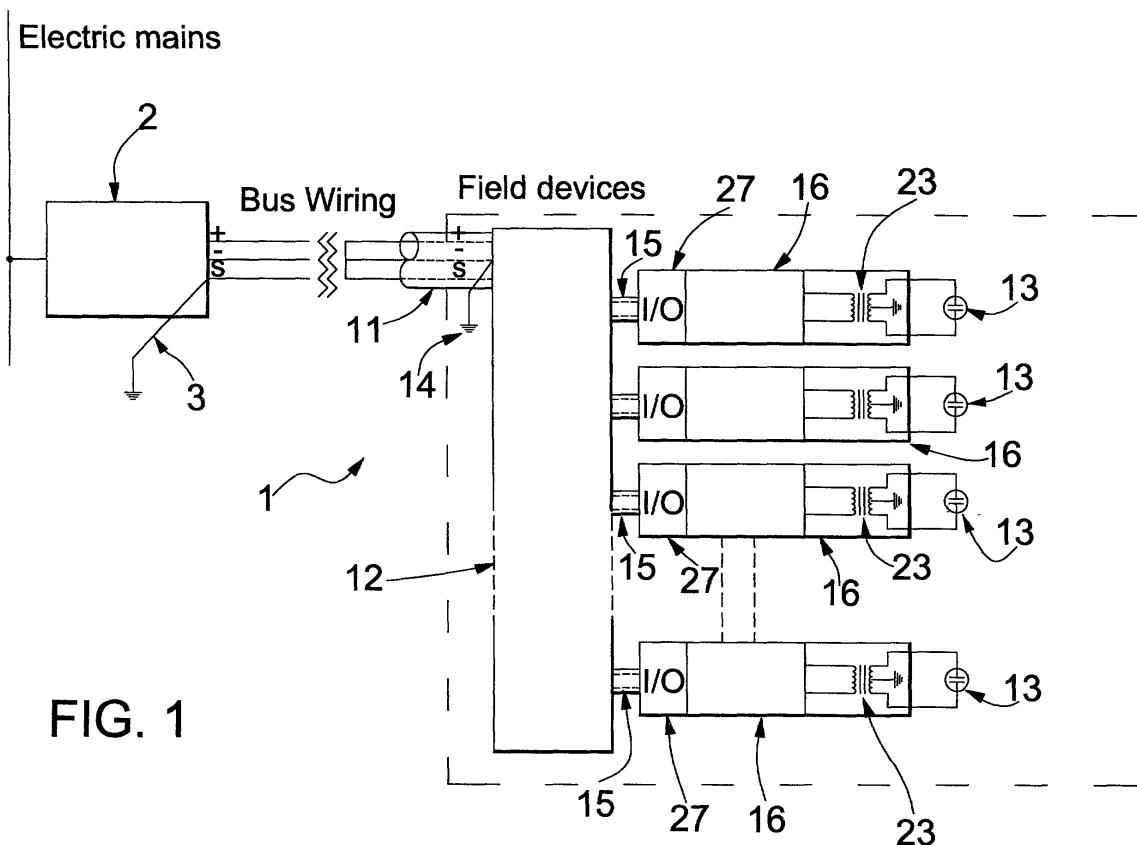


FIG. 1

Description

[0001] The present invention relates to a power supply device for cold-cathode discharge lamps, particularly discharge lamps based on noble gases such as argon, krypton, helium, xenon, with the possible addition of mercury vapors.

[0002] This type of lamp, which can be used for example to produce illuminated signs, billboard advertisements and road signs, requires a high-voltage power supply for its ignition; this fact requires particular measures for insulating the electric circuit.

[0003] Currently, power is supplied to cold-cathode discharge lamps connected in series by using devices of a known type which are usually constituted by 50/60 Hz transformers, inverters and high-frequency electronic conversion units, which require the use of special cables governed by a specific European standard (EN 50143) and for which length limitations are set as recommended by the EN 50107 standard at installation time.

[0004] The use of said special cables of a known type, however, does not eliminate the common problems due to the use of high voltages, i.e., problems in terms of radio interference and noise, the risk of discharge with consequent fire, and cable hum.

[0005] These drawbacks, which are due to the use of high voltages, are worsened by the custom of saving on installation costs by reducing the number of power supplies used by series-connecting two or more lamps, with a consequent increase in the ignition voltage.

[0006] In this manner, the required power supply voltage can reach almost 10,000 volts in Europe and 15,000 volts in other countries, with a considerable risk of fire and electrocution in case of accidental fault or during maintenance.

[0007] Another drawback due to the use of these known kinds of device is the fact that said special cables have dimensions such as to render them difficult to conceal and have an unpleasant aesthetic impact.

[0008] Furthermore, the EN 50107 standard prescribes the installation of safety modules protecting against any ground discharges and against the opening of the high-voltage circuit.

[0009] This entails two different types of execution: a first one, in which a respective safety module is associated with each power supply, with an evident increase in system costs, and a second one, in which a single safety module is installed for multiple power supplies, with the drawback that the failure of a single power supply switches off all the lamps and makes it difficult to locate the fault.

[0010] US Patent no. 5,814,938 is known which discloses a power supply for cold-cathode lamps comprising a control device, for modulating the mains current into a high-frequency low-voltage signal, with which a voltage booster is associated, said booster sending the required high-voltage current to the cold-cathode lamp.

[0011] Said voltage booster is advantageously arranged inside the lamp proper.

[0012] The control device can have multiple outputs for connecting a corresponding number of voltage boosters, each accommodated within, or proximate to, a respective cold-cathode lamp.

[0013] One drawback of this known type of power supply consists in that power is supplied individually to each voltage booster, thus entailing a number of power supply cables which is equal to the number of lamps used, leading to very high production and installation costs.

[0014] Another drawback of known types is due to the fact that since the control device has to adjust not only the voltage but also the frequency of the signal, it is particularly delicate and complicated.

[0015] Furthermore, the use of many cables increases aesthetic damage, EMC (electromagnetic compatibility) pollution, and problems in parasitic capacitances caused by installation.

[0016] The aim of the present invention is therefore to solve the above noted technical problems, eliminating the drawbacks of the cited known art by providing an invention which allows to obtain a power supply device for cold-cathode discharge lamps which operates mainly at low voltage, thus avoiding problems in terms of radio noise, interference and cable hum, and most of all reducing considerably the risks of discharge and consequent fire.

[0017] Within this aim, an object is to provide an invention which allows to reduce the dimensions of the power supply of each lamp, increasing the pleasantness and aesthetic impact of the installation.

[0018] Another object is to provide an invention which allows to reduce the number of parts to be manufactured and held in stock, with a consequent great reduction in production and inventory costs.

[0019] Another object is to provide an invention which is highly flexible and versatile in installation and ensures at the same time considerable ease and speed in producing said installation.

[0020] Another object is to provide an invention which comprises units which provide for diagnostics, programming and safety of the circuit in a simple and efficient manner.

[0021] Another object is to provide an invention which is structurally simple and has low manufacturing costs.

[0022] This aim and these and other objects will become better apparent hereinafter are achieved by a power supply device for cold-cathode discharge lamps, characterized in that it is constituted by a unit for conversion from alternating-current mains voltage to direct current with voltage reduction, by a distribution unit which supplies power to one or more inverters suitable to convert from low-voltage DC to high-voltage AC one or more cold-cathode discharge lamps, devices being provided for diagnostics, programming, functional testing, any ground leakage, and identification of failure of

individual lamp circuits.

[0023] Further characteristics and advantages of the invention will become better apparent from the detailed description of a particular embodiment thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a block diagram of an embodiment of the invention;

Figure 2 is a block diagram of the conversion unit;

Figure 3 is a block diagram of a detail of the conversion unit of Figure 2;

Figure 4 is a schematic view of the distribution unit;

Figure 5 is a block diagram of an inverter;

Figure 6 is a block diagram of a detail of the inverter of Figure 5.

[0024] With reference to Figure 1, the numeral 1 designates a power supply device for cold-cathode discharge lamps, particularly for discharge lamps based on noble gases such as argon, krypton, helium, xenon, optionally with the presence of mercury vapors.

[0025] The power supply device 1 comprises a conversion unit 2, also known as console, which is arranged in a location that can be accessed easily by the user, is appropriately connected to the mains, and is suitable to convert the mains voltage into direct current and lower said voltage.

[0026] The console 2 is provided with a first main grounding device of a known type, designated by the reference numeral 3 and usually connected to the ground system, and comprises at least one power supply unit 4, which optionally has means for connection to one or more auxiliary batteries, designated by the reference numeral 5, or to other similar power supply units 4.

[0027] The power supply units 4 are connected to a first control logic module or unit, designated by the reference numeral 6, which is adapted to process and send signals between a user interface 7 and a data transceiver system, also known as Tx/Rx system, designated by the reference numeral 8.

[0028] The user interface 7 can advantageously have a keypad with buttons for entering data, can optionally have a monitor, for example a liquid-crystal display, also known as LCD, for the onscreen display of data, and optionally a port for connection to an external modem, for example a serial port of the type known as RS232 or RS422 or other devices for interfacing with the user.

[0029] As shown in Figure 3, the Tx/Rx system 8 is constituted by two separate units, i.e., a first modulator 8a and a first demodulator 8b, which are respectively connected to a first transmitter or transmission coupling 9a and to a first receiver coupling 9b which are mutually separate; in Figure 2, said couplings have been combined, for the sake of simplicity, into a single block which constitutes a transceiver coupling, designated by the reference numeral 9.

[0030] The Tx/Rx system 8 preferably has a high im-

pedance at its operating frequency, so that data transmission has a low absorption.

[0031] A data carrier block, designated by the reference numeral 10, is arranged between the power supply unit 4 and the first Tx/Rx coupling 9, and is suitable to filter the input signal, preventing it from entering the power line.

[0032] At the output, said console 2 has a single first cable, designated by the reference numeral 11, which is of the two-pole type or optionally of the single-pole type if the electric ground cable is used for the return.

[0033] Said first cable 11 is suitable to transmit the low-voltage DC output signal to a distribution unit 12 which is arranged proximate to, or in the vicinity of, one or more cold-cathode lamps 13 (multiple lamps can be arranged in series) and therefore for example, in the case of use as illuminated signs, on the roof of a building or on a terrace.

[0034] The distribution unit, shown in detail in Figure 4, has an optional second grounding device, designated by the reference numeral 14, and is substantially constituted by one or more second power supply cables 15, each of which is connected in parallel to the first cable 11 which carries the DC signal.

[0035] Each one of said second cables 15 supplies an inverter, designated by the reference numeral 16, which is suitable to convert the low-voltage DC input current into a high-voltage AC output current, suitable to supply said cold-cathode lamps 13 (only one whereof is shown schematically in Figure 1).

[0036] The inverters 16 are preferably of the self-regulating type for all the lamp circuits that require less power than their nominal power, providing them with the exact potential that they require.

[0037] Figure 5 illustrates one of said inverters 16, which advantageously comprises a transceiver bus communications module, designated by the reference numeral 17, which is also known as Tx/Rx bus communications module.

[0038] Said bus communications module 17 is constituted by a second modulator and a second demodulator, designated by the reference numerals 18a and 18b, with which a second Tx coupling 19a and a second Rx coupling 19b are respectively associated.

[0039] The bus communications module 17, which receives the signal on a DC carrier from said second cable 15, is controlled by a second control logic module, designated by the reference numeral 20.

[0040] Downstream of said second bus communications module 17 there is a filter 21 which is suitable to eliminate or at least reduce the feedback (harmonic components introduced in the mains or conducted) on the AC line, thus limiting the presence of background noise and other noise, according to EMC directive 89/336 and the standards associated thereto.

[0041] Said filter 21 is connected to a device for switching the current from AC to DC, which is driven by a circuit which is commonly known as a driver and is

designated by the reference numeral 22, in order to send the DC current to a transformer 23, which raises the voltage to the values required by the associated cold-cathode lamp 13.

[0042] The inverter 16 is further provided with a third grounding device, designated by the reference numeral 24, which is advantageously arranged at entry of the second cable 15 in said inverter 16; conveniently, there is also a fourth grounding device 25 which is connected to the transformer 23.

[0043] Each inverter is further provided with an internal identification number 26, which is stored in the memory of said inverter 16, and with an input/output interface (input/output of data from and to the console 2), designated by the reference numeral 27, so that it is possible to switch on and off each individual lamp 13 in a fully independent manner.

[0044] The first control logic module 6, the data transceiver system 8, and the first Tx/Rx coupling 9 constitute a set of units or devices, designated by the reference numeral 28, which performs a diagnostic function on the entire power supply device 1, checking the operating status of each power supply unit 4 and of each inverter 16.

[0045] In particular, the status of each one of the inverters 16, which are distinguished from each other by means of the identification numbers 26, is managed on the basis of a continuous and mutual exchange of data, which occurs along said first cable between the I/O interface 27 and the console 2.

[0046] Said set of units or devices 28 also manages the programming, functional testing, any ground leakages and failure identification of each individual lamp 13.

[0047] The frequency used as a carrier is preferably chosen very low with respect to the operating frequency of the inverters 16, so as to minimize the electromagnetic emissions and the noise generated by said inverters 16.

[0048] Operation is therefore as follows: with reference to Figure 1, the current drawn from the mains is converted in the conversion unit 2 into a low-voltage direct current and from there is sent, by means of the first cable 11, to the distribution unit 12, which is arranged proximate to the discharge lamps 13.

[0049] Multiple second cables 15, one for each lamp circuit, branch out from the distribution unit in order to send the electrical signal to the inverters 16, in which said signal is converted into a high-frequency AC signal and sent to the respective lamps.

[0050] By means of the keypad and the display connected to the user interface 7, the user can perform control, programming and diagnostics of the power supply device 1.

[0051] It is further possible to control the power supply unit, reset the protections both automatically and manually, and control and test the system for communication between the console, the distribution unit and the con-

version units.

[0052] By means of the RS232 serial port or equivalent port it is possible to perform remote control of the power supply device 1 by means of an external computer and to perform remote control of the inverters 16, and perform system diagnostics or specific programming.

[0053] It is further possible to perform remote servicing over telephone lines in order to check the operating status of the entire power supply device 1, perform remote programming of the power-on and power-off sequences of the lamps 16, as well as synchronize a sequence with a particular time reference.

[0054] It has thus been found that the invention has achieved the intended aim and objects, a power supply device for cold-cathode discharge lamps having been provided which, by operating mainly with a low-voltage direct-current signal, avoids the usual problems of radio noise, interference and cable hum, eliminating almost completely the risks of discharge and consequent fire.

[0055] The invention further allows to reduce the size of the power supply of each lamp circuit, because it is sufficient to install an inverter locally: this simplifies installation and most of all considerably increases the aesthetic pleasantness of the discharge lamp.

[0056] Finally, a great reduction in the number and most of all in the type of parts to be manufactured and held in stock has been achieved and installation times also have been reduced.

[0057] The invention is of course susceptible of numerous modifications and variations, all of which are within the scope of the same inventive concept.

[0058] The materials used, as well as the dimensions that constitute the individual components of the invention, may of course be more pertinent according to specific requirements.

[0059] The disclosures in Italian Patent Application No. TV2000A000163 from which this application claims priority are incorporated herein by reference.

[0060] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A power supply device for cold-cathode discharge lamps, **characterized in that** it is constituted by a unit for conversion (2) from mains voltage to direct current with voltage reduction, by a distribution unit (12) which supplies power to one or more inverters (16) suitable to convert from low-voltage DC to high-voltage AC one or more cold-cathode discharge lamps (13), devices (28) being provided for diag-

nostics, programming, functional testing, any ground leakage, and identification of failure of said one or more lamps (13).

2. The device according to claim 1, **characterized in that** said conversion unit (2), also termed console, is preferably located in a place which can be easily accessed by the user and provided with a first grounding device (3), comprises at least one power supply unit (4) which is connected to a first module for a control logic system (6), which is suitable to process and send signals between a user interface (7) and a data transceiver system (8).
3. The device according to claims 1 and 2, **characterized in that** said data transceiver system (8) is conveniently constituted by a first modulator (8a) and a first demodulator (8b) which are respectively connected to a first transmission coupling (9a) and to a first reception coupling (9b) which are preferably mutually distinct.
4. The device according to claims 1 and 3, **characterized in that** a data carrier block (10) is conveniently arranged between said at least one power supply unit (4) and said first transmission coupling (9a) and is suitable to filter the input signal and therefore prevent it from entering the power line.
5. The device according to claim 1, **characterized in that** said conversion unit (2) has, at its output, a single first cable (11) which is preferably of the two-pole type and is suitable to transmit the DC low-voltage signal to said distribution unit (12), which is advantageously located proximate to, or in the vicinity of, said one or more cold-cathode lamps (13).
6. The device according to claims 1 and 5, **characterized in that** said distribution unit (12), optionally provided with a second grounding device (14), comprises one or more second power supply cables (15) which are conveniently connected to each other in parallel to said first cable (11) which carries the DC current signal.
7. The device according to claims 1 and 6, **characterized in that** said one or more inverters (16), supplied by said one or more second supply cables (15), are suitable to convert the low-voltage DC input current into a high-voltage AC output current, which is suitable to supply said one or more cold-cathode lamps (13).
8. The device according to claims 1 and 7, **characterized in that** each one of said inverters (16), advantageously of the self-adjusting type, comprises a transceiver bus communications module (17) which is preferably constituted by a second modulator

(18a) and a second demodulator (18b) with which a second transmitter coupling (19a) and a second receiver coupling (19b) are respectively associated.

9. The device according to claims 1 and 8, **characterized in that** said bus communications module (17) which receives the signal on a DC carrier from said second cable (15) is controlled by a second control logic module (20).
10. The device according to claims 1 and 9, **characterized in that** downstream of said bus communications module (17) there is a filter (21) which is preferably connected to a device for switching the current from DC to AC, which is driven by a circuit commonly known as driver (22), for sending the DC current to a transformer (23) which is suitable to raise the voltage to the values required by said one or more cold-cathode lamps (13).
11. The device according to claims 1 and 10, **characterized in that** said inverter (16), optionally provided with a third grounding device (24), is provided with an internal identification number (26), which is stored in the memory of said inverter (16), and with a data input/output interface (27).
12. The device according to one or more of the preceding claims, **characterized in that** said data input/output interface (27) allows the mutual exchange of information between said inverter (16) and said console (2), so as to allow to control said inverter (16) and test the status and operation of said one or more cold-cathode lamps (13) directly from said console (2).
13. The device according to claim 1 and 12, **characterized in that** said mutual exchange of information between said inverter (16) and said console (2) occurs along said first (11) and second (15), positive and negative, cables automatically and continuously.
14. The device according to claims 1 and 13, **characterized in that** said first control logic module (6), said first data transceiver system (8), said first transmitter coupling (9a) and first data receiver coupling (9b), by being connected by said first (11) and second (15) cables to each one of said inverters (16), constitute a set of units which performs diagnostics on said power supply device, checking the operating status of each one of said inverters (16), which are mutually distinguished by said identification numbers (26), and of said at least one power supply (4).
15. The device according to claims 1 and 14, **characterized in that** said set of units is programmable so

as to allow the user to program each one of said inverters (16) and to check for any ground leakage and locate failures for each circuit constituted by one or more of said lamps (13).

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16. The device according to one or more of the preceding claims, **characterized in that** the frequency used as a carrier is preferably chosen very low with respect to the operating frequency of said one or more inverters (16), so as to minimize electromagnetic emissions and the noise generated thereby.

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17. The device according to one or more of the preceding claims, **characterized in that** said user interface (7) can advantageously have a keypad provided with data entry keys, a monitor and/or a liquid crystal display in order to display the data on the screen and/or a port for connection to an external modem or to other devices for interfacing with the user.

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18. The device according to one or more of the preceding claims, **characterized in that** said at least one power supply unit (4) is provided with means for connection to one or more auxiliary batteries (5) and/or to separate power supply unit (4).

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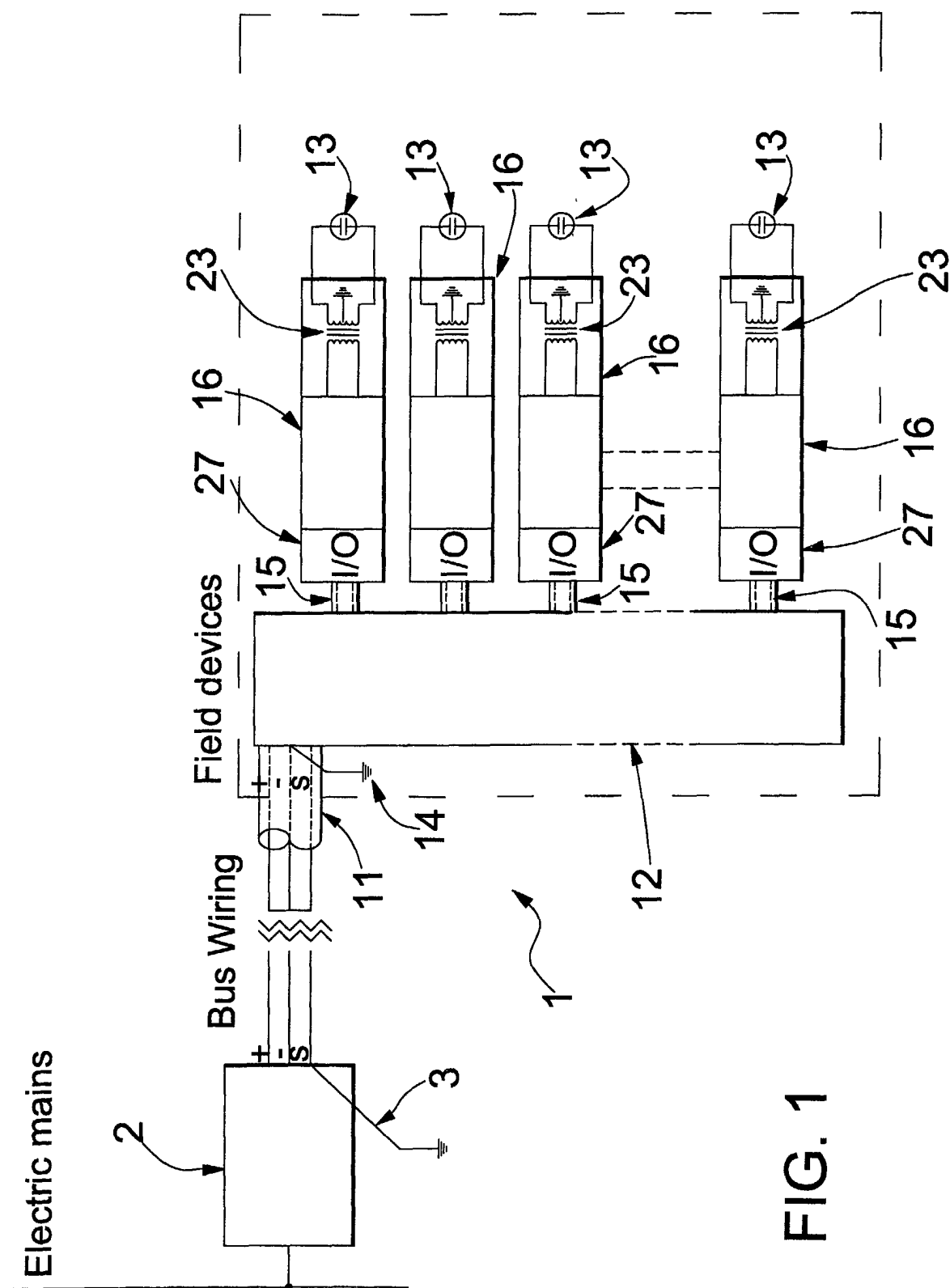
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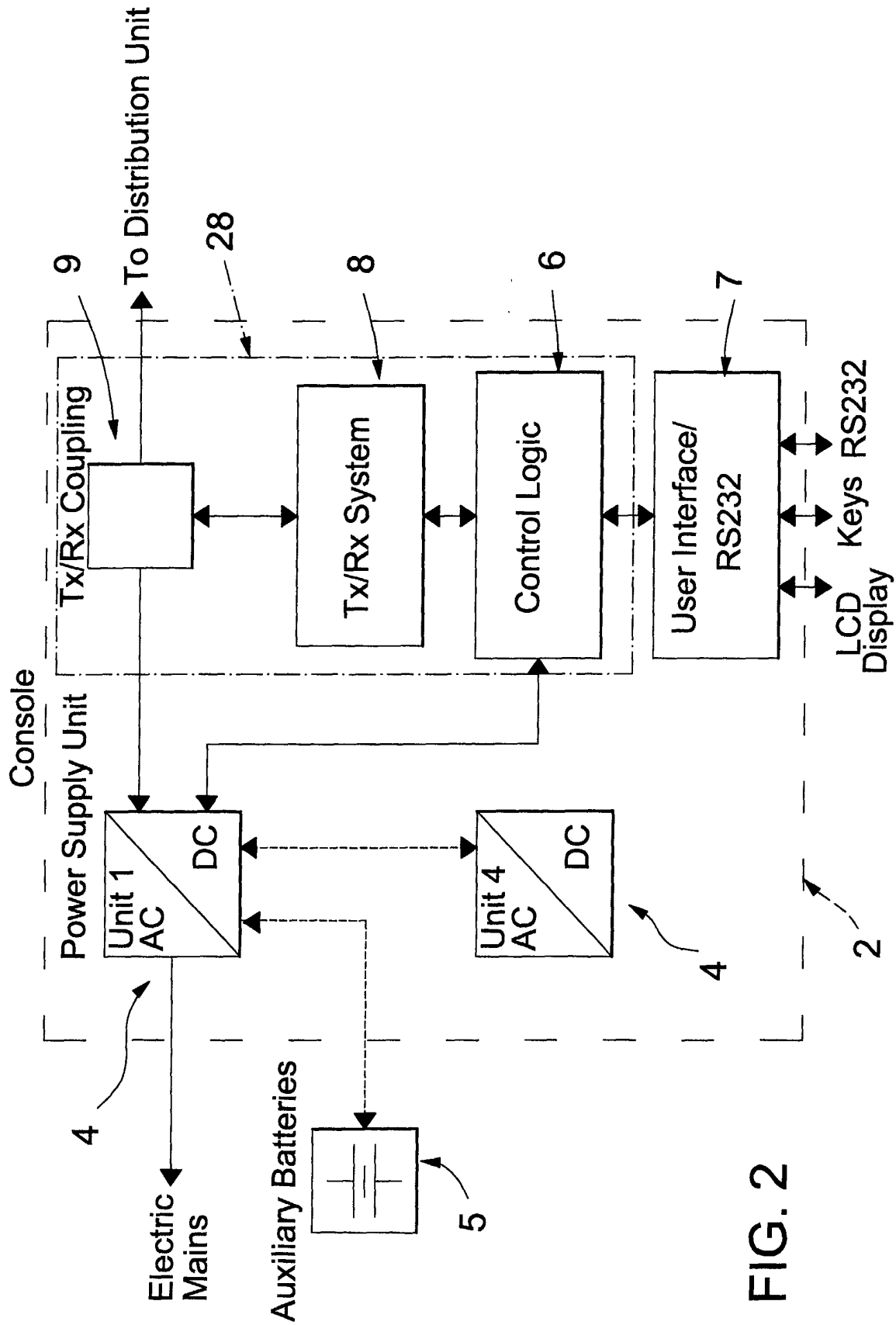
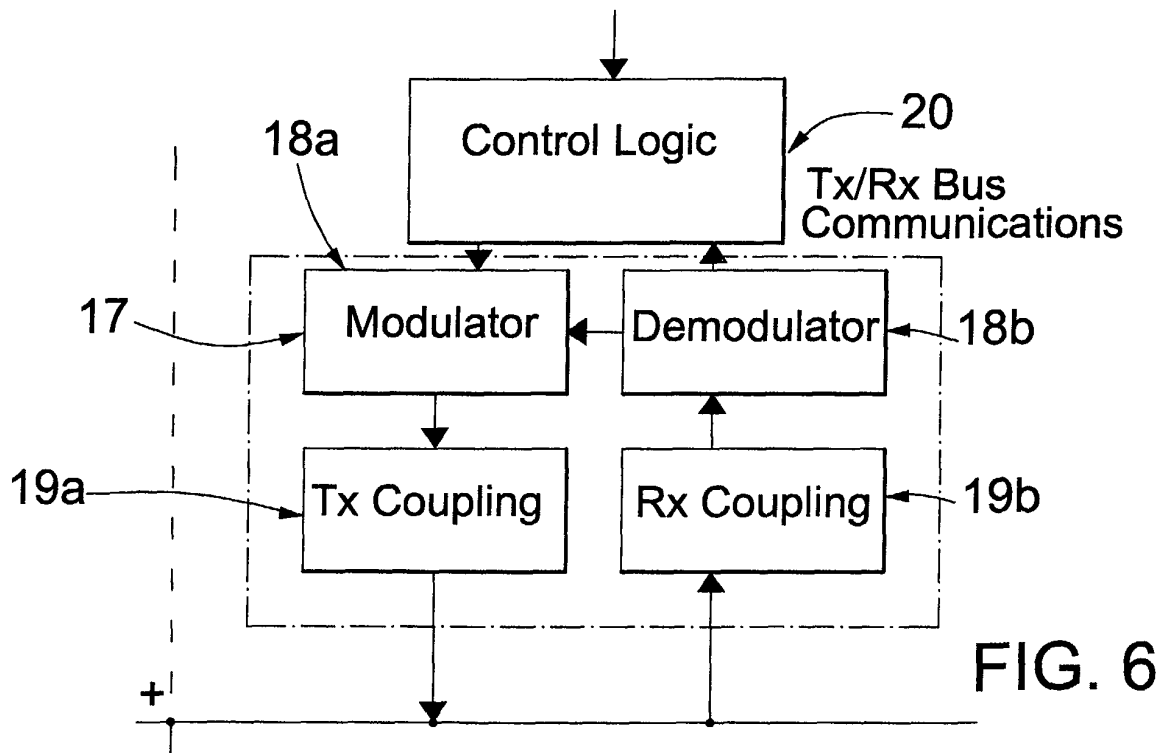
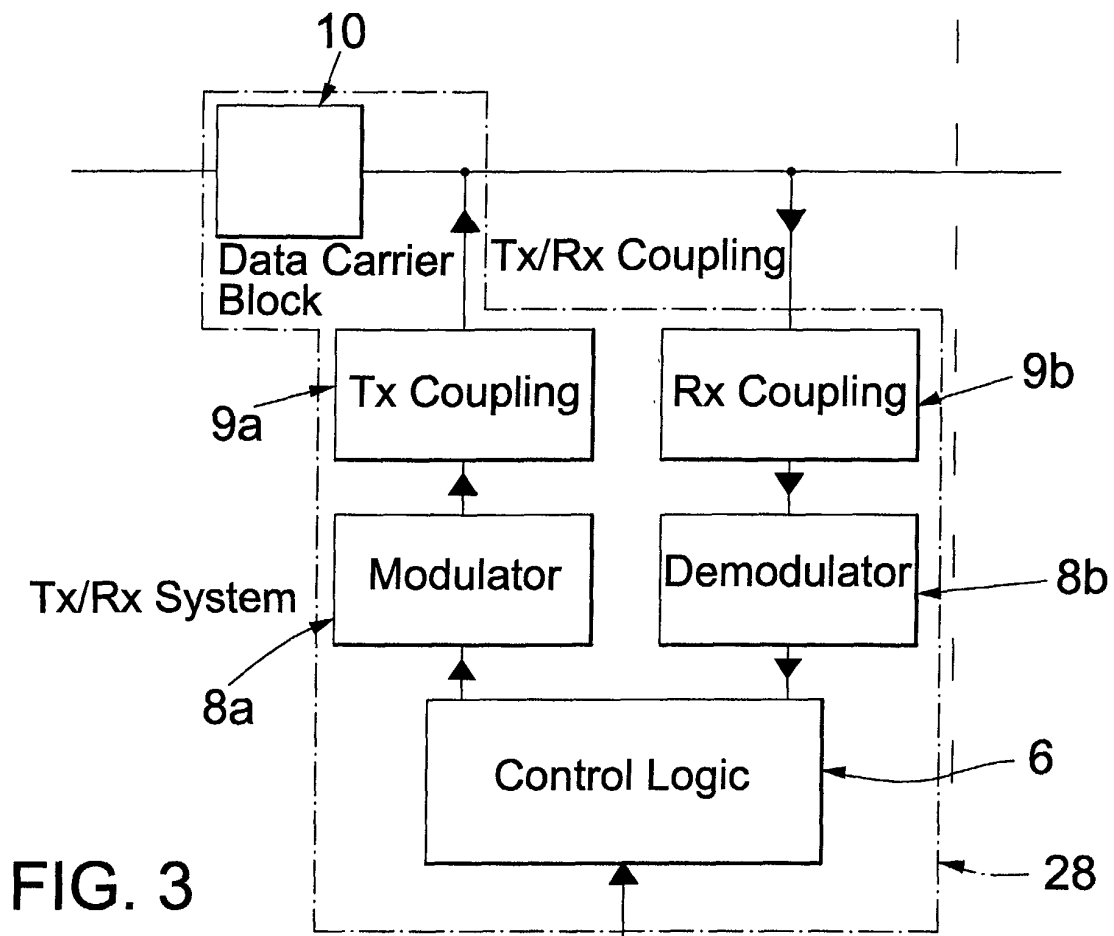


FIG. 2



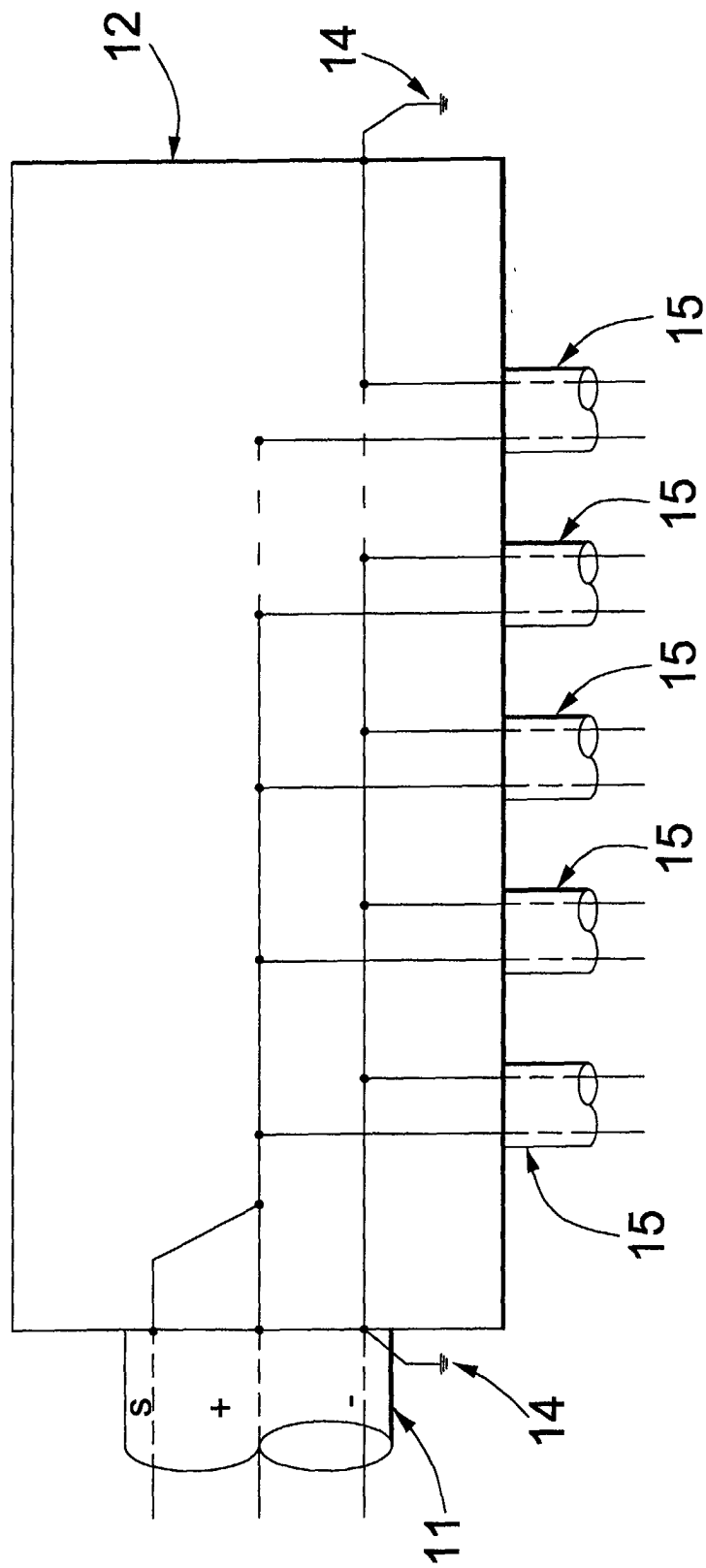


FIG. 4

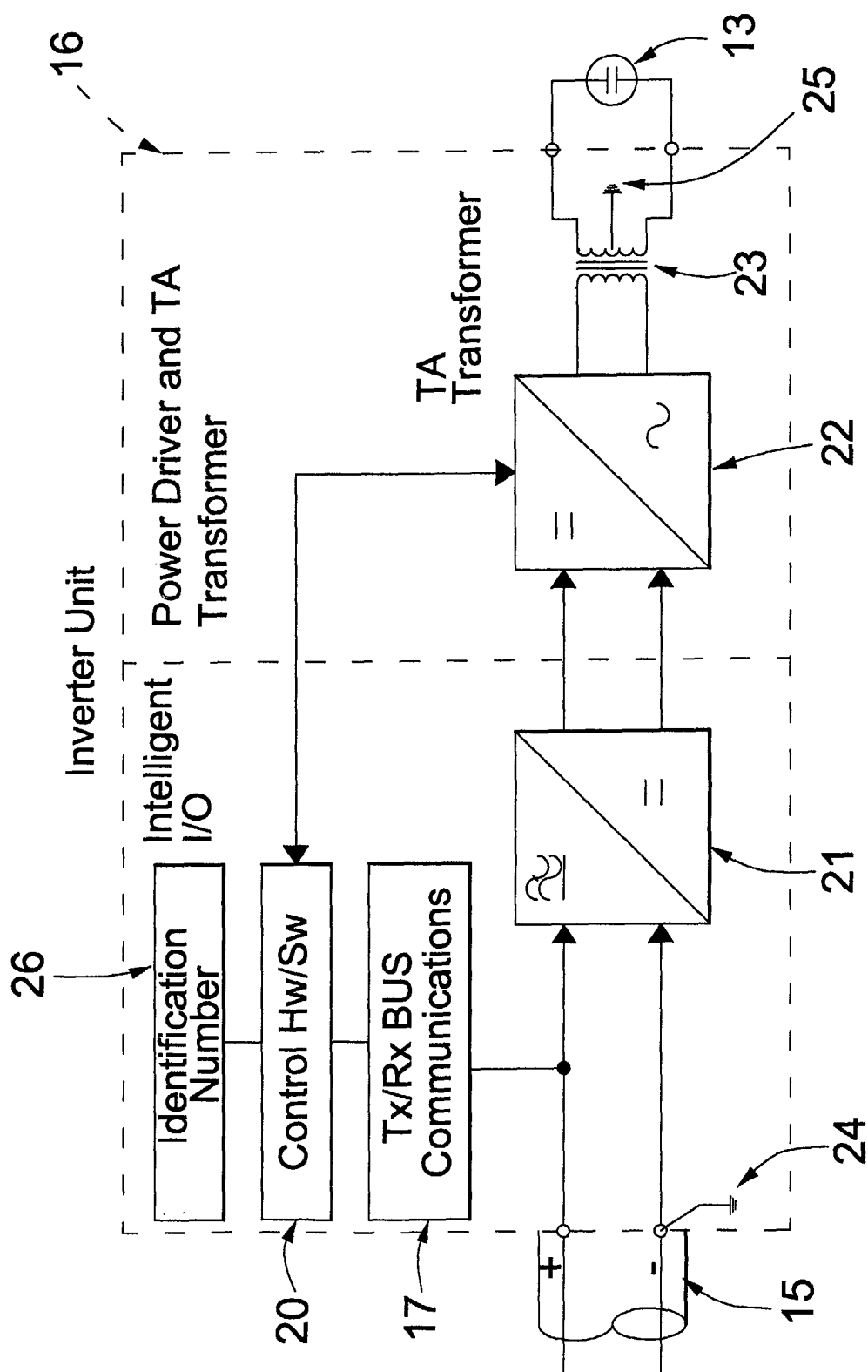


FIG. 5