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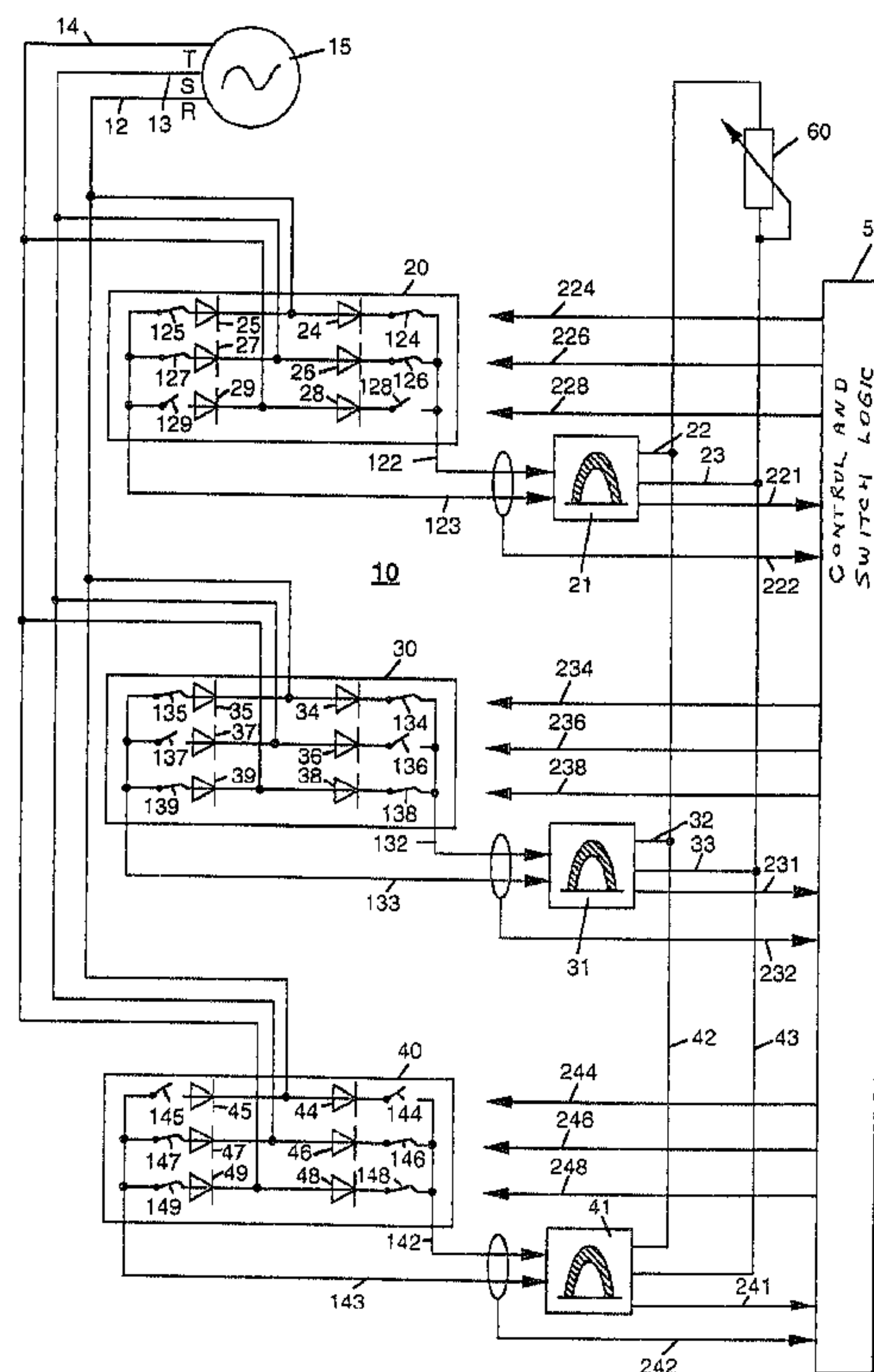
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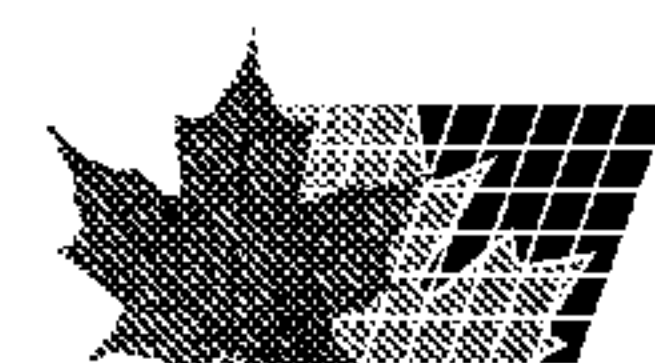
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(57) Abrégé/Abstract:

AC/DC convertor to connect to conductors of a multi-phase AC source and a plurality of parallel to each other power factor correction circuitries. There are as many rectifier circuits independent of each other as there are phases of the AC source. Each rectifier circuit has six rectifier elements connected in pairs to the conductors of the AC source and are commonly connected to the output conductors of the rectifier circuit associated therewith forming bridges. There is at least one switch associated with at least one pair of rectifier elements to separate such pair from the conductor of the AC source. Each rectifier circuit is connected to a power factor correction network. Sensors are used for the functional control of both of the phases of the AC source and the one phase power factor correction network. There is a switch control logic connected with such sensors and which based on the signals from the sensors closes or opens the switches of the rectifier network.



ABSTRACT

AC/DC convertor to connect to conductors of a multi-phase AC source and a plurality of parallel to each other power factor correction circuitries. There are as many rectifier circuits independent of each other as there are phases of the AC source. Each rectifier circuit has six rectifier elements connected in pairs to the conductors of the AC source and are commonly connected to the output conductors of the rectifier circuit associated therewith forming bridges. There is at least one switch associated with at least one pair of rectifier elements to separate such pair from the conductor of the AC source. Each rectifier circuit is connected to a power factor correction network. Sensors are used for the functional control of both of the phases of the AC source and the one phase power factor correction network. There is a switch control logic connected with such sensors and which based on the signals from the sensors closes or opens the switches of the rectifier network.

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AC/DC CONVERTOR

This invention relates to an AC/DC convertor for connection to a multi-phase AC network and to an operating procedure of such convertor.

5 AC/DC convertors for connection to a multi-phase network are known. For example US patent 5,045,991 discloses a convertor which, with the aid of a six-pulse controlled bridge rectifier, rectifies a 3 phase AC current.

10 DE patent 37 38 181 A1 discloses a current rectifier whose output DC current is controlled by a steady in phase switching of six bridge rectifier elements. The difference between the two patents is in the control logic where, especially in the first
15 mentioned patent, the alternating current of the network remains approximately sinusoidal even at varying load.

United States Patent 5,003,453 discloses an AC/DC convertor with equal loading of the three phases of a 3 phase network. This convertor is fed, in one
20 version, by all three phases and in another version with a single one of the three phases of the network three parallel power factor connection circuits. These supply, at their outputs, DC current which is then changed again through a DC/DC convertor for the various loads requested

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by a computer complex. The AC/DC convertor is built
manyfold redundant and is able, during interruption of a
network phrase, or a power factor connection circuit, or
a DC/DC convertor, to deliver the current that is

5 required by the computer. This AC/DC convertor is quite
complicated and specially built to deliver the diverse
loads of a large scale computer, and the computer
operation is mod interrupted even when the convertor
needs to be worked on (repaired).

10 The aim of the present invention consists of
building a regulated, redundant AC/DC convertor for
general usage, which is simple in its structure and which
is independent in its current delivery capability during
considerable interface. Also it should be flexible with
15 respect to its output values.

In keeping with the foregoing there is provided
in accordance with the present invention AC/DC convertor
for connection to the line conductors of a multi-phase AC
supply, which has, as a means of preventing complete
20 outage, a redundant design and loads the AC supply
substantially without non-linear distortion, and where a
plurality of parallel-arranged power factor correcting
circuits are provided, characterized in that provided are
a number of identical rectifier circuits, which are
25 independent of each other and correspond to the number of

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phases of the supply, provided are six rectifying
elements per rectifier circuit, said rectifying elements
being connected in pairs to lines of the supply and in
being connected to output leads of rectifier circuits
5 respectively, form bridges, at least one switch is
provided for each of said rectifier circuits with such
switch or switches operating in conjunction with at least
one pair of rectifying elements and being designed to
separate each respective pair from the circuit of supply
10 to which each such pair is assigned, one single-phase
power factor correcting circuit is arranged downstream of
its respective rectifier circuit, provided are sensors to
monitor operation of the phases of the supply and of
single-phase power factor correcting circuits, and
15 provided is a switch control that is connected via leads
to said sensors and which, depending on the signals from
the sensors, opens or closes the switches of the
rectifier circuits.

The invention is illustrated by way of example
20 in the accompanying drawings wherein:

Figure 1 is a schematic block diagram of an
AC/DC convertor of the present invention for connection
to a three phase network;

Figure 2 illustrates schematically a first
25 variation of the rectifier circuit;

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Figure 3 illustrates schematically a second variation of the rectifier circuit; and

Figure 4 is a block diagram of a control arrangement.

5 Referring to the drawings Figure 1 is a schematic block diagram of an AC/DC convertor 10. This convertor 10 is connected to the three phases 12, 13, 14 of a three-phase network which is represented by the generator 15. Each of the three phases 12, 13, 14
10 connects to a three phase network with phases R, S, T. A neutral phase is not necessary and therefore not shown.

The phases 12, 13, 14 are connected on the primary side and in parallel to three rectifier circuitries 20, 30, 40 which connect to respective ones
15 of one phase power factor correction units 21, 31, and 41.

Outputs 22, 23; 32, 33; and 42, 43 of the respective units 21, 31 and 41 are connected in parallel to a variable load 60, represented as an ohmic resistor.
20 The AC/DC convertor 10 consists further of a control and switch logic 50 which are connected with the DC rectifier circuits 20, 30, 40 and the power factor correction units 21, 31, 41.

The three rectifier circuits 20, 30, 40 are
25 built the same and each contains six rectifiers shown as

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six diodes designated 24-29, 34-39, and 44-49. Each diode is serially associated with a switch and these are designated 124-129, 134-139, 144-149 for the respective rectifier circuits 20, 30 and 40. The diodes and switches of each rectifier circuit 20, 30, 40 are connected in a six-pulse controlled bridge rectifier in pairs to the conductors 12, 13, 14 and in threes via respective connections 122, 123; 132, 133; and 142, 143 to respective power factor correction units 21, 31, 41.

10 In a normal case, i.e. defect free operation, two pairs of switches in each of the respective groups 124-129; 134-139; and 144-149 are closed (i.e. switched for current conduction) in the rectifier circuits 20, 30, 40 and the remaining two switches are open (i.e. no current conduction). The open and closed switches are chosen in such a way that in each rectifier circuit 20, 30, 40 a different open switch is assigned to the conductors 12, 13, 14. In Figure 1 for example, the pair of switches 128, 129 are open in the rectifier circuit 20 and assigned to conductor 14, the pair of switches 136, 137 are open in the rectifier circuit 30 and assigned to conductor 13, and the pair of switches 144, 145 are open in the rectifier circuit 40 and assigned to conductor 12. All other switches are closed. With this arrangement each rectifier circuit 20, 30, 40 works as a one phase

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bridge rectifier that is assigned to one of the phases R, S, T of the three phase AC currents. At the connections 122, 123; 132, 133; and 142, 143 to the respective power factor correction units 21, 31, 41 the voltage has been
5 derived from one phase rectification of a quasi sinusoidal waveform.

The three one-phase power factor correction units 21, 31, 41 are identical and work independent from each other. Each one of those networks 21, 31, 41
10 delivers at their respective outputs 22, 23; 32, 33; and 42, 43 a regulated DC current at any adjustable output voltage. The networks are built in such a way that the described one phase pulsing rectified voltage at the inputs 122, 123; 132, 133; and 142, 143 are used mostly
15 without nonlinear distortion. The load on the generator 15 (i.e. the AC network) is therefore similar to that of an ohmic load so that conductors 12, 13, 14 essentially are free of higher harmonics which could cause interference with other equipment. Such a power factor
20 connection unit is described e.g. in European patent 0218 267.

Further characteristics of the one-phase power factor connection circuits 21, 31, 41 are the galvanic separation between input and output as well as the size.
25 The galvanic separation is the reason why, as described,

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the outputs 22, 23; 32, 33; and 42, 43 can be connected together at any potential. The sizing can be made in such a way that always two of the three units 21, 31, 41 can provide the maximum power. Therefore, in the case of
5 a failure of one of the units 21, 31, 41 there is no loss of power to the user or load 60.

The control and switching logic 50 controls the switches 124-129; 134-139; and 144-149 of the rectifier networks 20, 30, 40 common and in pairs in the open state
10 via the corresponding control signal conductors 224, 226, 228; 234, 236, 238; and 244, 246, 248. The control signal information is fed via signal conductors 222, 232, 242 for example from connections 122, 123; 132, 133; and 142, 143 and over conductors 221, 231, 241 from the power
15 factor correction units 21, 31, 41.

The AC/DC convertor 10 works as follows:

During defect free, normal operation each rectifier circuit 20, 30, 40 the alternating current, which is sinusoidal, and is derived through the changing of the
20 phases R, S, T of the three phase alternating current according to a triangle or delta connection. There is no need for the switches 124-129, 134-139, 144-149 to operate. They remain in the described normal position. The power factor correction units 21, 31, 41 produce a
25 regulated direct current of a high quality from the

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accordingly generated one-phase pulsing rectifier current. The three units deliver the power required by the load essentially in equal parts.

If for any reason one of the power factor correction units 21, 31, 41 fails then this condition is transmitted to the control and switching logic 50 via the corresponding signal lines 221, 231, 241. The control and switching logic reacts by opening all switches of the corresponding rectifier circuit 20, 30, 40 thereby disconnecting the failing part of the convertor 10 from the generator 15. The remaining two power factor correction units 21, 31, 41 will now automatically increase their power output thereby continuing to deliver to the load 60 an unchanged current.

If one of the phases R, S, T of the generator 15 is lost then this condition will be transmitted to the control and switching logic over at least one of the signal lines 222, 232, 242. In this case logic 50 closes all up to now open switches of all three rectifier circuits 20, 30, 40 and enables therefore an emergency operation. The remaining voltages between lines 12, 13, 14 are essentially still sinusoidal so that all rectifier circuits 20, 30, 40 and the power factor correcting units 21, 31, 41 that follow work essentially unchanged. The rectifier diodes provide the necessary decoupling in this

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case. In order to improve the decoupling it is also possible to open those switches via logic 50 that are associated with the lost phase R, S, T.

The AC/DC convertor 10, in its described construction, possesses in many respects redundancy which is simple and can be used in cases of disturbances so that a mostly secure current supply to the load 60 can be guaranteed.

Figure 2 schematically illustrates a variation 201 which may be substituted for one of the rectifier circuits 20, 30, 40. This circuit 201 contains as described six diodes 24-29 but only two switches 128, 129 which are associated with the pair of diodes 28, 29. These switches, in this example associated with conductor 14, will be open during normal, uninterrupted operation and will be closed if one of the phases R, S, T is interrupted.

Figure 3 schematically illustrates yet another variation 202 of the rectifier circuit. This circuit 202 has only a single switch 128a. This switch 128a is associated with diodes 28, 29 and connected to conductor 14. This switch functionally replaces the two switches 128, 129 of the variation according to Figure 2.

In principle switches 124-129; 134-139; 144-149 and 128a can be electromagnetic switches, e.g. the

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contacts of a relay or circuit breaker since the switches are switched very seldom and there are no special requirements for the actual switching operation, e.g. a requirement that the switching can only take place at
5 zero voltage. However, a preferred solution would use controlled semi-conductors as for example thyristors as triacs, especially when combined in a single unit with the diodes for the rectifier function and the switching function. The switches according to Figures 1 and 2 may
10 be unipolar. The switch 128a in Figure 3, however, must be a bi- polar switch.

Figure 4 shows in a block diagram form, a simple controller for phases R, S, T of a three-phase AC generator 15 as well as the associated switching logic
15 50. Three voltage controllers 70, 71, 72 serve as sensors which are connected in a triangular fashion to the conductors 12, 13, 14. Logic 50 is made of a logical and with an inverted output 51. This output can be used to control the thyristors directly via the amplifiers 54,
20 59. The thyristors represent switches 24-29.

It is basically possible to use any convertor for the power factor correction units 21, 31, 41 that produces a direct current out of a rectified sinusoidal alternating current. However, no linear distortions are
25 allowed to be fed back into the resistor 15 and

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preferably it should provide a voltage decoupling. Such a known convertor is described in the European patent 0 218 267. There the voltage decoupling is achieved through a controlled bridge switch followed by a
5 transformer and rectifier. It is advantageous when the power factor correction units 21, 31, 41 are built as high/low (boost/buck) placers because this way the flexibility of the ratio input voltage (i.e. voltage between conductors 12, 13, 14) to output voltage (i.e.
10 voltage between outputs 22, 23; 32, 33; and 42, 43) can be made very large.

The outputs of the power factor correction units 21, 31, 41 can, with appropriate voltage decoupling, be connected to a simple load 60. But it is
15 also possible that each unit 21, 31, 41 can be connected to a separate load and these loads need be equal.

The construction of the AC/DC convertor 10 is relatively simple and robust. It can be connected to the generator or AC network 15 without a neutral or ground
20 connector. The convertor is flexible and adaptable to many special applications. A very good characteristic is its redundancy and therefore satisfies the high demands for security against interruptions. The switches described are only operated during a power failure and
25 therefore do not require continuous operation. The

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convertor 10 is therefore a comparatively very useful device for almost any application.

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**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. An AC/DC convertor for connection to line
conductors of a three-phase AC supply, which has, as a
5 means of preventing complete outage, a redundant design
and loads the AC supply substantially without non-linear
distortion, and where a plurality of parallel-arranged
power factor correction circuits are provided,
characterized in that provided are three identical
10 rectifier circuits, which are independent of each other
and which correspond to the three phases of said supply,
provided are six rectifying elements per rectifier
circuit, said rectifying elements being connected in
pairs to said line conductors of said AC supply and in
15 being connected to output leads of said rectifier
circuits respectively, form bridges, at least one switch
is provided for each of said rectifier circuits, with
each said switch operating in conjunction with at least
one pair of said rectifying elements and being designed
20 to separate each respective pair from said line
conductors of said AC supply to which each said pair is
assigned, a single-phase power factor correction circuit
is arranged downstream of its respective rectifier
circuit, provided are sensors to monitor operation of the
25 phases of the AC supply and of the single-phase power

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factor correcting circuits, and provided is a switch control that is connected via leads to said sensors and which, depending on the signals from the sensors, opens or closes the switches of the rectifier circuits.

5 2. The AC/DC convertor as defined in claim 1, characterized in that said three-phase AC supply is a generator with three line conductors and no neutral and no ground conductor.

3. The AC/DC convertor as defined in claim 1,
10 characterized in that for each rectifier circuit a single switch is used which is accordingly associated with a pair of rectifier elements of said line conductors of said three-phase AC supply, and where each rectifier circuit of the associated switch is connected to said
15 line conductors.

4. The AC/DC convertor as defined in claim 1, characterized in that for each rectifier circuit two switches are used, which are connected in series with the two rectifier elements associated with the pair of
20 switches, and where in each rectifier circuit the appropriate switches and rectifier elements are associated with another line conductor of said three-

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phase AC supply.

5. The AC/DC convertor as defined in claim 1, characterized in that for each rectifier circuit six switches are used which are connected individually and in series with the six rectifier elements of the associated rectifier circuits.

6. The AC/DC convertor as defined in claim 1, characterized in that said at least one switch is built as an electrically controllable semi-conductor switch.

10 7. The AC/DC convertor as defined in claim 1, characterized in that said at least one switch together with the corresponding rectifier element is built as a common electrically controlled unit.

8. The AC/DC convertor as defined in claim 1, characterized in that each said one-phase power factor correction circuit is connected to a separate load.

9. The AC/DC convertor as defined in claim 1, characterized in that each said one-phase power factor correction circuit is built as a convertor with galvanic separation, and that these said convertors are connected

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to a common load.

10. The AC/DC convertor as defined in claim 9,
characterized in that said convertors are built in such a
way that two of said convertors are sufficient to supply
5 the common load.

11. Operation of an AC/DC convertor according to
claim 3 characterized in that during disturbance free
operation a switch is open in a rectifier circuit for
each of the respective phases of a three-phase AC supply
10 and that when one of the phases of the three-phase AC
supply is interrupted then all switches of the remaining
phases will be closed for the duration of the
interruption.

12. Operation of an AC/DC convertor according to
15 claim 4, characterized in that during disturbance-free
operation two switches in each rectifier circuit are
open, and that at the time of an interrupt of one of the
phases of a three-phase AC supply all switches of the
remaining phases are closed for the duration of the
20 interruption.

13. Operation of an AC/DC convertor according to

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claim 5, characterized such that during disturbance-free operation of the convertor, four switches in each rectifier circuit associated with two pairs of the rectifier elements are closed, and two of the switches
5 that are associated with the third pair of the rectifier-elements are open, each rectifier circuit of the corresponding open switches and the corresponding rectifier-elements are assigned to another line conductor of the three-phase AC supply, all switches that were open
10 during normal operation will be closed for the duration of an interruption.

14. Operation as defined in claim 13, characterized such that during interruption of one of the phases additionally all these switches are opened that are
15 associated with said line conductor of the interrupted phase.

15. Operation as defined in claim 13, characterized in that at the time of failure of one of the one-phase power factor connection units and for the duration of the
20 failure all switches will be opened that belong to the rectifier circuit that is connected to the failing power factor connection unit.

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16. In an AC/DC convertor for connection to the line conductors of a three-phase AC supply and a plurality of power factor correction units the improvement comprising three identical rectifier circuits
5 which are independent of each other, each said rectifier circuit having six rectifying elements connected in pairs to the supply lines with at least one switch operating in conjunction with at least one selected pair of rectifying elements to selectively separate the same from the power
10 supply line associated therewith, a single-phase power factor correcting means downstream of the respective rectifier circuits, and sensor means to monitor operation of the respective phases of the AC supply and power factor correcting means and provide signals that actuate
15 the switches of said rectifier circuits.

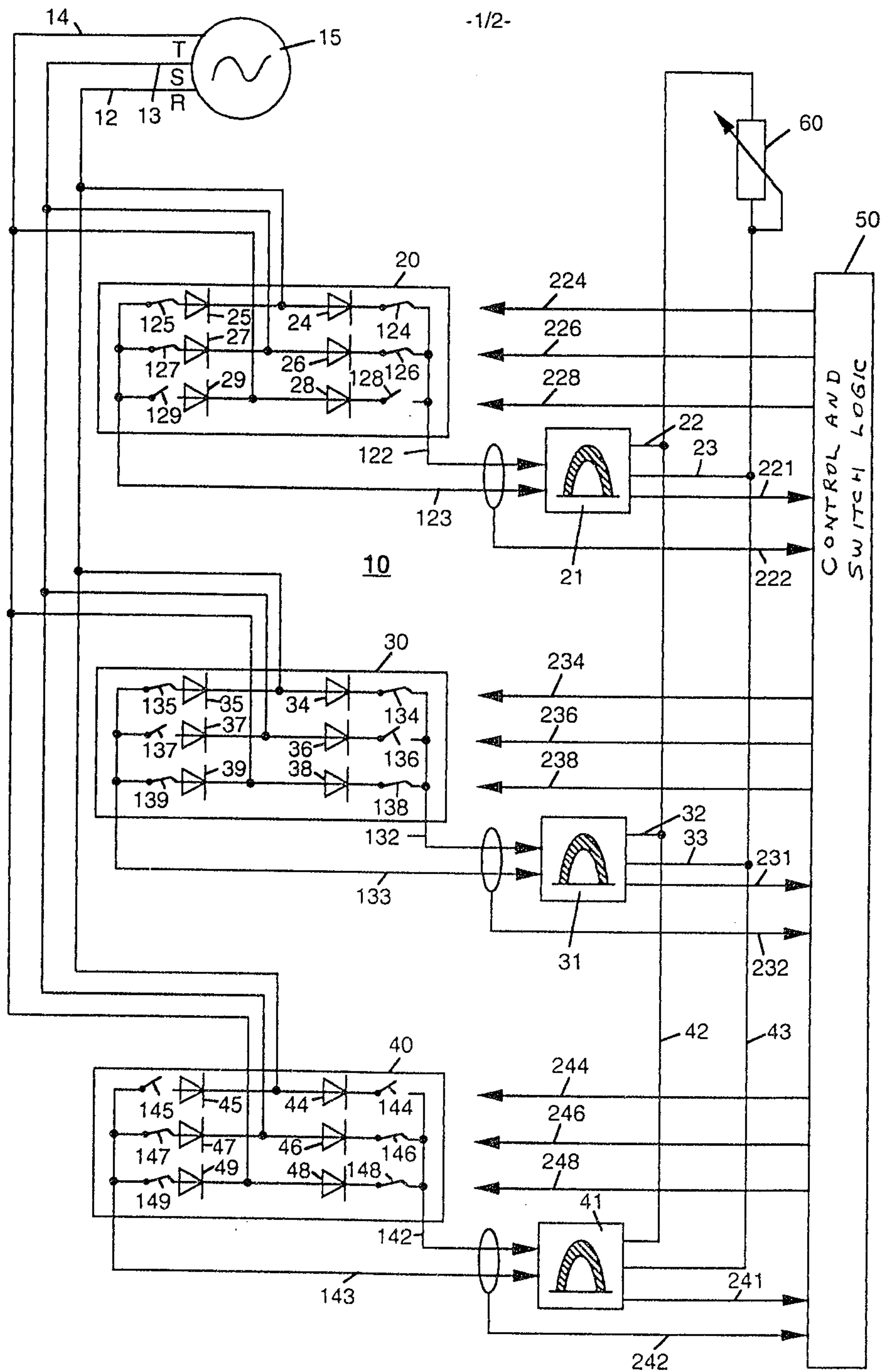


Fig. 1

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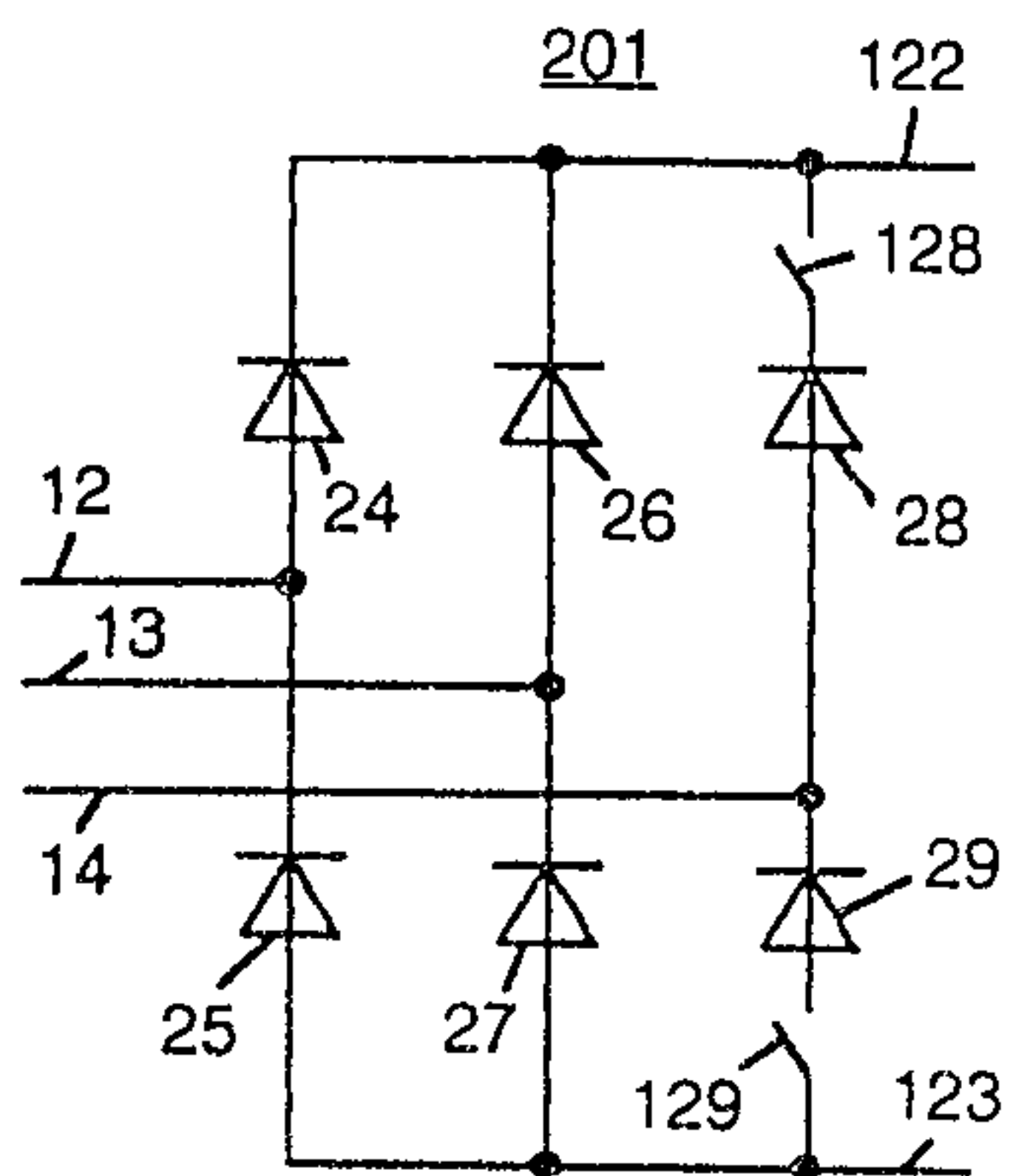


Fig. 2

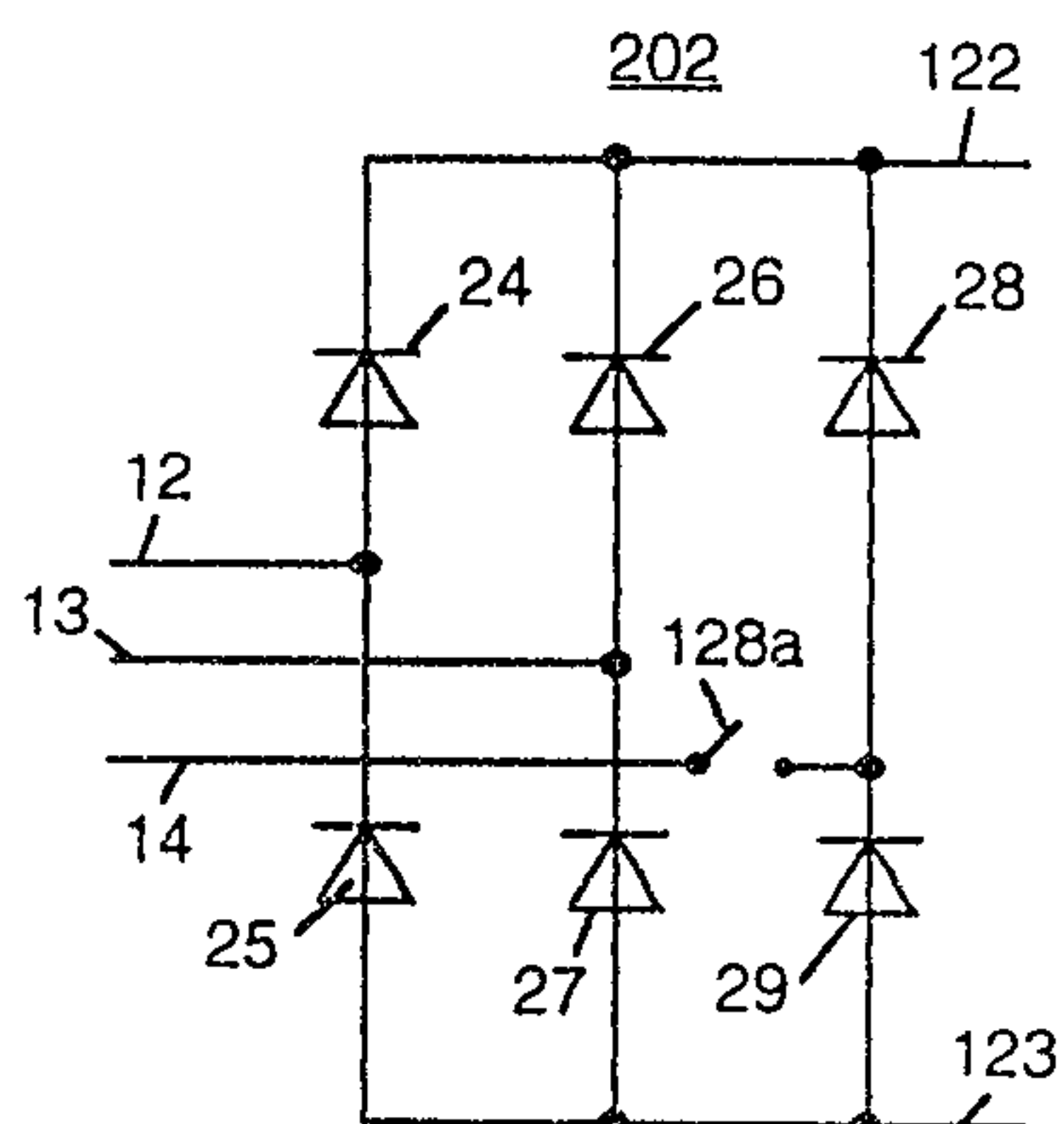


Fig. 3

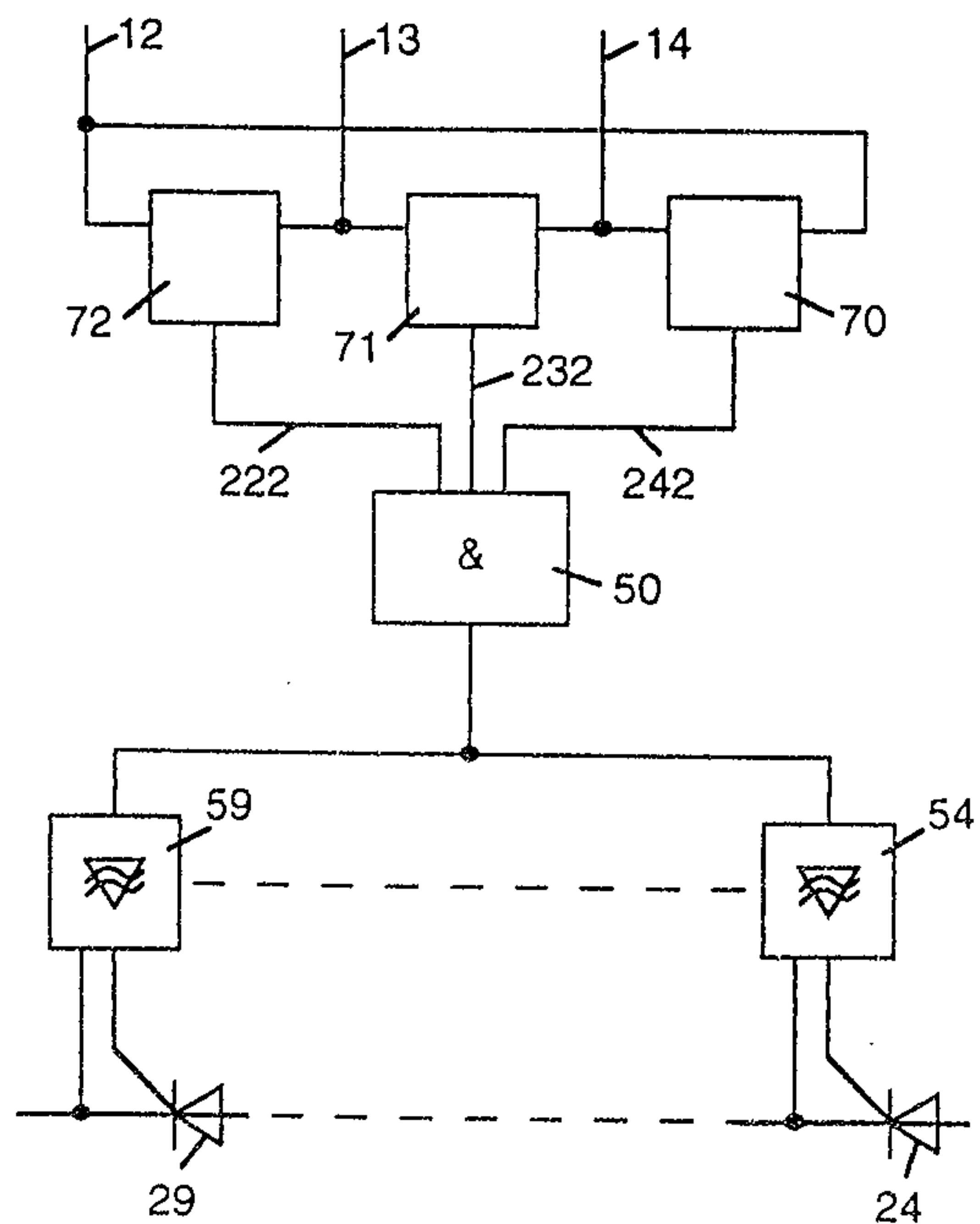


Fig. 4

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