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UNINTERRUPTIBLE POWER SUPPLY FOR LOADS

The subject matter relates to an uninterruptible power supply (UPS), a method of operating a UPS, and a system having a UPS.

Uninterruptible power supply (UPS) are used to ensure the supply of critical electrical loads in case of disturbances in the electrical supply network.

Electrical supply networks are exposed to a wide variety of operating conditions and can lead to both frequency fluctuations and voltage fluctuations. Particularly with rapid changes in the load situation or the feed situation along a supply ply in an electrical supply network, voltage fluctuations to the load can occur. In the event of major changes in the feed-in conditions or load conditions, frequency fluctuations in the low-voltage networks may also occur.

However, some electrical loads are not designed to operate in such diverse network conditions. In order to be able to operate such consumers safely, a wide variety of UPS topologies exist.

DE 20 2014 100 723 U1 describes an uninterruptible power supply which has a modular design and has a main connection and a bypass connection on the network side. By means of this, a load connection can either be connected to the energy storage or directly to the network via the bypass connection.

According to IEC 62040-3, three different categories of UPS are defined. Category 3 UPSs are Voltage and Frequency Dependent (VFD). In normal operation, a mains connection is switched directly to a load connection. When malfunctioning, a switch arranged on the load connection, in particular a contactor, switches over to battery operation and a battery is connected to the load output via an inverter. The battery is charged from the mains connection via a rectifier.

Category 2 UPSs are voltage independent (VI). The load in these is supplied by the network in normal operation. An automatic voltage regulator (AVR) always allows a constant voltage at the load output. However, the frequency at the load output is still dependent on the frequency of the supply network. When the mains voltage leaves the tolerance range, the battery supplies the load via an inverter.

Category 1 UPSs are voltage and frequency independent (VFI). In these, the mains connection is first connected via a rectifier and an inverter to a load output and the battery is arranged between the rectifier and the inverter. The inverter always provides a constant voltage at a constant frequency at the load output. For emergency operation, in which an

error occurs in the UPS, an automatic bypass is provided, which can interconnect the load output with the supply network. In maintenance mode, the load can be supplied directly from the network via the maintenance bypass. The maintenance switch is closed manually or automatically.
The described UPS topologies can also be operated redundantly. In particular, data centres can be supplied redundantly by being connected to supply networks via two separate mains connections. In particular, an automatic bypass and a maintenance bypass of a category 1 UPS can be connected to an electrical supply network via a second mains connection.
To protect against prolonged power failures, the batteries can be larger in dimension and thus have an increased storage capacity. The batteries or other energy storages can thus have several 100 kWh. The operation or the provision of such large energy storages is disadvantageous because they are rarely used. The network quality in Western Europe is so good that the UPS is very rarely used. For most of the year, the energy storages are idle and are only recharged to receive their charge. The charging power of the conventional energy storage is very low compared to the storage capacity, usually 0.2xC10 and thus not suitable, for example, for network services.
Thus, the object of the invention was to provide energy storages of UPS with multiple uses.
This problem is representationally solved by an uninterruptible power supply according to claim 1, a method according to claim 9 and a system according to claim 15.
It has been recognized that by suitable interconnection of the electrical components within a UPS, their energy storage can be used for network services (e.g. primary control power), for participation in the electricity market and/or for peak shaving. The energy storage is designed to provide electrical energy.
It has been recognized that the energy storage can be used not only to supply the load in case of failure, but also can be operated to serve the network. For this purpose, the energy storage can be loaded or unloaded to serve the network. Thus, a power flow can flow in the direction of the energy storage or from the energy storage in the direction of the load and/or a mains connection or supply network. The regulation of the power flow to the energy storage can be frequency-dependent, voltage-dependent and/or load-dependent and/or triggered externally.
A frequency-dependent regulation of the power flow at which the energy storage can be used, for example, for primary control power.
A load-dependent regulation of the power flow at the energy storage can be used, for

example, for peak shaving.

For example, external triggering can be used to provide minute reserves or second reserves.

It is understood that is discharged at a power flow from the energy storage of the energy storage and is charged at a power flow to the energy storage of the energy storage.

There are several scenarios for charging or discharging the energy storage. The charging of the energy storage can take place, for example, when an electrical power drawn from the supply network is greater than the power of the load. As a result, frequency control can be carried out, for example, at an increased mains frequency. Electrical power is thus used by the supply network both for charging the energy storage and for operating the load.

Discharging the energy storage, especially at low mains frequencies, may result in the power of the load being partially supplied by the energy storage and partially by the supply network. In addition, the energy storage can, for example, be discharged so that the power of the load is fully fed in and preferably in addition flows an electrical power flow flows in the direction of the supply network.

A redundant UPS preferably has two separate mains connections. A first mains connection is connected via a rectifier and an inverter to a load connection. A second mains connection is preferably connected to the load connection via an automatic bypass. In this case, a switching component may be arranged in the bypass, in particular a thyristor switch. The two mains connections are preferably connected to, in particular, independently operated plies of an electrical supply network. In this case, the plies may preferably be connected to transformers which are operated independently of one another and which are connected to a superordinate supply network, in particular in another higher voltage level. The mains connections can also be connected to a common feed point. The supply networks are preferably operated on the low-voltage side at a voltage level up to 0.4 kV and on the medium-voltage side at a voltage between 1 kV and 65 kV.

The energy storages are preferably deep-cycle batteries that withstand more than 200 charging cycles, in particular more than 1000 charging cycles. These are in particular lithium-ion batteries. Furthermore, the energy storages can be designed to realize high charging and discharging currents. In particular, currents of more than 1C, in particular up to 10C are possible.

Preferably, the uninterruptible power supply is switched such that a discharging of the energy storage for a power flow in the direction of one of the mains connections is made possible and at the same time a discharge of the energy storage in the direction of the load connection is possible. However, it is also possible that either discharging the energy storage for a power flow in the direction of one of the mains connections is made possible or discharging of the energy storage occurs in the direction of the load connection.

For operation, it may be useful to connect the rectifier in a switchable manner to the first mains connection. For this purpose, a switch between the first mains connection and the rectifier can be arranged.

Further, it is possible to disconnect the load connection from the inverter and the switching component. For this purpose, a switch may also be provided at the output of the load connection. In addition, two switches can be provided at the output of the load connection. The maintenance bypass can be connected between these two switches.

Finally, it may also be useful to separate the switching component in the automatic bypass from the second mains connection. For this purpose, a switch can be provided between the second mains connection and the switching component.

The switches are preferably closers or openers. The switches are preferably in operative connection with a control unit. In addition to a control unit arranged in the UPS, a telecontrol device can also be provided, via which control commands can be fed into the UPS. The telecontrol device can interact with the control unit. Power values for charging and/or discharging the energy storage can be specified externally. In addition, a battery management system for charging/discharging the energy storage may be provided, which may also interact with the control unit and/or the telecontrol device.

In order to allow additional redundancy in the UPS, it is also proposed that a maintenance bypass be provided in parallel with the automatic bypass between the load connection and the second mains connection. Preferably, the maintenance bypass is connected on the output side of the switch to the load connection, whereas the path of the electrical switching component can be connected to the load connection on the input side of the switch. An electrical switch may be provided in the maintenance bypass.

An ampere meter, in particular a smart meter, may preferably to arranged in the maintenance bypass. This may be useful, since a power flow from the energy storage to the second supply network can take place via the maintenance bypass. In this case, there is a direct connection of the energy storage to the supply network and an ampere meter may be expedient.

Alternatively or cumulatively, an ampere meter, in particular a smart meter, may be arranged on the energy storage and detect the power flow from and to the energy storage, in particular also in a temporal resolution.

The electrical switching component is preferably formed from semiconductor switches that can switch very quickly. In particular, thyristor switches can be used. The switching component can also be, for example, a bidirectional AC converter. In addition, the electrical switching component may be formed of a series circuit of a rectifier and an inverter. In this case, the UPS along both plies is a category 1 UPS, with a frequency and voltage independence at the load connection.

The energy storage may be formed from a parallel connection of at least two storage plies. As a result, the storage capacity of the energy storage can be increased almost arbitrarily. Each storage ply can be connected to the rectifier separately from the other via at least one DC voltage converter. It is possible to perform a charge management between the individual storage plies using a DC voltage converter. Individual plies of the energy storage or individual storage cells can be randomly charged and discharged. A compensation of the storage charge between the individual memory cells is also possible using the DC voltage converter. In addition, the charging and discharging of the energy storage can be controlled by means of the DC voltage converter independently of a converter arranged on the first mains connection.

For primary control power, it is necessary that a frequency control takes place locally, for example at the mains connection of the UPS. This frequency control is preferably independent of external control signals. For this reason, a frequency measuring device can detect a mains frequency on at least one of the mains connections. Depending on the measured mains frequency, an electrical power flow can be conducted from the energy storage to the at least one mains connection. Preferably, a P, PI or PID regulation of the feed-in power and/or the frequency of the feed-in voltage from the energy storage in the direction of the mains connection is dependent on the mains frequency. Preferably, the frequency measurement is provided at both mains connections, so that the two supply networks can be monitored independently of each other and, depending on necessity, discharging of the energy storage can be done for one or both of the supply networks. The frequency of the supply voltage can be adjusted depending on the measured frequency.

It is also possible that the frequency measuring device is in operative connection with a control unit and that the control unit controls the electrical components within the UPS depending on the measured mains frequency.

For a minute reserve or a second reserve, switching of the electrical components within the UPS can be effected by means of the control unit by an external control signal. For this purpose, the control unit can then effect charging or discharging of the energy

storage.
With peak shaving, i.e. to reduce power peaks or load peaks, the control unit can trigger a discharging of the energy storage. Thus, for example, the electrical load on the load connection are at least partially supported by the energy storage.
Preferably, the state of charge of the energy storage is monitored. In particular, the state of charge can be monitored in such a way that a previously described mains-serving switching of the UPS is only possible up to a lower limit of the state of charge. In particular, depending on the autarky requirement of the load, a minimum reserve capacity may be set as the lower limit of the state of charge of the energy storage.
The control unit can store the charging processes during which the energy storage is discharged in the mains, together with a time stamp. This makes it possible to prove that the energy storage has been operated in a network-serving manner. In particular, the mains frequency can additionally be stored in the control unit or the frequency measuring device in order to enable the detection of the primary control power supply.
It is also possible to use the converter or an inverter for reactive power compensation. For this purpose, the reactive current in the supply network can be compensated via the converter. The reactive power can be regulated depending on a measured phase angle between current and voltage at least at one of the mains connections. An apparent power can be applied to one of the mains connections via the converter, the phase angle of which can be adjusted as a function of the measured phase angle at the mains connection.
During normal operation, the UPS is operated in such a way that electric power flows from the first mains connection to the load connection via the converter and the inverter. In parallel, the energy storage can be charged via the first mains connection. On the AC side of the inverter, there is a constant voltage with a constant frequency. A switch on the output of the mains connection can be closed.
In parallel or alternatively, a power flow can flow from the second mains connection in the direction of the load connection using the switching component, which is preferably a switch, an AC switch, a thyristor switch or the like. This can be done in particular if the voltage and current quality of the network are within the tolerance range of the load. In case of quality problems of the network, the switching component is deactivated. The load is supplied by the first mains connection via the rectifier and the converter.
Also, for example, a constant voltage with a constant frequency can be present on the output side of the switching component, if it is formed for example of a series circuit of a rectifier and an inverter or a bidirectional AC converter. By suitable adjustment of the

switching component and of the inverter, the proportions of the power supply for the load can be adjusted starting from the first and the second mains connection. This can be achieved, for example, by adjusting the voltage level. The maintenance bypass is preferably open.

For network-serving operation at the second mains connection, it may be useful to close a maintenance bypass and disable the switching component. In particular, a switch arranged there can be opened. In the case of network-serving operation, the converter can be inactivated or a switch arranged thereon can be opened and the inverter can set an output voltage and an output frequency depending on a control unit. The maintenance bypass thus results in a power flow in the direction of the second mains connection with a defined voltage at a defined frequency.

In case of charging the energy storage, the converter can be activated or the switch can be closed and the inverter can be deactivated. The converter can be controlled by a control unit such that the power consumed is set by the first mains connection.

In both modes of operation described above, the energy storage is intended only for the stabilization of the supply networks. In the event of a fault, the UPS operation must be reactivated, disconnecting the maintenance bypass and activating the switching component for UPS operation or closing its switch.

Another possibility of network-serving operation can be made possible by opening the maintenance bypass. The converter can be deactivated or the switch can be opened and the inverter receives a control signal from the control unit. The switching component is also active and a power flow from the energy storage to the second mains connection is possible. Charging from the first mains connection can be made possible by deactivating the inverter and controlling the converter using the control unit in order to draw power via the first mains connection. The switching component is thus disabled and the energy storage can be charged.

Again, in the case of a fault, the UPS operation described above is resumed.

For network-serving operation at the first mains connection, it may be useful to open a maintenance bypass. Furthermore, the inverter can be deactivated. The energy storage is connected to the first mains connection via the converter. On the one hand, the converter can be operated in such a way that a power flow flows from the mains connection in the direction of the energy storage and this is charged. On the other hand, the energy storage can be discharged and a power flow can also be made via the converter in the direction of the first mains connection. The converter receives a control signal from the control unit and can thus adjust a power consumption. On the other hand, in the case of discharging, the converter can adjust, on the output side, both a voltage level and a frequency level and/or a phase position between voltage and current and thus be used for frequency stabilization in the context of the primary control power and/or for reactive power compensation.

In the event of a fault, the UPS operation is again possible as described above.

If operation of the UPS according to category 3 is possible, the switching component at the second mains connection can be used to supply the load. On the other hand, the inverter may be inactivated and charging and discharging may be facilitated via the converter at the first mains connection point.

It is also possible to operate the UPS in category 1 and at the same time as network-serving. For this purpose, the load can be operated via the switching component, which can be formed from a series circuit of rectifier and inverter, and simultaneously operated via the inverter arranged on the first mains connection.

With the help of converters, e.g. rectifiers and/or DC voltage converter, the charging and discharging of the energy storage can be controlled. Depending on a control signal, the converter can allow charging and discharging of the energy storage, whereby a passage of the electrical power in the direction of the load connection is also possible. In this case, the load can also be fed 100% via the inverter.

It is also possible to only supply the load from the first mains connection via the converter and to operate the UPS in category 1. For this purpose, the charging and discharging of the energy storage can be realized via the converter. The converter can preferably be dimensioned larger here.

The invention is explained in more detail below on the basis of drawings depicting an exemplary embodiment. Brief description of the drawings:

Fig. 1 is a schematic structure of a UPS in normal operation;

Fig. 2 shows a network-serving operation of a UPS according to a first exemplary embodiment;

Fig. 3 shows a network-serving operation of a UPS according to a second exemplary embodiment;

Fig. 4 shows a network-serving operation of a UPS according to a third exemplary embodiment;

Fig. 5 shows a network-serving operation of a UPS according to a fourth exemplary embodiment;

Fig. 6 shows the operation of a UPS according to a fifth exemplary embodiment;

Fig. 7 shows the operation of a UPS according to a sixth exemplary embodiment.

In Figs. 1 to 7, exemplary topologies of UPSs are shown. The components and elements shown, although not shown in some of the figures, may be used in all topologies. In part, some components and elements have been omitted in some figures for clarity, but this does not mean that these elements cannot be used in corresponding topologies.

Fig. 1 shows a topology of a UPS 1 having an automatic bypass and a maintenance bypass. The UPS 1 is connected to a first mains connection 2 to a first supply network 4. The supply network 4 is connected via a transformer 4a, for example, a local power transformer, to a medium voltage network.

The UPS 1 is connected with a second mains connection 6 to a second supply network 8. The second supply network 8 is also connected via a transformer 8a to the medium voltage network. The transformers 4a, 8a are preferably operated independently of each other.

A load connection 10 is provided on the output side of the UPS 1. A load, for example a consumer group in a data centre 12, can be connected to the load connection 10.

The UPS 1 is characterized in that the load 12 is connected reliably to the load connection 10 on the supply networks 4, 8, so that wherever possible no frequency or voltage fluctuations outside permissible areas on the load connection 10 occur and thus the load 12 can work with as little interference as possible.

For this purpose, the UPS 1 has an energy storage 14. The energy storage 14 may be, for example, a set of accumulators (batteries). In particular, lithium-ion batteries can be used.

The energy storage 14 is connected on the network side with a converter 16 and with an inverter 18 on the load side. The converter 16 can be formed, where necessary, as a rectifier or as a bidirectional converter, which allows both power flows in the direction of the supply network 4 and power flows in the direction of the energy storage 14 and the inverter 18.

At the mains connection 6, a switching component 20 is arranged, which may be formed as a switch, for example, a bidirectional thyristor or as a combination of an inverter and a rectifier. The structure of the switching component 20 may vary depending on the application, which will be described below.

At the switching output 10, a switch 22 may be arranged.

A switch 24 may be arranged on the input side of the converter 16 and a switch 26 may be arranged may be arranged on the input side of the switching component 20.

A maintenance bypass 28 may be provided on the output side of the switch 22 between the switch 22 and the load connection 10. The maintenance bypass 28 connects the load connection 10 to the mains connection 6. The maintenance bypass 28 preferably has a switch 30, which may be both a manual switch and an automatically operated switch.

In addition, a measuring device 32, in particular a smart meter 32 (dashed lines) may be provided in the maintenance bypass 28. The smart meter 32 can be used, in particular, when power flows are switched by the energy storage 14 in the direction of the second supply network 8. Alternatively or cumulatively, a measuring device 32 may be provided on the energy storage 14 for the detection of the charging processes of the energy storage. The measuring device 32 may preferably be an electricity meter or a smart meter 32. The measuring device 32 can be installed at the input of the energy storage 14 and can thus register all charging processes of the energy storage 14. Thus all uses of the energy storage 14 can be detected.

Measuring devices 34a, 34b, which respectively measure electrical parameters at the mains connections 2, 4, can be provided for a network-serving operation. The measuring devices 34a, b may be frequency meters, voltmeters and/or both. With the aid of frequency meters, it is possible to measure the mains frequency at the mains connections 2, 6 and thus to determine whether primary control power must be triggered or not. Primary control power is preferably triggered in a locally autonomous manner. For this purpose, a local frequency measurement using the measuring device 34a, b is necessary. Also, voltage measurements with the aid of the measuring device 34a, b may be useful to measure, for example, the local voltage levels at the mains connections 2, 6 and, if necessary, to regulate intervention.

The measurement results of the measuring devices 34 are preferably transmitted to a control unit 36. In the control unit 36, the measurement results can be evaluated and the components 14-32 can be switched. For this purpose, the control unit can be in operative connection with the respective components 14-32 as required. The control unit 36 can also be controlled by an external control signal 38. This can be useful, for example, for triggering minute or second reserves or triggering of auctioned electrical services at specific times. For this purpose, a corresponding control signal 38 can instruct the control unit 36 that the energy storage 14 is being charged or discharged and the supply networks and being correspondingly loaded or relieved. In this case, a power flow can flow from the energy storage 14 in the direction of or from the direction of at least one of the mains connections 2, 6 and/or the load 12.

In normal operation, the load 12 is connected either directly via the switching component 20 to the mains connection 6 and operated by the second supply network 8 or operated by the supply network 4 via the converter 16 and the inverter 18. An emergency supply

of the load 12 is possible by the energy storage 14.
If the current parameters in the supply network 8 are outside the tolerance range, the supply network 4 can still provide a stable supply of the load 12, in which the inverter 18 outputs a constant voltage with a constant frequency on the output side, independently of the voltage and the frequency at its input.
If a problem also occurs in the supply network 4, the inverter 18 can be operated via the energy storage 14 and, as before, the inverter 18 can output a constant voltage at a constant frequency at the output side. Thus, in normal operation, a power flow from the mains connection 6 to the load connection 10 and/or from the mains connection 2 to the load connection 10 is possible. In addition, in normal operation, a power flow may be switched from the energy storage 14 to the load connection 10. The switches 22, 24, 26 may be closed during normal operation. The maintenance bypass 28 is preferably open in normal operation, in which the switch 30 is opened. Problems in the supply network can be, in particular, power failures, voltage fluctuations, voltage spikes, undervoltages, overvoltages, surges, lightning strikes, voltage bursts, harmonics and/or frequency fluctuations.
In the event of a failure of the UPS 1, in particular if one or preferably a number of the elements 16, 18, 20, 22 fails, the automatic bypass can be activated, in which the switching component 20 is enabled for the power supply of the load. The maintenance bypass 28 can be used when the UPS 1 needs to be serviced or repaired.
However, the energy storage 14 is used very rarely in normal operation. It is only recharged from the supply network 2 via the converter 16, so that it permanently receives a defined state of charge. In the case of the above problems at the mains connections 2, 6, the energy storage 14 is used to provide a constant voltage at a constant frequency on the output side of the inverter 18 of the load 12. This exclusive use of the energy storage 14 to maintain the supply of the load 12 is uneconomical and a waste of resources.
The inventors have now recognized that the energy storage 14 can be supplied for multiple uses. An additional variant is shown in figure 2. According to Fig. 2, the energy storage 14 can be used to feed electrical power into the supply network 8. For this purpose, the switch 26 can be opened or the switching component 20 can be blocked. The energy storage is charged via the supply network 4 and the converter 16 and the energy storage 14 can be discharged via the inverter 18 and a closed switch 30, and a power flow from the energy storage 14 in the direction of the second mains connection 6 can be realized.
A power flow 42a flows from the energy storage 14 to the supply network 8. At the same

time, the energy storage 14 may feed the load 12 in which a power flow 42b flows to the load 12. As a result, the power flow 40a from the supply network 4 in the direction of the UPS 1 is reduced. The power flow 40b can feed the energy storage 14 and/or the load 12.

In the example shown in Fig. 2, the energy storage 14 can be fed, for example, via the supply network 4. In this case, the inverter 18 can be deactivated, so that only a power flow 40 from the mains connection 2 in the direction of the energy storage 14 is possible. In the case of discharging the energy storage 14, the converter 16 may be deactivated or the switch 24 may be open, so that a power flow 42a flows from the energy storage 14 via the inverter 18 and the maintenance bypass 28 in the direction of the mains connection 6.

Since there is a connection between the energy storage 14 and the supply network 8, a power flow 42a or a related amount of energy can be detected via the smart meter 32.

In this connection, it should be mentioned that the control unit 36 can detect when the energy storage 14 has been charged and when it was discharged, as well as the corresponding switching states of the components 16, 18. In this way, for example, in connection with the detection of the frequencies at the mains connections 2, 6, it can be detected when and how the energy storage 14 has delivered primary control power. This is possible for all exemplary embodiments shown.

In a second application, the energy storage 14 can also be used in a network-serving manner for the supply network 8, as Fig. 3 shows. In the example in Fig. 3, the switch 30 is opened. The supply network 4 feeds the energy storage 14, as represented by the power flow 40. The switch 30 may be opened and a power flow 42a flows via the inverter 18, the switching component 20 and the switch 26, which is closed, in the direction of the mains connection 6. The energy storage 14 can also feed the load 12 via the power flow 42b.

Fig. 4 shows a further operating mode, in which the energy storage 14 is used in a network-serving manner for the supply network 4. During normal operation, i.e. when the supply network 4 is working properly, the energy storage 14 can be charged via the converter 16, which is represented by the power flow 40. The inverter 18 is deactivated here. The control unit 36 may control the converter accordingly to adjust the power flow 40.

In the case of discharging, the inverter 18 remains deactivated and the converter feeds the mains connection 2, as represented by the power flow 42. Again, the converter 16 may receive a control command from the control unit 36 and, in particular, adjust the output frequency and the output voltage on the side of the mains connection 2.

Fig. 5 shows a further usage concept in which the UPS 1 can be used both for operating the load 12 and can also be used in a network-serving manner. When the switch 30 is open and the switch 26 is closed, a power flow 40a can be realized in the direction of the load 12 via the switching component 20. The load 12 is operated depending on voltage and frequency, namely, depending on the voltage of the frequency on the supply network 8.

The inverter 18 may be deactivated or separated from the energy storage 14 via an additional switch 44, which may be open.

The energy storage 14 can be operated via the DC converter 14a. The DC converters 14a may also receive control signals from the control unit 36. The energy storage 14 can be operated on the mains connection 2 in a network-serving manner. In the case of charging, a power flow 40b can be realized from the mains connection 2 in the direction of the energy storage 14. In the case of discharging, a power flow 42 can be realized by the energy storage 14 in the direction of the mains connection 2. The converter 16 receives the corresponding control signals from the control unit 36 in order to be able to adjust the power drawn by the mains connection 2 in the case of charging, as well as to be able to set the output power in the case of discharging. In this case, in particular, an output frequency of the converter 16 can be determined.

Fig. 6 shows a further possibility of operating the USV 1. First, it can be seen that the switching component 20 is now formed from a rectifier 20a and an inverter 20b, both of which can receive control signals via the control unit 36. On the output side of the inverter 20b, an output voltage and an output frequency can be set, in particular by the control unit 36. The load 12 can thus be operated independently of voltage and frequency by the power flows 40a, 40b, wherein a voltage and a frequency can be set on the output side of the inverter 20b, as well as on the output side of the inverter 18. Thus, the load 12 is fed by the two supply networks 4, 8, wherein the respective proportion of the total load through the supply network 4 and the supply network 8 is adjustable through control by the control unit 36. Of course, the load can also be supplied exclusively by the supply network 4 or supply network 8.

Also, as shown by the power flows 40c (when the energy storage 14 is charging or the discharge power of the energy storage 14 is lower than the load 12) and 42 (when the discharge power is higher than the load 12), an exchange between the energy storage 14 and the supply network 4 takes place. Adjusting the converter 16 controls whether power is drawn, according to the power flow 40c, or a power is provided, according to the power flow 42. The converter 16 can be adjusted via the control unit 36.

The UPS 1 according to Fig. 6 can also be operated with the power flows 40b, c and 42. In this case, the converter 16 can enable charging as well as discharging of the energy storage 14. When the converter 16 is switched such that a power flow 40b flows, the energy storage 14 can be charged at the same time.

It is also possible that the power consumption of the supply network 4 is throttled by the load by discharging the energy storage 14 and partially feeding the load. In this case, the power flow 42 does not occur even though the energy storage is being discharged.

Fig. 7 shows another further usage concept in which the UPS 1 can be used both for operating the load 12 and can also be used in a network-serving manner. The switching component 20 is blocked for power flows in normal operation. The load 12 can be fed via the converter 16 and the inverter 18 (power flow 40a).

The energy storage 14 can be used in a network-serving manner. As shown by the power flows 40c (when the energy storage 14 is charging) and 40b (when the discharge power of the energy storage is lower than the load 12) and 42 (when the discharge power is higher than the load 12), an exchange between the energy storage 14 and the supply network 4 takes place. Adjusting the converter 16 controls whether power is drawn, according to the power flow 40c, or a power is provided, according to the power flow 40b and 42. The converter 16 can be adjusted via the control unit 36.

The UPS 1 according to Fig. 7 can also be operated with the power flows 40b, c and 42. In this case, the converter 16 can enable charging as well as discharging of the energy storage 14. When the converter 16 is switched such that a power flow 40b flows, the energy storage 14 can be charged at the same time.

It is also possible that the power consumption of the supply network 4 is throttled by the load 12 by discharging the energy storage 14 and partially feeding the load 12. In this case, the power flow 42 does not occur even though the energy storage is being discharged.

In this usage concept, the converter 16 can preferably be dimensioned larger because both the charging current for the energy storage 14 and the current for the load 12 flow via the converter 16.

List of reference symbols

1 Uninterruptible power supply (UPS)

2 Mains connection

4 Supply network

4a Transformer

6 Mains connection

8 Supply network

8a Transformer

10 Load connection

12 Load

14 Energy storage

16 Converter

18 Inverter

20 Switching component

20a Rectifier

20b Inverter

22, 24, 26, 30 Switch

28 Maintenance bypass

32 Smart meter

34a, b Measuring device

36 Control unit

38 Control signal

40 Power flow

42 Power flow

44 Switch

Afbrydelsesfri strømforsyning til belastninger

PATENTKRAV

1. System med i det mindste én afbrydelsesfri strømforsyning med

- en første nettilslutning (2) i et første elektrisk forsyningsnet (4),
- en anden nettilslutning (6) i et andet elektrisk forsyningsnet (8), der er forskelligt fra det første elektriske forsyningsnet (4),
- en belastningstilslutning (10) til en elektrisk belastning og
- en energilagringsenhed (14),
- hvor der mellem energilagringsenheden (14) og den første nettilslutning (2) er anbragt en omformer (16) og mellem energilagringsenheden (14) og belastningstilslutningen (10) er anbragt en vekselretter (18), og
- mellem den anden nettilslutning (6) og belastningstilslutningen (10) er anbragt en elektrisk koblingskomponent (20a, 20b),
- således at den første nettilslutning (2) og den anden nettilslutning (6) er tilsluttet elektrisk til belastningstilslutningen (10), hvor
- omformeren (16), vekselretteren (18) og koblingskomponenten (20a, 20b) er koblet på en sådan måde, at der ledes en elektricitetsstrøm mellem energilagringsenheden (14) og i det mindste en af nettilslutningerne (2, 6),

kendetegnet ved,

- at den elektriske koblingskomponent (20a, 20b) indeholder en serieforbindelse bestående af en ensretter (20a) og en vekselretter (20b), og hvor det første og det andet elektriske forsyningsnet (4, 8) via to transformatorer (4a, 8a), der drives adskilt fra hinanden, er forbundet med et overordnet forsyningsnet eller er forbundet via et fælles forsyningspunkt på en transformator.

2. System ifølge krav 1,

kendetegnet ved,

at der ved belastningstilslutningens udgang er anbragt en elektrisk kontakt (22).

3. System ifølge et af de foregående krav,

kendetegnet ved,

at der mellem den første nettilslutning (2) og omformeren (16) er anbragt en elektrisk kontakt (24), og/eller at der mellem den anden nettilslutning (6) og den elektriske koblingskomponent (20a, 20b) er anbragt en elektrisk kontakt (26).

4. System ifølge et af de foregående krav,
kendetegnet ved,
at der parallelt med den elektriske koblingskomponent (20a, 20b) er tilkoblet et vedligeholdelsesbypass (28) mellem belastningstilslutningen (10) og den anden nettilslutning (6), hvor der i vedligeholdelsesbypasset (28) er anbragt en kontakt (30), særligt at vedligeholdelsesbypasset (28) er forbundet med belastningstilslutningens (10) udgang, og/eller at der i vedligeholdelsesbypasset (28) er anbragt en strømmåler, særligt et smart meter.

5. System ifølge et af de foregående krav,
kendetegnet ved,
at energilagringsenheden (14) er dannet af en parallelforbindelse af i det mindste to lagringsstrenge, og at hver lagringsstreng er forbundet med omformeren (16) via i det mindste en jævnspændingsomformer (14a).

6. System ifølge et af de foregående krav,
kendetegnet ved,
at en frekvensmåler (34a, 34b) registrerer en netfrekvens ved i det mindste en af nettilslutningerne (2, 6), og at der afhængigt af den målte netfrekvens ledes en elektricitetsstrøm mellem energilagringsenheden (14) og i det mindste en af nettilslutningerne (2, 6).

7. System ifølge et af de foregående krav,
kendetegnet ved,
at en styreenhed kobler omformeren (16), vekselretteren (18), koblingskomponenten (20a, 20b) og særligt kontakterne (24, 30) afhængigt af et eksternt styresignal og/eller den målte netfrekvens.

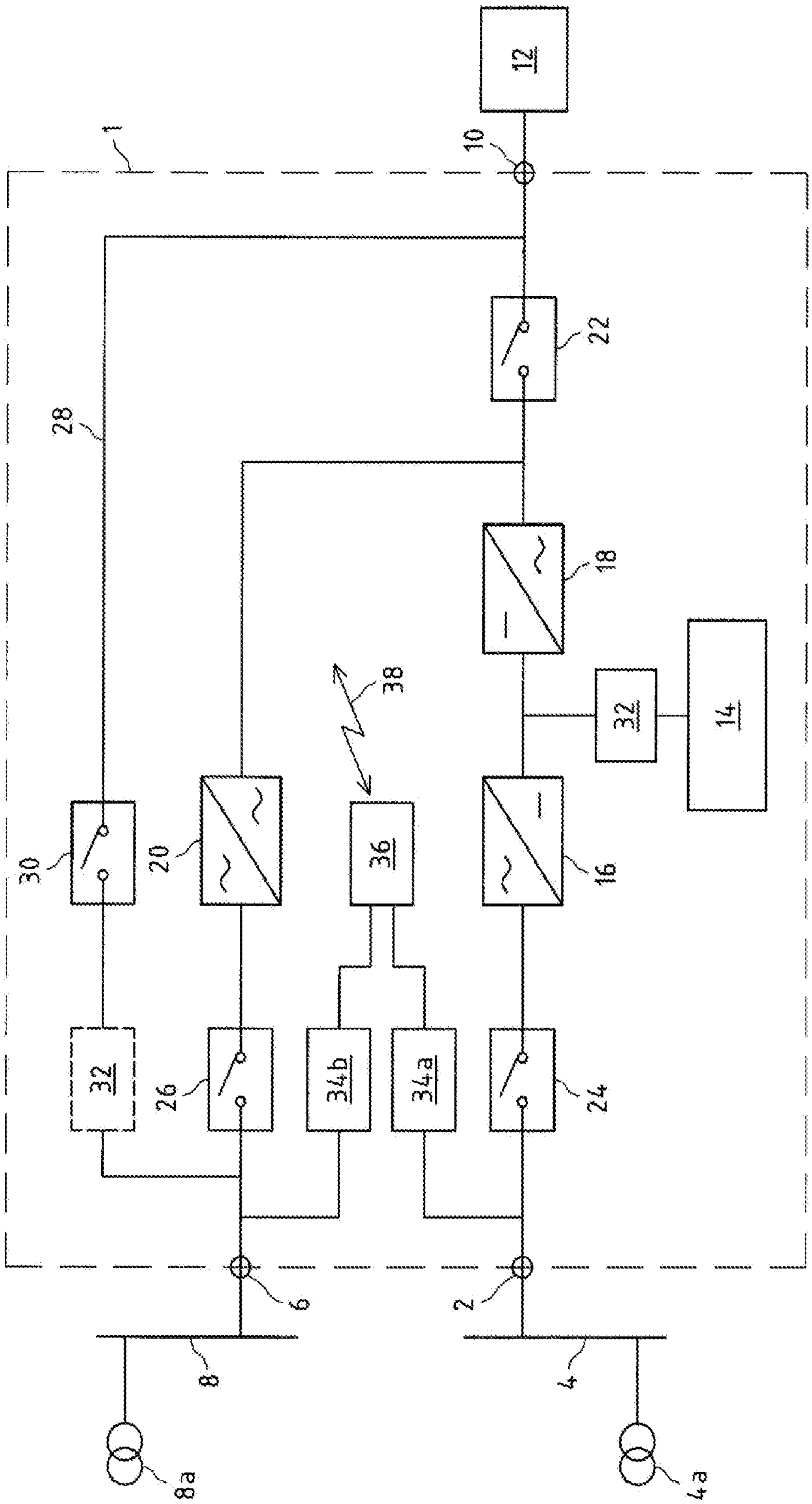

Fig.1

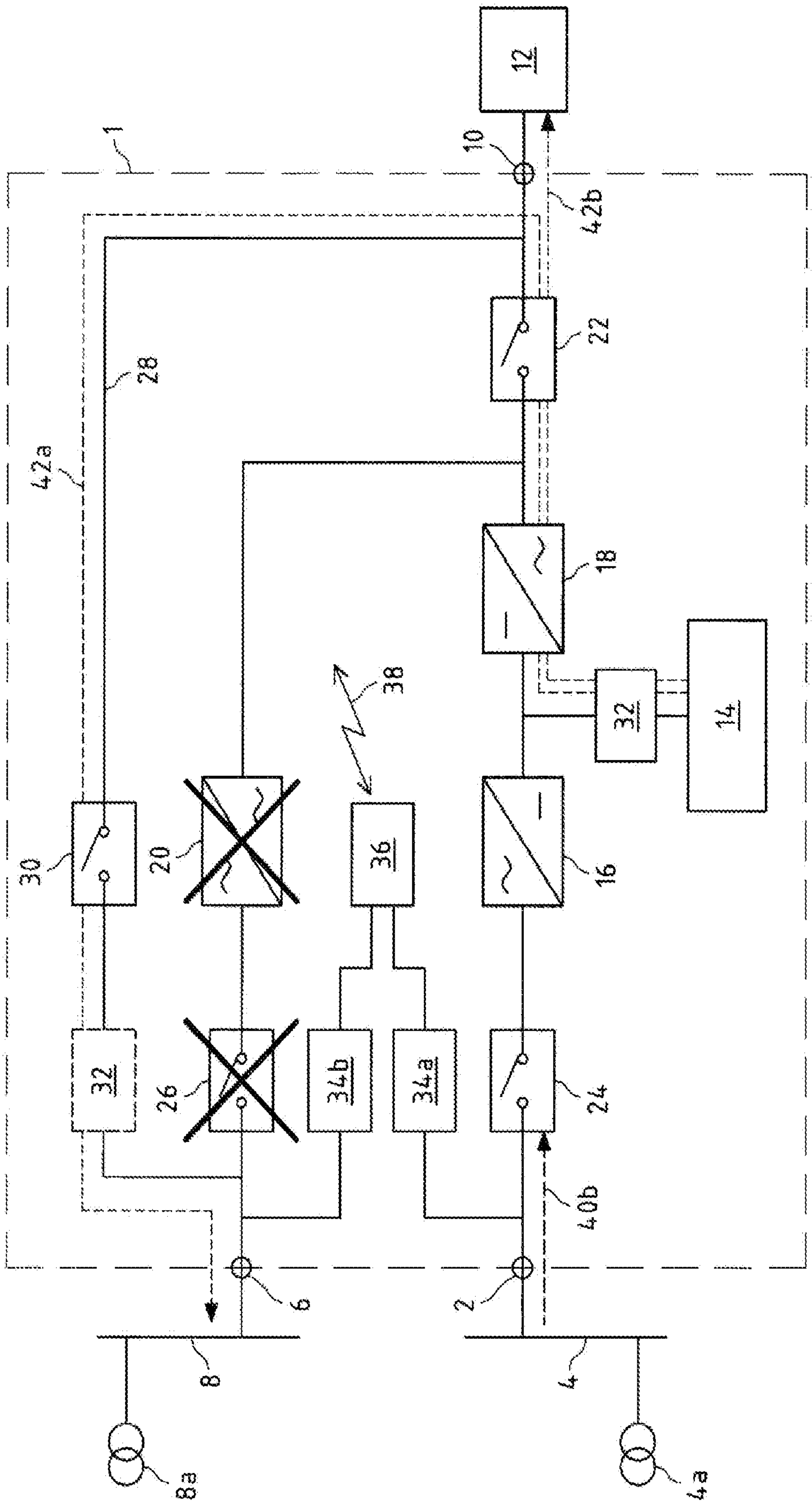
12
10
1
42b
22
28
42a
18
38
32
14
30
20
36
16
32
26
34b
34a
24
40b
6
2
8
4
8a
4a

Fig.2

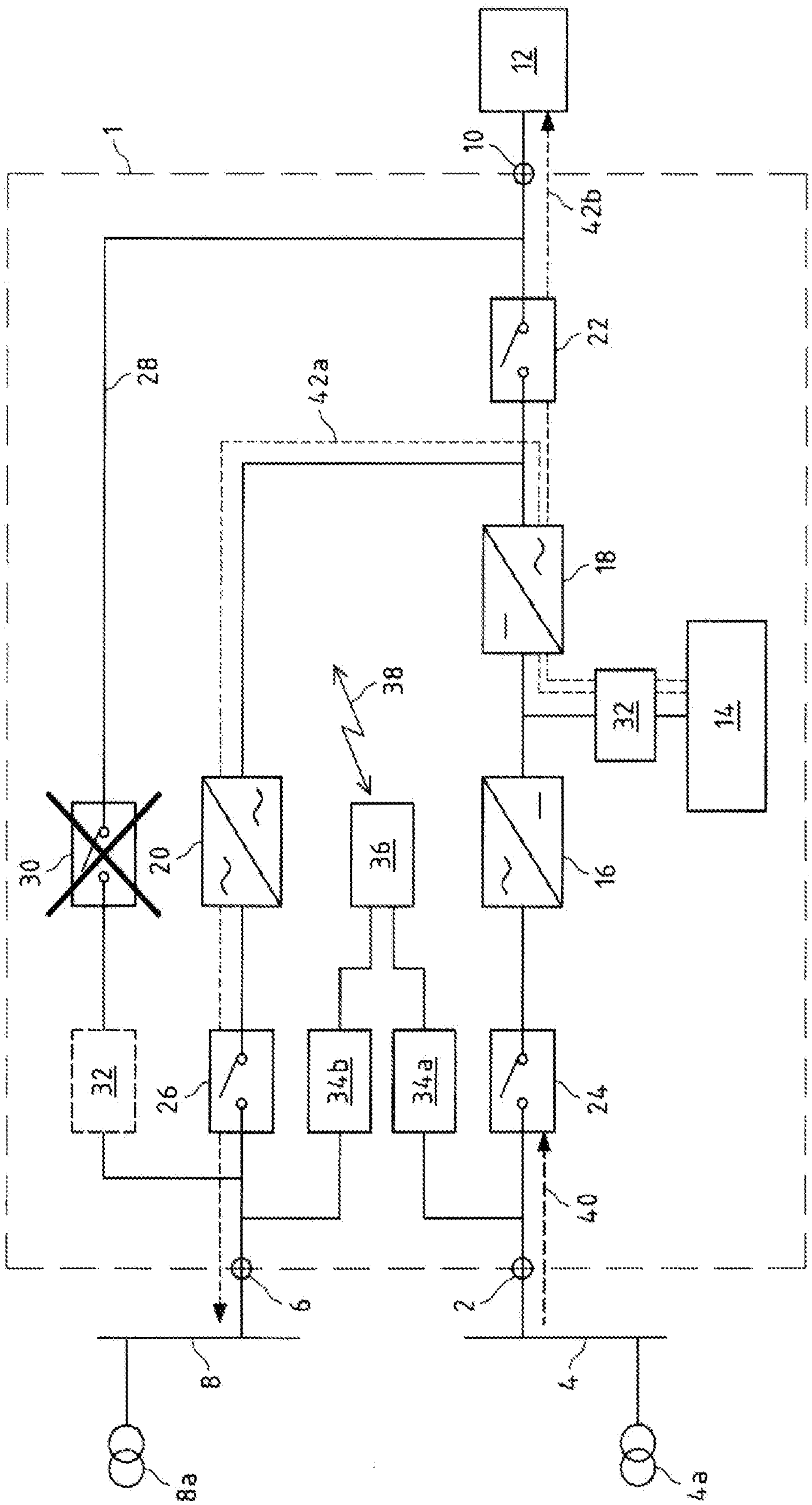
12
10
1
42b
22
28
42a
18
38
32
14
30
20
36
16
32
26
34b
34a
24
40
6
2
8
4
8a
4a

Fig.3

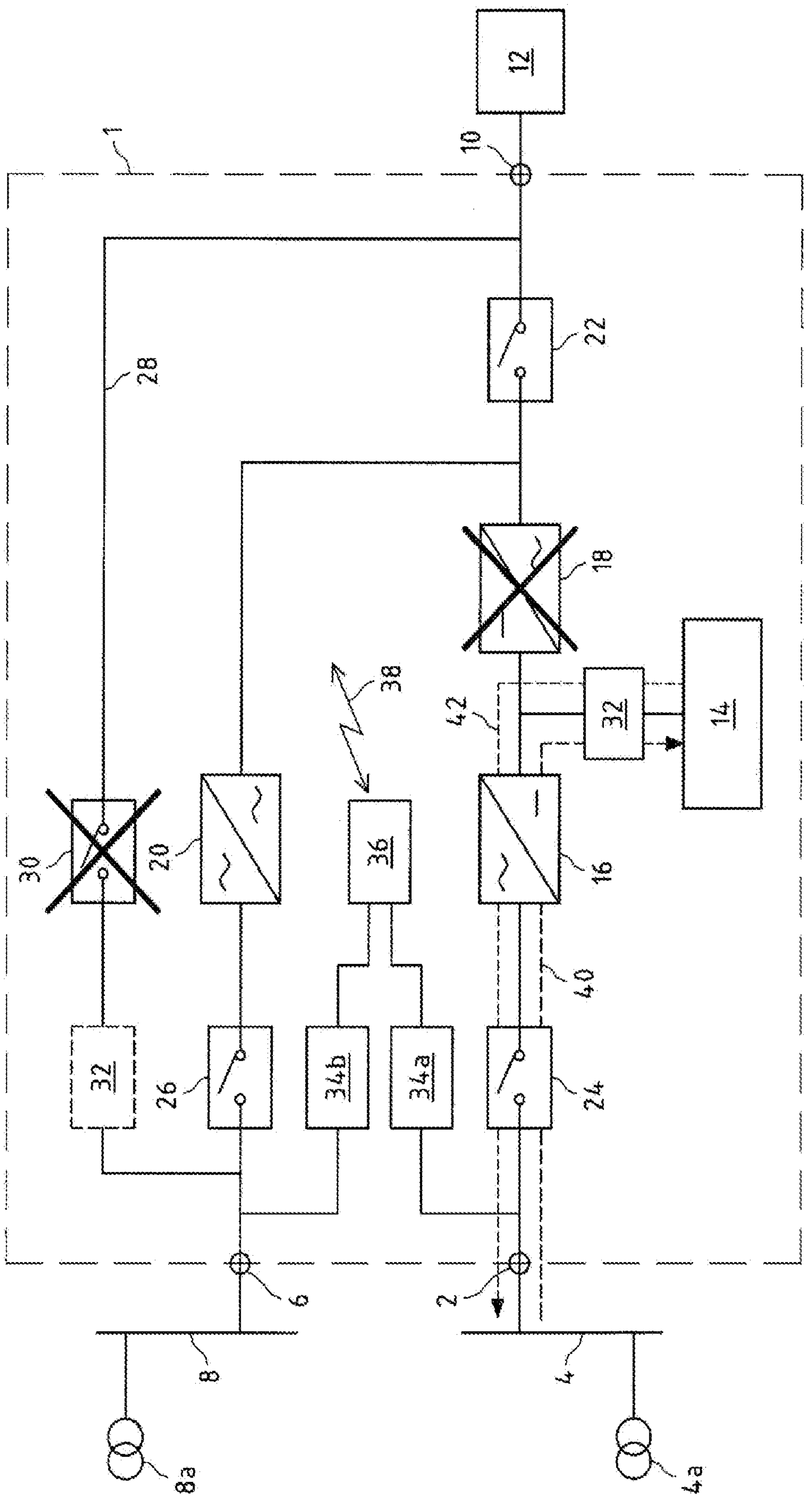

Fig.4

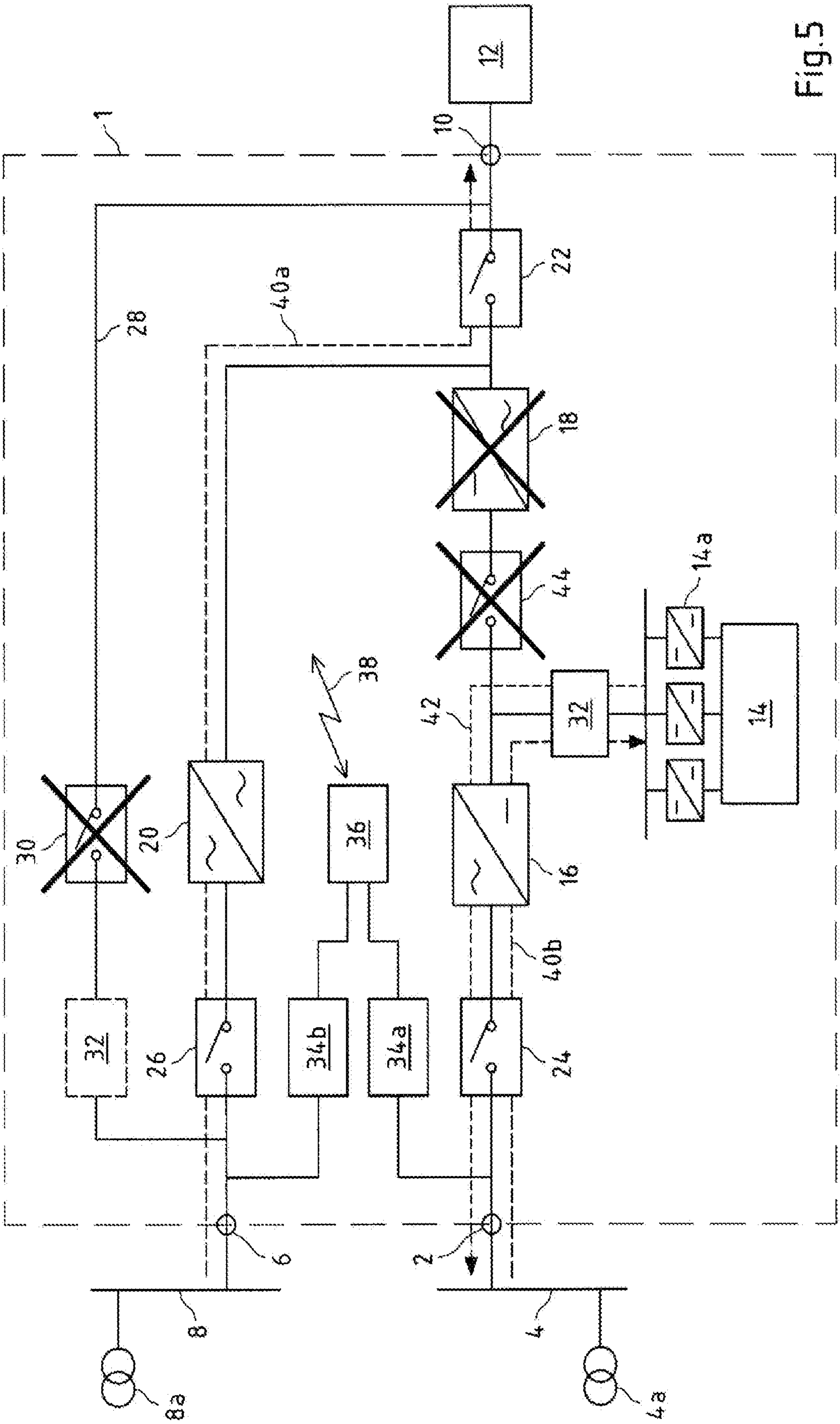
1
2
4
4a
6
8
8a
10
12
14
14a
16
18
20
22
24
26
28
30
32
32
34a
34b
36
38
40a
40b
42
44

Fig.5

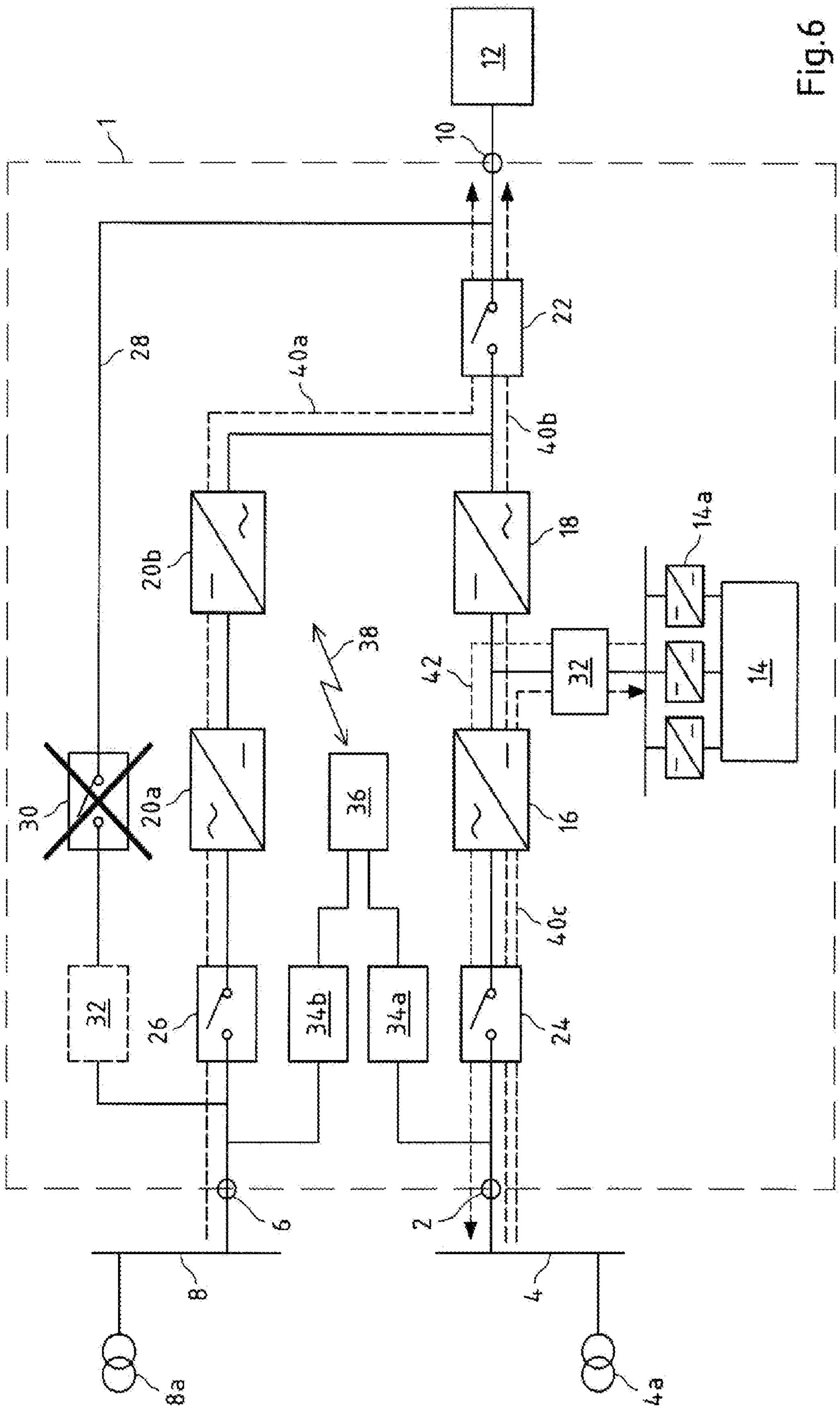
1
12
10
28
40a
22
40b
20b
18
14a
38
42
32
14
30
20a
36
16
40c
32
26
34b
34a
24
6
2
8
4
8a
4a

Fig.6

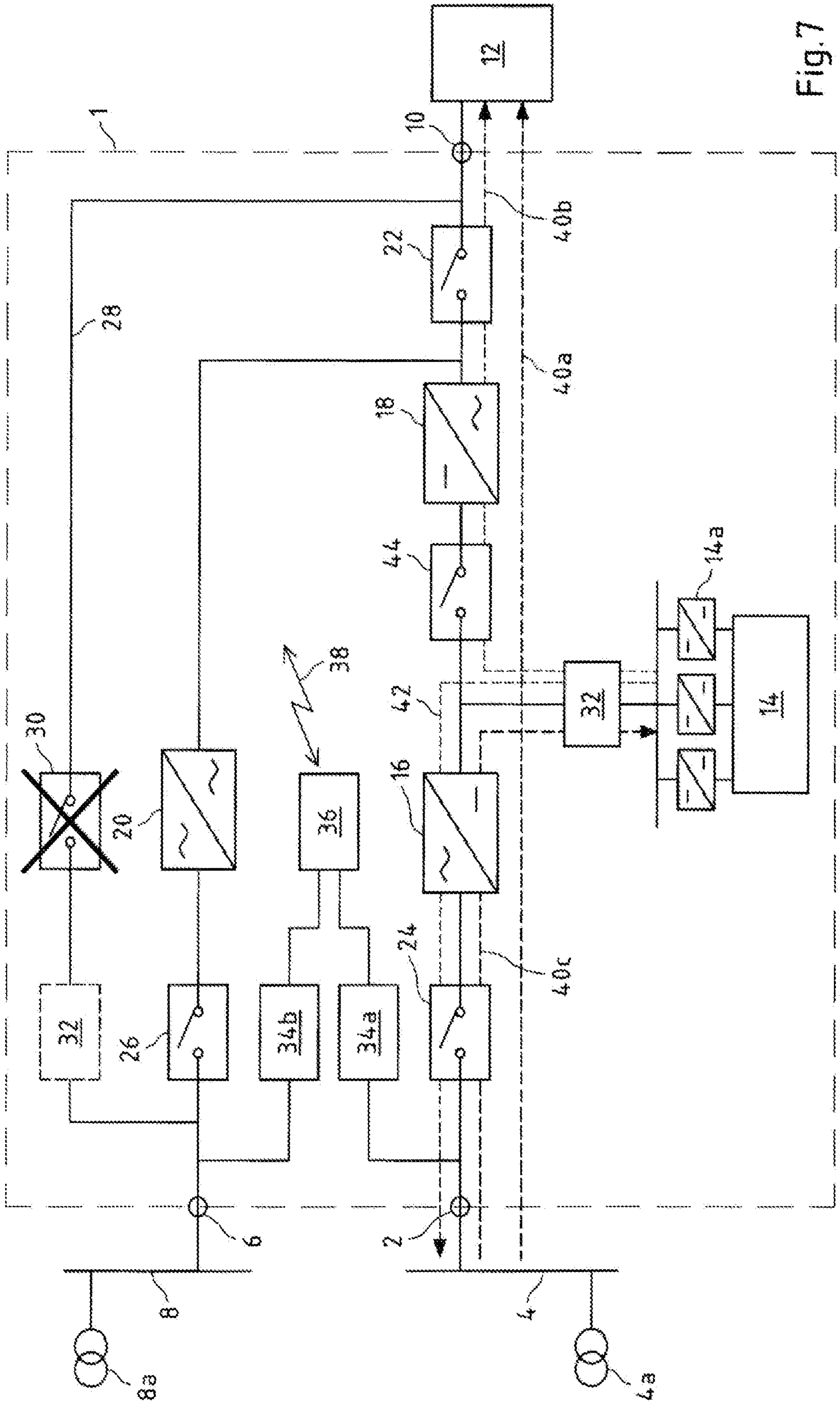
1
2
4
4a
6
8
8a
10
12
14
14a
16
18
20
22
24
26
28
30
32
32
34a
34b
36
38
40a
40b
40c
42
44

Fig.7