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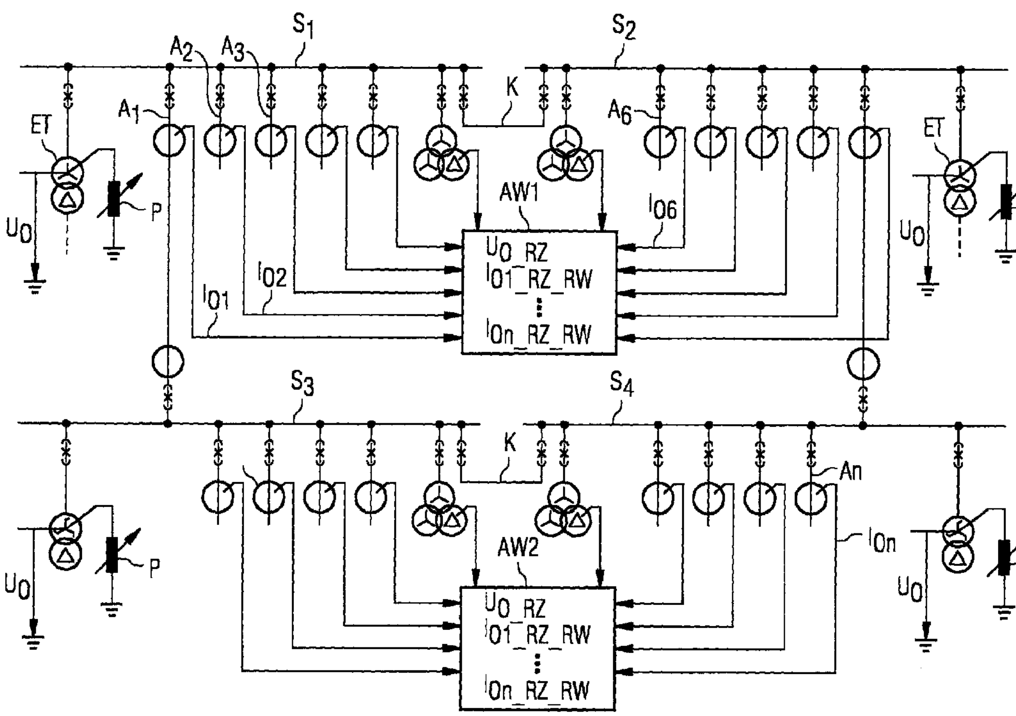
(54) Titre : PROCEDE D'IDENTIFICATION D'UNE DERIVATION SUJETTE A UN DEFAUT DE FUITE A LA TERRE D'UN RESEAU ELECTRIQUE TRIPHASE
(54) Title: METHOD FOR IDENTIFYING AN OUTGOING CIRCUIT HAVING AN EARTH FAULT IN A THREE-PHASE POWER SUPPLY SYSTEM



(57) Abrégé/Abstract:
The invention relates to a method for identifying an outgoing circuit having an earth fault in a three-phase power supply system, wherein the zero voltage (U_0) occurring at a neutral point and the zero currents ($I_{01}, I_{02},..., I_{0n}$) of the outgoing circuits ($A_1, A_2,..., A_n$)

(57) Abrégé(suite)/Abstract(continued):
are measured and stored at periodically recurring times, wherein a space vector representation of the zero voltage (U_{0_RZ}) and an active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) are determined on the basis of the space vector representation of the zero voltage (U_{0_RZ}) by means of transformation and, after an earth fault has been determined at a first time (t_1), a second time (t_2) at which the space vector representation of the zero voltage (U_{0_RZ}) has a local minimum is determined, and a third time (t_3) at which the space vector representation of the zero voltage (U_{0_RZ}) has a local maximum is determined, wherein the trapezoidal sum of the active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) is determined between the second time (t_2) and the third time (t_3) and is used to determine the outgoing circuit having the earth fault in that manner, and wherein the trapezoidal sum of the active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) is compared with a predefined variable threshold value and an earth fault is determined if this threshold value is exceeded.

Abstract

The invention relates to a method for identifying an outgoing circuit having an earth fault in a three-phase power supply system, wherein the zero voltage (U_0) occurring at a neutral point and the zero currents (I_{01}, I_{02},..., I_{0n}) of the outgoing circuits (A_1, A_2,..., A_n) are measured and stored at periodically recurring times, wherein a space vector representation of the zero voltage (U_{0_RZ}) and an active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) are determined on the basis of the space vector representation of the zero voltage (U_{0_RZ}) by means of transformation and, after an earth fault has been determined at a first time (t_1), a second time (t_2) at which the space vector representation of the zero voltage (U_{0_RZ}) has a local minimum is determined, and a third time (t_3) at which the space vector representation of the zero voltage (U_{0_RZ}) has a local maximum is determined, wherein the trapezoidal sum of the active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) is determined between the second time (t_2) and the third time (t_3) and is used to determine the outgoing circuit having the earth fault in that manner, and wherein the trapezoidal sum of the active component of the space vector representation of the zero currents ($I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,..., $I_{0n\_RZ\_WK}$) is compared with a predefined variable threshold value and an earth fault is determined if this threshold value is exceed

Description

Method for identifying an outgoing circuit having an earth fault in a three-phase power supply system

Technical Field

The invention relates to a method for identifying an outgoing circuit having a reigniting or intermittent earth fault in a three-phase power supply system.

Prior Art

Earth faults represent the most common faults in medium-voltage systems. They are triggered for example by cable damage, by a tree growing into an overhead line, by wind damage or by faulty insulation of the installation. The physical principles of the earth fault and methods for locating and clearing it using Petersen coils are described in "*Druml, Gernot. Innovative Methoden zur Erdschlussortung und Petersen-Spulen Regelung [Innovative methods for earth fault location and Petersen coil control]. na, 2012*".

Reigniting or intermittent earth faults are a particular challenge in this context. These occur primarily in three-phase power supply systems in which the neutral point of the transformer is earthed via a Petersen coil.

A method is known from EP 1 526 621 B1 for identifying an outgoing circuit having an intermittent earth fault in a busbar of a three-phase supply system, in which each occurrence of a transient earth fault on an outgoing circuit is detected and a criterion is obtained from the occurrence which displays an outgoing circuit as having an intermittent earth fault.

According to the teaching of this publication a measurement value is periodically obtained for each outgoing circuit, which for each period:

- upon the occurrence of a transient earth fault on this outgoing circuit is increased by a first value maximally to an upper limit value,
- upon the occurrence of a transient earth fault on another outgoing circuit is reduced by the first value minimally to a lower limit value, and
- in the absence of a transient earth fault is varied by a second, smaller value in the direction of zero, wherein an outgoing circuit is displayed as affected if the measurement value of said outgoing circuit exceeds a threshold value which is greater than the first value and smaller than or equal to the upper limit value.

DE 10 302 451 B3 describes a method for identifying the direction from the charging oscillation of one-time igniting, reigniting and intermittent earth faults, in which an earth fault is established if the amount of the zero voltage exceeds a predefined limit value at which furthermore charging conditions of the outgoing circuits are determined and the outgoing circuits affected by an earth fault are determined from the characteristic curve of the charging conditions.

The object underlying the present invention is to further develop the prior art.

Summary of the Invention

According to one aspect of the present invention, there is provided a method for identifying an outgoing circuit having an earth fault in a three-phase power supply system, wherein a zero voltage occurring at a neutral point and zero currents of outgoing circuits are measured and stored at periodically recurring times, in that a space vector representation of the zero voltage and an active component of a space vector representation of the zero currents are determined on the basis of the space vector representation of the zero voltage by means of transformation, in that after an earth fault has been determined at a first time, a second time at which the space vector representation of the zero voltage has a local minimum is determined and subsequently a third time at which the space vector representation of the zero voltage has a local maximum is determined, in that a trapezoidal sum of the active component of the space vector representation of the zero currents is determined between the second time and the third time and is used to determine the outgoing circuit having the earth fault such that the trapezoidal sum of the active component of the space vector representation of the zero currents is compared to a predefined variable threshold value and an earth fault is determined if this threshold value is exceeded.

In some embodiments, an earth fault is determined if the amount of the space vector representation of the zero voltage exceeds a predefined limit value.

In some embodiments, the space vector representation of the zero voltage and of the active component of the space vector representation of the zero currents is not stored until the first time.

In some embodiments, the difference between a local minimum and a local maximum of the space vector representations of the zero voltage must have a predefined minimum value.

In some embodiments, the procedure is aborted if the amount of the space vector representation of the zero voltage exceeds a predefined range.

In some embodiments, the trapezoidal sum is evaluated for each output circuit using a respective weighting function, in that the respective weighting function used for each output circuit is increased upon occurrence of an earth fault on that outgoing circuit by a first value up to maximally an upper limit value, in that upon occurrence of a transient earth fault on another outgoing circuit the weighting function is reduced by the first value down to minimally a lower limit value, and in that in the absence of a transient earth fault is modified by a second, smaller value in the direction of zero, wherein an outgoing circuit of said outgoing circuits is displayed as affected if the trapezoidal sum of said outgoing circuit evaluated using a weighting function exceeds a threshold value.

In some embodiments, the variable threshold value is determined from a total capacity of the outgoing circuits connected to a busbar.

In some embodiments, the variable threshold value is determined as a particular percentage of the total capacity of the outgoing circuits connected to a busbar.

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Brief Description of the Figure

The invention is explained in greater detail with reference to the exemplary medium-voltage three-phase power supply system schematically illustrated in the figure.

Embodiment of the Invention

A medium-voltage three-phase power supply system, as illustrated by way of example in the figure, is typically used to supply electrical energy to a region which comprises a plurality of localities, or in cities an urban district.

The nodes of the system are formed by busbars S, to which the outgoing circuits A_1, A_2, …A_n, i.e. the branches to consumers, as well as infeeds and couplings to other system nodes, are connected via switchgear.

In the illustrated example the infeed takes place by means of infeed transformers ET from superordinate high-voltage systems.

The secondary-side neutral points of the infeed transformers ET are connected to the earth potential via a so-called Petersen coil P or earth fault suppression coil, so that in the event of unintended earth faults in a line conductor the capacitive earth fault currents are compensated and at the location of the fault the fault voltage is reduced, as is described by way of example in "*Druml, Gernot. Innovative*

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Methoden zur Erdschlussortung und Petersen-Spulen Regelung [Innovative methods for earth fault location and Petersen coil control]. na, 2012".

The earth fault compensation takes place in each partial system of the medium-voltage system divided via couplings K.

The automatic tuning of the adjustable Petersen coils can for example take place by means of earth fault compensation regulators of the type EFC50 and EFC50i from Trench Austria GmbH.

The aforementioned company also offers devices of the type EFD 500 for the detection of earth faults. To this end the zero voltage U_0 of the medium-voltage system occurring on the Petersen coil P and the zero currents $I_{01}, I_{02}, \ldots I_{0n}$ of the outgoing circuits $A_1, A_2, \ldots A_n$ are detected and evaluated.

According to the invention, by means of evaluation devices AW1, AW2 for identifying an outgoing circuit having an earth fault in a three-phase power supply system, the values, measured and stored at periodically recurring times, of the zero voltage U_0 occurring at a neutral point or a Petersen coil are now converted by means of transformation into a space vector representation of the zero voltage U_{0_RZ} and the zero currents $I_{01}, I_{02}, \ldots, I_{0n}$ of the outgoing circuits $A_1, A_2, \ldots, A_n$ into an active component of the space vector representation of the zero currents $I_{01\_RZ\_WK}, I_{02\_RZ\_WK}, \ldots, I_{0n\_RZ\_WK}$ on the basis of the space vector representation of the zero voltage U_{0_RZ}.

The space vector representation, as described in "*Druml, Gernot. Innovative Methoden zur Erdschlussortung und Petersen-Spulen Regelung [Innovative methods for earth fault location* *and Petersen coil control]. na, 2012"*, results in a clear representation of transient operations.

Upon detection of an earth fault at a first time t_1 using known methods, as are also used for example by the devices of the type EFD 500 cited above, a second time t_2 is determined, at which the space vector representation of the zero voltage U_{0_RZ} has a local minimum. Subsequently a third time t_3 is determined, at which the space vector representation of the zero voltage U_{0_RZ} has a local maximum.

In the period between the second time t_2 and the third time t_3 the trapezoidal sum of the active component of the space vector representation of the zero currents $I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$, …, $I_{0n\_RZ\_WK}$ is ascertained and is used to determine the outgoing circuit having an earth fault.

The way in which this happens is that the trapezoidal sum of the active component of the space vector representation of the zero currents $I_{01\_RZ\_WK}$, $I_{02\_RZ\_WK}$,…, $I_{0n\_RZ\_WK}$ is compared to a predefined variable threshold value and an earth fault is determined if this threshold value is exceeded.

The threshold value is adaptively adjusted to the total capacity of the outgoing circuits connected to a busbar and thus brings about the consideration of changing system variables. For example, it can be set as a particular percentage of the total system capacity.

The determination of the system capacity can take place using known methods, as are applied for example in the devices of the type EFC50 and EFD500 from Trench Austria GmbH.

This adaptive adjustment of the threshold value has the advantage that the method becomes more reliable.

A further increase in the reliability of the method is achieved in that the method is aborted if the amount of the space vector representation of the zero voltage U_{0_RZ} exceeds a predefined range.

Thus the physical limits of the measurement devices are taken into account, which otherwise could lead to erroneous results.

The exemplary embodiment shows a resonant-earthed system with Petersen coils P. However, the invention is also equally applicable to non-earthed systems. In these cases the system capacity must for example be determined via cable data and switching states to determine the adaptive threshold value.

List of reference characters:

P	Petersen coil
K	Coupling
ET	Infeed transformer
A_1, A_2,… A_n	Outgoing circuits
I_{01}, I_{02}, … I_n	Zero currents of the outgoing circuits
U_0	Zero voltage
S_1, S_2, S_3, S_4	Busbars
AW_1, AW_2	Evaluation device

Claims

1. A method for identifying an outgoing circuit having an earth fault in a three-phase power supply system, wherein a zero voltage occurring at a neutral point and zero currents of outgoing circuits are measured and stored at periodically recurring times, in that a space vector representation of the zero voltage and an active component of a space vector representation of the zero currents are determined on the basis of the space vector representation of the zero voltage by means of transformation, in that after an earth fault has been determined at a first time, a second time at which the space vector representation of the zero voltage has a local minimum is determined and subsequently a third time at which the space vector representation of the zero voltage has a local maximum is determined, in that a trapezoidal sum of the active component of the space vector representation of the zero currents is determined between the second time and the third time and is used to determine the outgoing circuit having the earth fault such that the trapezoidal sum of the active component of the space vector representation of the zero currents is compared to a predefined variable threshold value and an earth fault is determined if this threshold value is exceeded.

2. The method as claimed in claim 1, wherein an earth fault is determined if the amount of the space vector representation of the zero voltage exceeds a predefined limit value.

3. The method as claimed in claim 1 or 2, wherein the space vector representation of the zero voltage and of the active component of the space vector representation of the zero currents is not stored until the first time.

4. The method as claimed in any one of claims 1 to 3, wherein the difference between a local minimum and a local maximum of the space vector representations of the zero voltage must have a predefined minimum value.

5. The method as claimed in any one of claims 1 to 4, wherein the procedure is aborted if the amount of the space vector representation of the zero voltage exceeds a predefined range.

6. The method as claimed in any one of claims 1 to 5, wherein the trapezoidal sum is evaluated for each output circuit using a respective weighting function, in that the respective weighting function used for each output circuit is increased upon occurrence of an earth fault on that outgoing circuit by a first value up to maximally an upper limit value, in that upon occurrence of a transient earth fault on another outgoing circuit the weighting function is reduced by the first value down to minimally a lower limit value, and in that in the absence of a transient earth fault is modified by a second, smaller value in the direction of zero, wherein an outgoing circuit of said outgoing circuits is displayed as affected if the trapezoidal sum of said outgoing circuit evaluated using a weighting function exceeds a threshold value.

7. The method as claimed in any one of claims 1 to 6, wherein the variable threshold value is determined from a total capacity of the outgoing circuits connected to a busbar.

8. The method as claimed in claim 7, wherein the variable threshold value is determined as a particular percentage of the total capacity of the outgoing circuits connected to a busbar.

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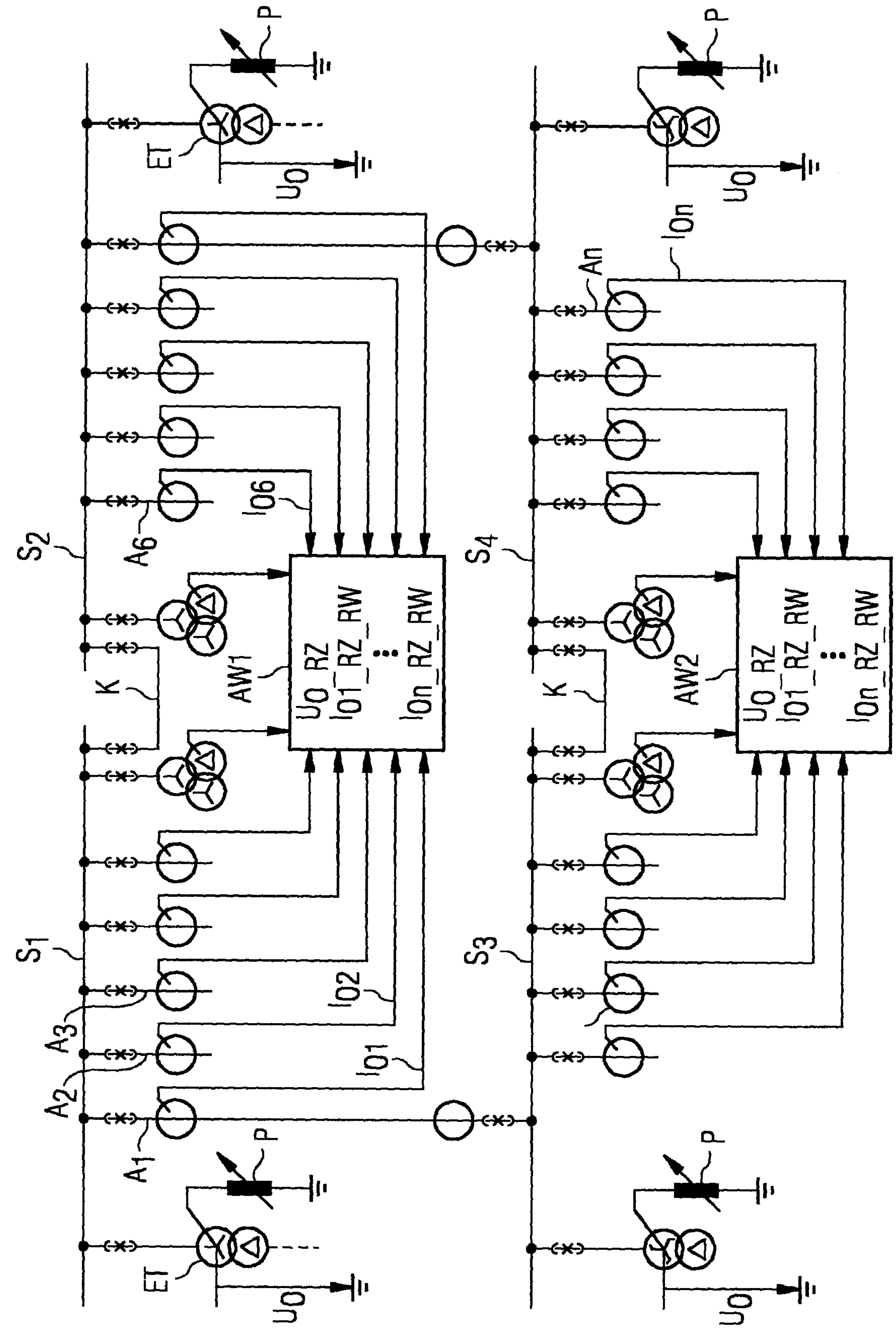
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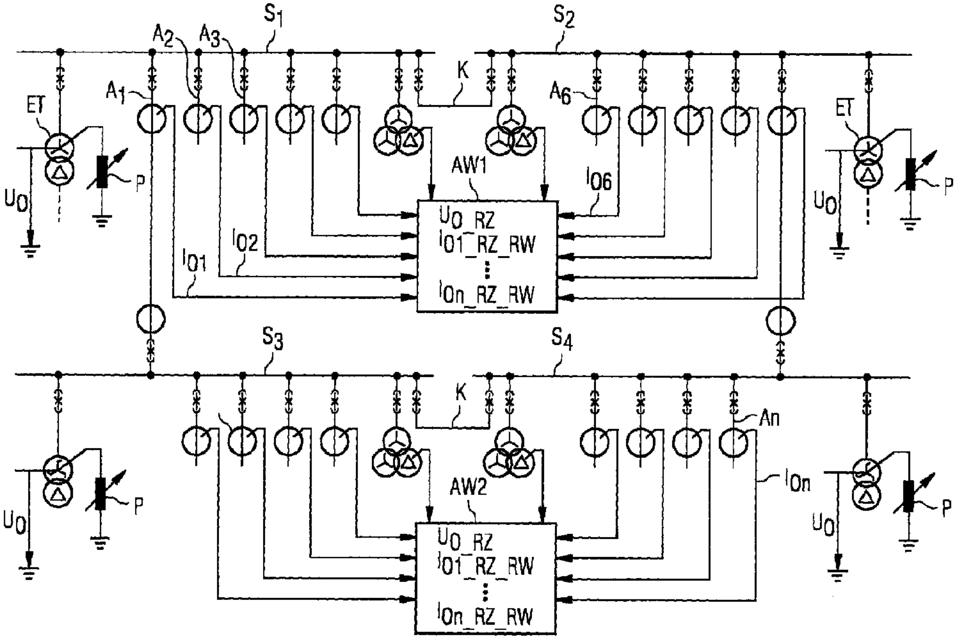
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