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(54) **Voltage measuring transformer**

(57) The invention relates to a voltage measuring transformer for transforming a high voltage into a low voltage, which transformer comprises:

- an iron core;
- a primary, high voltage, coil (2) wound around the core;

- a secondary, low voltage, coil (3) wound around the core; and
- means (4,5) for increasing the resistance upon the occurrence of ferro-resonance arranged in series with the primary, high voltage, coil.

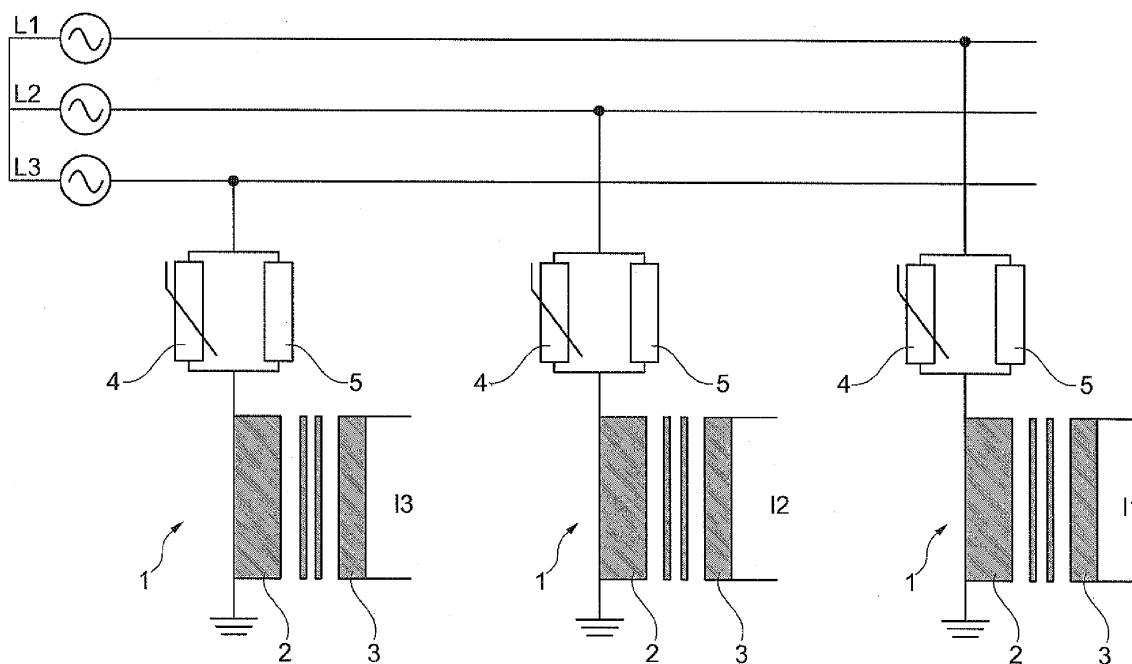


Fig. 1

Description

[0001] The invention relates to a voltage measuring transformer for transforming a high voltage into a low voltage, which transformer comprises:

- an iron core;
- a primary, high voltage, coil wound around the core; and
- a secondary, low voltage, coil wound around the core.

[0002] The invention relates in particular to voltage measuring transformers or potential transformers which are used in power distribution. voltage measuring transformers are typically used to reduce a high voltage of several kilo-voltage down to typical voltages of for example 100 V. This enables one to measure high voltage at low voltage level

[0003] A known phenomenon with voltage measuring transformers is the occurrence of ferro-resonance. Due to ferro-resonance, the current can increase out of control, damaging the voltage measuring transformer due to overheating.

[0004] This damaging of the voltage transformer could result in a violent failure and damage to switchgear and other components nearby.

[0005] Ferro-resonance is typically initiated when the following elements are present:

- The power system has a floating neutral but is grounded at the voltage transformer;
- The shielded cable length or overhead conductor length connected to the transformer is sufficient to create a capacitance necessary to generate ferro-resonance;
- The size of the transformer permits saturation of the iron core at temporary over voltages;
- The transformer is unloaded or lightly loaded.

[0006] These conditions could be met if some kind of failure arises, for example when clearing an earth fault.

[0007] To prevent ferro-resonance as a result of these condition, several solutions are known. EP 1727257 describes the use of a tertiary coil on the low voltage side of the transformer to provide a damping or load to dampen possible ferro-resonance. This publication proposes a load consisting of a positive temperature coefficient thermistor in series with two other resistances. When ferro-resonance occurs, the voltage and current in the tertiary coil will increase in a 3-phase circuit. As a result the positive temperature coefficient thermistor will warm up and provide additional resistance, damping and clearing the ferro resistance.

[0008] This solution requires however a three phase setup, in which the tertiary coils of the separate voltage measuring transformers are connected in series.

[0009] Providing a resistance in the primary coil on the

high voltage side of the voltage measuring transformer is not obvious. The additional resistance will influence the accuracy of voltage measuring and is not desired.

[0010] It is an object of the invention to reduce the above mentioned disadvantages. This object is achieved according to the invention with a voltage measuring transformer, which is characterized by means for increasing the resistance upon the occurrence of ferro-resonance arranged in series with the primary, high voltage, coil.

[0011] The current on the high voltage side of a transformer is typically small. Only when ferro-resonance occurs, the current will increase rapidly. By having means for increasing the resistance upon such an occurrence, the ferro-resonance can be damped.

[0012] As the resistance will only be increased on ferro-resonance, the means for increasing the resistance will have no effect during normal operation. This ensures that voltage measurements can be conducted at high accuracy.

[0013] In a preferred embodiment of the voltage measuring transformer according to the invention, the means for increasing the resistance comprise at least a positive temperature coefficient thermistor arranged in parallel with a resistor.

[0014] The resistance of a positive temperature coefficient (PTC) thermistor increases when the temperature rises. When ferro-resonance occurs, the current will substantially increase resulting in a substantial temperature rise. This will cause the PTC thermistor to increase the resistance and damp and extinct the ferro-resonance.

[0015] To relieve the PTC thermistor from a too high current during ferro-resonance, an additional resistance is arranged in parallel, which will partly take over, when the resistance of the thermistor has increased due to the temperature rise.

[0016] During normal operation of the voltage measuring transformer, the current in the high voltage coil is low and the temperature of the transformer is low, such that the resistance of the PTC thermistor is small or even not relevant. So, the current in the high voltage coil during normal operation will flow through the PTC thermistor leaving the additional resistance out of use.

[0017] An additional advantage of having means for increasing the resistance arranged in the primary, high voltage, coil is that these means can be arranged per voltage measuring transformer. So, a three phase setup is not required and the invention can also be applied to a single phase voltage measuring transformer.

[0018] Preferably, a varistor is provided for protection of the thermistor. The resistance of a varistor decreases abruptly upon increased voltage. So, when the voltage due to ferro-resonance increases to such a high level, that otherwise the PTC thermistor would be damaged, the varistor will shunt the thermistor and prevent damage to the thermistor. Yet another embodiment of the voltage measuring transformer according to the invention comprises at least two thermistors being in heat conducting

contact with each other.

[0019] By putting the two thermistors in heat conducting contact it is ensured that the thermistors will heat up evenly during ferro-resonance and that the increase in resistance will be even between the at least two thermistors. Without the heat conducting contact, it could occur that only one thermistor takes up the increased current.

[0020] Preferably, the at least two thermistors are arranged on a heat conducting frame. This heat conducting frame could be integrated in the frame of the voltage measuring transformer.

[0021] In yet another embodiment of the voltage measuring transformer according to the invention, the means for increasing the resistance comprise at least a bipolar transistor.

[0022] Instead of a PTC thermistor it is also possible use a bipolar transistor like an Insulated-gate bipolar transistor (IGBT) or Gate turn-off thyristor (GTO). These and other features of the invention will be elucidated in conjunction with the accompanying drawings.

[0023] The figure shows a schematic view of an embodiment of the voltage measuring transformer according to the invention.

[0024] The figure shows a three phase setup for transforming a high voltage three phase current L1, L2, L3 into a low voltage three phase current I1, I2, I3.

[0025] For each phase L1, L2, L3 a voltage measuring transformer 1 according to the invention is provided. Each voltage measuring transformer 1 has a high voltage primary coil 2 and a low voltage secondary coil 3 (shown schematically in the figure).

[0026] One side of each high voltage primary coil 2 is grounded while the other side of the primary coil is connected to one of the phases L1, L2, L3 of the high voltage power supply.

[0027] In this embodiment, shown in the figure, means 4, 5 for increasing the resistance upon the occurrence of ferro-resonance are arranged in series with the primary, high voltage, coil 2 of the voltage measuring transformer 1. These means 4, 5 are arranged on the high voltage side of the transformer 1, but can also be arranged on the grounded side.

[0028] The means for increasing the resistance have a positive temperature coefficient thermistor 4 and a conventional resistor 5 arranged in parallel.

[0029] During normal operation, the current through the primary coil 2 will be low, such that the temperature remains low. As a result, the resistance of the PTC thermistor 4 will be small, such that the current goes through the PTC thermistor 4.

[0030] The resistance of the resistor 5 will be selected high, such that in normal operation, virtually no current will flow through the resistor 5.

[0031] Only when ferro-resonance occurs, which is accompanied with high currents in the primary coil 2, will the temperature rise. Due to the temperature rise, the resistance of the thermistor 4 will increase providing a load to dampen the ferro-resonance.

[0032] The conventional resistor 5 will ensure that the current through the thermistor 4 will be kept within limits, as with increasing resistance of the thermistor 4, part of the current will go through the conventional resistor 5.

Claims

1. voltage measuring transformer for transforming a high voltage into a low voltage, which transformer comprises:
 - an iron core;
 - a primary, high voltage, coil wound around the core; and
 - a secondary, low voltage, coil wound around the core, **characterized by** means for increasing the resistance upon the occurrence of ferro-resonance arranged in series with the primary, high voltage, coil.
2. voltage measuring transformer according to claim 1, wherein the means for increasing the resistance comprise at least a positive temperature coefficient thermistor arranged in parallel with a resistor.
3. voltage measuring transformer according claim 2, wherein a varistor is provided for protection of the thermistor.
4. voltage measuring transformer according to claim 2 or 3, comprising at least two thermistors being in heat conducting contact with each other.
5. voltage measuring transformer according to claim 4, wherein the at least two thermistors are arranged on a heat conducting frame.
6. voltage measuring transformer according to claim 1, wherein the means for increasing the resistance comprise at least a bipolar transistor.

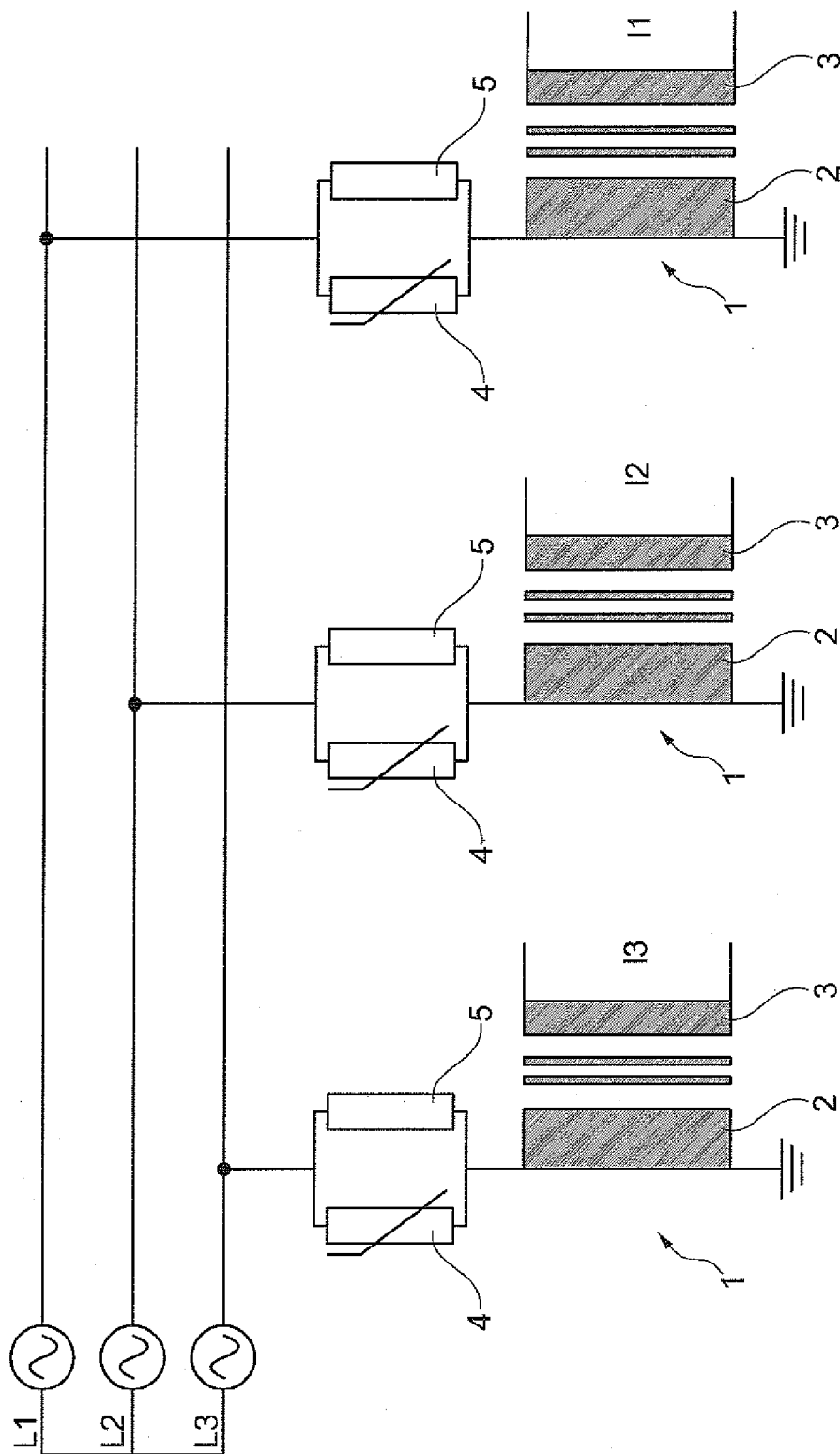


Fig. 1



EUROPEAN SEARCH REPORT

Application Number
EP 12 15 2587

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 June 2012	Examiner Warneck, Nicolas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 15 2587

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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15-06-2012

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