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Earth-leakage protective circuit arrangement

Description

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The invention relates to an earth-leakage protective circuit arrangement in accordance with the preamble of Claim 1.

10 In electrical installations, the principle of selectivity is used in order to increase the availability of electrical energy. In this case, in a power supply with a plurality of loads, the intention is to avoid the situation where, in the event of a
15 fault occurring at one load, the entire associated power supply installation is switched off.

DE 196 02 911 has disclosed a circuit arrangement for detecting a fault current in which the primary winding
20 is conducted through a core-balance current transformer; there are two windings on the current transformer, one of which is connected to a release, whereas the other serves for premagnetizing the core. Both an AC fault current and a DC fault current can be
25 detected with this configuration, because when a DC fault current occurs, owing to the premagnetization of the core, the induction of the latter changes, and this can be detected by means of a suitable evaluation circuit.

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DE 25 55 255 C3 has disclosed an earth-leakage protective circuit-breaker arrangement in which two core-balance current transformers are provided, both of which are premagnetized by a generator supplied with
35 power supply current, in order that the circuit arrangement can respond even in the event of DC fault currents.



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DE 38 23 097 A1 has disclosed a selective main switch of an arrangement for protection against fault currents comprising a main switch and branch switches arranged downstream. In this case, the main switch is said to have two sub-devices, one of which is designed according to the principle of action of an earth-leakage protective circuit-breaker of a first type of fault currents, and the other of which is designed to detect fault currents from smooth direct current. The way in which the circuit arrangement is ultimately designed cannot be gathered from DE 38 23 097 A1.

DE 38 23 099 C2 has disclosed a device for protection against fault currents of the type mentioned in the introduction. The so-called first sub-device responds to alternating current or to pulsed direct current independently of the power supply voltage; the second sub-device has a second core-balance current transformer, which is premagnetized, the premagnetization frequency corresponding to the power supply frequency. The second sub-device is coupled to the first sub-device via a bridge rectifier whose diodes cannot completely prevent one circuit from influencing the other. If, by way of example, a DC fault current and an AC fault current are present and, by themselves, are each smaller than the rated fault current value, then triggering can take place since, on account of the bridge circuit, the two fault currents can be added at the release.

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DE 197 35 412 A1 has disclosed a circuit arrangement in which the first sub-device, which detects AC or pulsed fault currents independently of the power supply voltage, is assigned a decoupling circuit.

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The object of the invention is to provide an earth-leakage protective circuit arrangement of the type mentioned in the introduction which also has selective properties as a universal-current-sensitive circuit

arrangement and is an improvement on the known circuit arrangements.

This object is achieved according to the invention by
5 means of the characterizing features of Claim 1.

According to the invention, accordingly, the first device element is an energy storage circuit with a first energy store. The premagnetizing device of the
10 second device element is an oscillator which premagnetizes the core at a predetermined frequency, and the second device element with a second energy store is connected to the first energy store via a controllable semiconductor and a threshold-value
15 switch, with the result that, in the event of a fault current occurring, the energy store is charged only when a predetermined fault current is reached; in order to decouple the two device elements, a diode is situated between the first energy store and the
20 threshold-value switch, which diode is forward-biased in the direction of the first energy store.

In contrast to DE 38 23 099 C2, the first device element is designed as an energy storage circuit. The
25 capacitor illustrated in the drawing of the citation serves merely for detecting pulsed fault currents, but not as an energy store. The premagnetizing device is an oscillator in the subject-matter of the application, with the result that the core can be premagnetized at
30 frequencies that can be higher than the power supply frequency. This increases the effectiveness and reliability of the earth-leakage protective circuit arrangement.

35 The two device elements are fitted together with a power supply unit, having a rectifier, on a common printed circuit board.



- According to a further configuration of the invention, the second device element may have a sine-wave generator as oscillator, whose output premagnetizes the second core-balance current transformer. When a fault current occurs, the induction of the core-balance current transformer changes, which is evaluated, with the result that the energy store of the first device element is charged.
- Furthermore, the earth-leakage protective circuit arrangement has a test circuit which, according to the invention, is assigned to the second core-balance current transformer.
- The particular advantages of the circuit arrangement consist in the fact that it provides a selective universal fault current main protective circuit-breaker. Furthermore, the earth-leakage protective circuit-breaker can trigger with a time delay and also have a high surge withstand strength. Moreover, the arrangement according to the invention can be used in a current-operated earth-leakage circuit-breaker with overcurrent release with high surge withstand strength and with selective properties.
- The invention and also further advantageous configurations and improvements of the invention will be explained and described in more detail with reference to the drawing, which illustrates an exemplary embodiment of the invention.

In the figures:

Figure 1 shows a schematic block diagram of the earth-leakage protective circuit arrangement, and

Figure 2 shows a circuit arrangement for the earth-leakage protective circuit according to Figure 1.

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In a three-phase power supply having the three phase conductors L1, L2 and L3 and also having the neutral conductor N, two core-balance current transformers 10 and 11 are provided, the power supply conductors being routed as primary windings through the transformers 10 and 11. In the power supply lines there are contact points 12 for the phase conductors L1 to L3 and the neutral conductor, which are driven by a latch 13, with the result that the latch 13, which has a latching point (not shown), permanently opens the contact points 12. The latch is furthermore assigned an actuating knob 14, with which the latch or the earth-leakage protective circuit-breaker can be switched on and off.

The secondary winding 15 of the transformer 11 is assigned to a release device 16, which is configured selectively and responds to AC fault currents and releases the latch independently of the power supply voltage by means of a release (not specifically illustrated).

The further transformer 10 is assigned a further secondary winding 17, which is connected to a further evaluation device 18, which is universal-current-sensitive and is selective and is supplied with current by power supply conductor connections 19.

The second core-balance current transformer 10 is assigned a test circuit 20, which has a test resistor 21 and is routed through the core-balance current transformer 10. The test circuit is situated between the phase conductor L3 and the neutral conductor N. It has a test button 22; when the latter is closed, a fault current is simulated which is detected by the further evaluation device 18 and leads to the unlatching of the latch 13.



Figure 2 shows the circuit arrangement according to Figure 1 in detail.

A power supply device is connected to the power supply
5 conductors L1, L2 and L3 and also the neutral
conductor N and generates a positive and negative
voltage with respect to earth M by means of diodes D7
to D12 and further protective circuitry elements,
10 namely resistors R6 to R14, a capacitor C5 in series
therewith, 2 threshold-value switches D13 and D14 and
also a further capacitor C6.

A power supply device of this type is known per se as a
power supply unit.

15

This power supply unit, then, is used to drive the
device 18, which is separated off by the dashed lines
at the bottom in Figure 2. The circuit arrangement
illustrated in the block diagram 16 in Figure 1 serves
20 for detecting a fault current independently of the
power supply current.

The latter circuit arrangement 16 will now be
considered first of all.

25

The terminals 31 and 32 connect the circuit
arrangement 16 to the secondary winding 15 of the
transformer 11. Connected in parallel with the
terminals 31 and 32 is a resistor R1 and, in parallel
30 with the latter, a varistor V1, and connected in series
with the terminal 31 is a resistor R2, a capacitor C1
and also a diode D4, which is forward-biased in the
direction of the terminal 34 associated with a release
(not shown).

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Between the resistor R2 and the capacitor C1, two zener
diodes D1 and D2 are connected in parallel with the
terminals 31 and 32, which diodes are connected
oppositely in terms of their forward direction. A





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capacitor C2 is connected in parallel with the two zener diodes; a further diode D3 is inserted between the capacitor C1 and the diode D4 in parallel with the terminals 31, 32 and constitutes a rectifier arrangement together with the diode D4. A first storage capacitor C3 is connected downstream of the diode D4 and in parallel with the terminals 31 and 32. Connected in parallel with this first storage capacitor C3 is a drive unit IC1 for a transistor Q1, whose collector is connected via a resistor R3 to the terminal 31 and whose emitter is connected via a capacitor C4 with respect to earth. Connected between the emitter of the transistor Q1 and the capacitor C4 is a parallel circuit formed by a resistor R4 and R5, the resistor R5 being connected in parallel with the base-emitter junction of a further transistor Q2. A freewheeling diode D6 is arranged between the emitter and the collector of the transistor Q2, and a diode D5 is connected between the collector of the transistor Q2 and the connecting line between the terminals 31 and 34, this diode D5 being forward-biased in the direction of the connecting line. A second terminal 33 is connected between the connection of the diode D6 to the collector of the transistor Q2 and the diode D5 and is the other terminal of the release which is not illustrated.

The resistor R1 serves for damping; the varistor V1 with the zener diodes D1 and D2 increases the surge withstand strength. The capacitors C1 and C2 together with the diodes D3 and D4 form a standard voltage doubler; the drive element IC1 is a comparator. The capacitor C4 maintains the charge state for the output pulse.

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In the event of a fault current on the secondary winding between the terminals 31 and 32, the first storage capacitor C3 is charged, and drives the transistor Q1 via the drive element IC1; the



transistor Q1 drives the transistor Q2, with the result that the energy charged in the first storage capacitor C3 can be discharged to the terminals 33 and 34 of the release.

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The circuit arrangement 18 will now be considered:

The terminals 35 and 36 are connected to the secondary winding 17 of the core-balance current transformer 10.

10 A varistor V2 is connected in parallel with the terminals 35 and 36 and is connected by one of its ends to the output of an operational amplifier IC2, which is supplied with energy by the power supply unit (plus, minus), the output of the operational amplifier IC2
15 being connected to the terminal 35.

One input, the non-inverting input, of the operational amplifier IC2, which is connected to its output, contains a resistor R17 and also a capacitor C7; the
20 output is additionally connected to earth M via a parallel circuit formed by a resistor R18 and a capacitor C8.

The other, inverting input of the operational
25 amplifier IC2 is connected on the one hand to earth via a resistor R19 and on the other hand to its output via a resistor R20 as protective circuitry elements; two zener diodes D15 and D16 are situated between the output and the resistor R20 and earth.

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The comparator IC2 together with its protective circuitry, in which the capacitor C7 and the resistor R17 are connected to the non-inverting input, serves as an oscillator, as a sine-wave generator, with
35 the result that a sinusoidal signal is generated at the output of the comparator IC2, which signal is passed via the terminals 35 and 36 to the coil of the second core-balance current transformer 10, whereby the core-balance current transformer is premagnetized, i.e.



magnetized or demagnetized, by this sinusoidal signal. By virtue of the fact that the output signal of the comparator IC2 is a sinusoidal signal, the power loss is low, which would not be the case with square-wave signals.

A voltage divider having the resistors R21 and R22 is connected in series with the varistor V2 and earth M. Connected between the two resistors R21 and R22 is a capacitor C9 and also a rectifier circuit having the diodes D17 and D18 and a second storage capacitor C10 is connected in parallel therewith. A further resistor R23 is connected in parallel with the said second storage capacitor; the base of a transistor Q3 is connected to the junction point between the second storage capacitor C10 and the resistor R23, the collector of which transistor is connected to the positive pole of the supply voltage and the emitter of which transistor is connected to a comparator IC3, whose output signal is fed to the store C3 via the line 40 via a resistor R25 and a forward-biased diode D19. A resistor R24 is connected in parallel with the comparator IC3.

The second storage capacitor C10 serves as an energy store for a fault-current signal originating from the associated core-balance current transformer 10 and also serves for increasing the surge withstand strength.

If a fault current occurs, in particular a DC fault current, then the hysteresis of the core-balance current transformer is shifted, the impedance of the coil changing, i.e. the inductance decreasing, with the result that a changed voltage can be tapped as a signal on the voltage divider R21/R22. This secondary signal is fed to the second storage capacitor C10, and the transistor Q3 is driven via the latter such that it is turned on. As a result, a signal corresponding to the secondary signal is conducted via the comparator IC3 to

the first storage capacitor C3, with the result that the latter is charged and, when a specific charge state is exceeded, outputs an output signal to the release via the terminals 34, 33.

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For decoupling purposes, the transistor Q3, the comparator IC3 and a diode D19 are provided in the circuit arrangement according to the invention. On account of the driving of the transistor Q3 in
10 conjunction with the comparator IC3, the storage capacitor C3 is charged only when a DC fault current at the rated value (or exceeding the latter) occurs.

On account of the transistor Q3 and the comparator IC3,
15 a fault current which is smaller than the rated fault current is not switched through, and, furthermore, reverse decoupling is achieved by means of the rectifier diode D19 in conjunction with the comparator IC3 and the transistor Q3, thereby likewise preventing
20 the device element 18 from being influenced by the device element 16.

Both the circuit arrangement 18 and the circuit arrangement 16 operate via the terminals 34 and 33
25 jointly on a release, the two circuit arrangements 16 and 18 not influencing one another.

On account of the particularly simple configuration (with respect to the low power loss) of the sine-wave
30 generator with the operational amplifier IC2, the entire circuit arrangement including a power supply unit can be placed onto a printed circuit board, as a result of which the space requirement is considerably reduced.

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Patent claims

1. Earth-leakage protective circuit arrangement that can be built into a power supply to be
5 safeguarded, having a latch which is released by a release in the event of a fault current occurring and, at the same time, permanently opens contact points situated in the power supply, having a first device element having a first core-balance
10 current transformer whose secondary signal is fed to the release, with the result that the release triggers independently of the power supply voltage in the event of a fault current occurring, and having a second device element having a second
15 core-balance current transformer whose core is premagnetized by a premagnetizing device supplied by the power supply, in which case, in the event of a fault current, in particular a DC fault current, occurring, the operating point of the
20 core is altered, with the result that a signal is generated which can be fed to the release and the latter triggers in a manner dependent on the power supply voltage, characterized in that the first device element (10) is an energy storage circuit
25 with a first energy store (C3), in that the premagnetizing device of the second device element (18) is an oscillator which premagnetizes the core at a predetermined frequency, in that the second device element (18) is connected to the first energy store (C3) via a controllable semiconductor
30 (Q3) and a threshold-value switch (IC3), with the result that, in the event of a fault current occurring, the first energy store is charged only when a predetermined fault current is reached, and in that a diode (D19) is provided, for the purpose
35 of decoupling the two parts, between the first energy store (C3) and the threshold-value switch (IC3), which diode is forward-biased in the direction of the first energy store (C3)





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2. Earth-leakage protective circuit arrangement according to Claim 1, characterized in that the second device element (18) has a sine-wave generator as oscillator.
- 5 3. Earth-leakage protective circuit arrangement according to Claim 1 or 2, characterized in that the second device element (18) has a second energy store (C10), which drives the controllable
10 semiconductor (Q3) when a specific charge state is reached, with the result that a signal corresponding to the fault current detected by the second device element (18) can be fed to the first energy store (C3).
- 15 4. Earth-leakage protective circuit arrangement according to one of Claims 1 to 3, characterized in that the two release devices are constructed on a common printed circuit board.
- 20 5. Earth-leakage protective circuit arrangement according to one of the preceding claims, characterized in that the test circuit is assigned to the second core-balance current transformer
25 (10).

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