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The invention relates to an electrical switching device comprising control electronics capable of having a control signal applied thereto, the control electronics being connected to a switching relay whose switching contacts are connected between at least one alternating voltage terminal capable of having
5 a voltage-carrying conductor of an alternating voltage system connected thereto and at least one load terminal capable of having an electrical consumer connected thereto.

An example of such an electrical switching device is disclosed in
10 EP-A-0997921.

Such switching devices are in particular used in building installations and serve for example to switch on and off electrical lighting fixtures but can as well serve to control a contactor, said contactor in turn switching a high-powered
15 electrical consumer. By way of the control electronics, the magnet coil of the switching relay can have an electric current applied thereto so that the switching contacts are opened or closed by the magnet coil. The current to the magnet coil is provided by the control electronics, to which the user can apply a control signal, such as a voltage impulse which the user can trigger by way
20 of a pushbutton element. Such electrical switching devices are customarily configured as DIN rail-mounted devices and can be latched onto support rails.

An advantage of the use of a switching relay is that the switching relay permits the control electronics to be separated from the potential of the
25 alternating voltage present at the alternating voltage terminal in a structurally simple way because, by way of the switching relay's magnet coil, the switching contacts of the switching relay can be actuated inductively so that the switching contacts are not connected galvanically to the control electronics.

30 The actual switching operation of the switching device takes a few milliseconds. If an alternating voltage is switched, the transition of the switching state can involve imposing a considerable load upon the switching device because in the presence of a large voltage amplitude the switching

contacts may become fused together. In switching devices where a semiconductor, for example a MOSFET, is used instead of a relay, it is therefore known to perform the switching operation at a time when the alternating voltage present at the alternating voltage terminal passes through a zero-crossing. This reduces the load upon the switching device.

However, if the switching is operated in the region of the zero-crossing of the applied alternating voltage and if the switching device is used to switch a contactor, the result then is that due to the introduction of switching delays, although the switching operation of the switching device takes place at a point in time that is at least near the zero-crossing of the applied alternating voltage, the switching operation of the downstream contactor often takes place at a point in time at which the amplitude of the alternating voltage is already passing through a maximum again.

It is an object of the present invention to improve an electrical switching device of the generic type in such a manner that the switching operation can be optionally performed dependently or independently of the zero-crossing of the alternating voltage present at the alternating voltage terminal while maintaining potential separation between the alternating voltage present at the alternating voltage terminal during the operation of the switching device and the control electronics.

This object is achieved, in accordance with the invention, in an electrical switching device of the type mentioned at the outset in that the switching device has a neutral conductor terminal that is capable of being connected to the neutral conductor of the alternating voltage system and in that the control electronics control the switching relay depending on the zero-crossing of a measuring current flowing from the alternating voltage terminal to the neutral conductor terminal, provided that the neutral conductor terminal is connected to the neutral conductor.

The switching device constructed in accordance with the invention uses, in addition to an alternating voltage terminal and a load terminal, a neutral conductor terminal to which the installer can connect the neutral conductor of the alternating voltage system if required. If the neutral conductor is

5 connected to the neutral conductor terminal, there can then be a flow of measuring current from the alternating voltage terminal to the neutral conductor terminal. Based upon the measuring current, the control electronics can then determine the zero-crossing of the alternating voltage present at the alternating voltage terminal and can control the switching relay depending on

10 the zero-crossing. This allows the lifetime of the electrical switching device to be considerably prolonged because the risk of the switching relay's switching contacts fusing together or being otherwise adversely affected is very greatly reduced.

15 However, as has been mentioned at the outset, it is not always advantageous to perform the switching operation at a point in time at which the alternating voltage present at the alternating voltage terminal is at its zero-crossing. For instance, if the electrical switching device is used to switch a contactor, then the switching at zero-crossing may result, on account of the resulting

20 switching delay, in the contactor performing its switching operation at a point in time at which the amplitude of the alternating voltage is already passing through its maximum again. In accordance with the invention, it is therefore provided for the neutral conductor of the alternating voltage system to be connected to the neutral conductor terminal of the switching device only if

25 required. If no such connection is made, the control electronics control the switching relay independently of the zero-crossing of the alternating voltage. The switching device is thus configured such that it is only when there is a flow of a measuring current from the alternating voltage terminal to the neutral conductor terminal that the switching relay is controlled depending on

30 the zero-crossing of the alternating voltage present at the alternating voltage terminal, whereas in the absence of a measuring current, the switching relay is controlled independently of the zero-crossing of the alternating voltage.

In a preferred embodiment of the invention, the switching device comprises a zero-crossing detection member and a measuring line which connects the alternating voltage terminal to the neutral conductor terminal, wherein the measuring line is optically, inductively or capacitively coupled to the zero-crossing detection member. Due to the optical, inductive or capacitive coupling, the zero-crossing detection member can detect the zero-crossing of the alternating voltage present at the alternating voltage terminal. The zero-crossing detection member thus provides a simple way for the control electronics to control the switching relay depending on the zero-crossing of the alternating voltage, provided that a measuring current flows in the measuring line. If such a measuring current is absent because the neutral conductor terminal is not connected to the neutral conductor of the alternating voltage system, then the zero-crossing detection member receives no input signal and the control electronics control the switching relay without taking into account the zero-crossing of the alternating voltage.

Preferably, the control electronics comprise a microcontroller with integrated zero-crossing detection member. This affords the advantage that the circuit complexity of the electrical switching device and therefore its cost of manufacture can be reduced. With such an embodiment, the zero-crossing detection member is integrated in the control electronics.

In an advantageous embodiment, the measuring line is coupled to the zero-crossing detection member via an opto-coupler. Such opto-couplers are per se known to the person skilled in the art. They allow potential separation between the measuring line and the zero-crossing detection member to be maintained and still allow a signal to be transmitted from the measuring line to the input of the zero-crossing detection member.

It is particularly advantageous for the switching relay and the opto-coupler to have an insulation voltage of at least 3,500 V, preferably to have an insulation voltage of at least 4 kV. This allows a potential-free switching operation to be

performed which, if required, can be performed dependently of the zero-crossing of the alternating voltage present at the alternating voltage terminal.

5 Advantageously, the switching relay and the opto-coupler have a creepage distance of at least 5 mm, in particular a creepage distance of 6 mm. This reliably ensures the insulation strength of the electrical switching device that is required for potential-free switching.

10 It is preferred for the measuring line which connects the alternating voltage terminal to the neutral conductor terminal to have connected therein a current limiting element, for example an ohmic resistance.

15 It is advantageous for the measuring line to have a protective diode connected therein.

As mentioned at the outset, it is advantageous for the electrical switching device to comprise a housing which is capable of being latched onto support rails.

20 The following description of a preferred embodiment of the invention, taken in conjunction with the drawing, serves to explain the invention in greater detail.

25 The only figure of the drawing is a schematic representation of a block diagram of an electrical switching device in the form of a current impulse switch 10. The current impulse switch 10 comprises a housing 12 which is customarily capable of being latched onto support rails in the form of a DIN rail-mounted device. The corresponding latch elements are known to the person skilled in the art and are therefore not shown in the drawing, in the interest of clarity.

30 The current impulse switch 10 comprises two control terminals 14, 15 which are connected to control electronics provided in the form of a microcontroller 16. Connected to the control terminal 14 is a control line 18

which has connected therein an electromechanical pushbutton 20 that is capable of being actuated by a user. Via the control line 18, the current impulse switch 10 is capable of being connected to a control voltage source known per se, not shown in the drawing. The control terminal 15 is connected
5 to ground potential.

The microcontroller 16 controls the magnet coil 22 of a switching relay 24 whose switching contacts 26, 27 are connected into a supply line 29 via which an alternating voltage terminal 30 of the current impulse switch 10 is
10 connected to a load terminal 32. The alternating voltage terminal 30 can have connected thereto a voltage-carrying conductor of an alternating voltage system, and the load terminal 32 can have connected thereto an electrical consumer, such as an electrical lighting fixture or also a contactor.

15 In addition to the alternating voltage terminal 30 and the load terminal 32, the current impulse switch 10 comprises a neutral conductor terminal 34 which is connected to the alternating voltage terminal 30 via a measuring line 36. Connected into the measuring line 36 and coupled in series relative to each other are a protective diode 38 and a current limiting element provided in the
20 form of an ohmic resistance 39.

An opto-coupler 40 is at its input side connected to the measuring line 36. At its output side, the opto-coupler 40 is in electrical communication with a zero-crossing detection member 42 which is integrated in the microcontroller 16.
25

By applying power to the magnet coil 22 of the switching relay 24, the electrical connection between the alternating voltage terminal 30 and the load terminal 32 can be optionally established or interrupted. The magnet coil 22 and the microcontroller 16 are separated from the electric potential that is
30 present at the alternating voltage terminal 30. Potential separation is ensured by the use of the switching relay 24 and by the optical coupling between the measuring line 36 and the zero-crossing detection member 42 via the opto-

coupler 40. The switching relay 24 as well as the opto-coupler 40 has an insulation voltage of about 4 kV and a creepage distance of about 6 mm.

When the pushbutton 20 is momentarily depressed by the user, a control
5 voltage impulse is applied to the control terminal 14. As a result of this, the
microcontroller 16 provides a control current to the magnet coil 22 so that the
switching contacts 26, 27 can then be opened or closed. The switching
operation can be optionally performed dependently or independently of the
zero-crossing of the alternating voltage present at the alternating voltage
10 terminal 30. If the switching operation of the switching relay 24 is to be
performed in dependence on the zero-crossing, this then requires the neutral
conductor terminal 34 to be connected to the neutral conductor of the
alternating voltage system. In this condition, a measuring current flows from
the alternating voltage terminal 30 through the measuring line 36, and the
15 zero-crossing of said measuring current can be detected by the zero-crossing
detection member 42 due to the optical coupling via the opto-coupler 40. As a
result, after actuation of the pushbutton 20, the microcontroller 16 then
provides to the magnet coil 22 the control voltage for changing the switching
state of the switching relay 24 in dependence on the zero-crossing. The
20 switching operation, which usually takes about 2 to 5 ms, can then take place
in the region of the zero-crossing of the alternating voltage. It is thereby
possible for the mechanical load on the switching contacts 26, 27 to be kept
very low and, therefore, for the lifetime of the current impulse switch 10 to be
prolonged.

25

If the switching operation is to be performed independently of the zero-
crossing of the alternating voltage, it is only necessary for the neutral
conductor of the alternating voltage system to be separated from the neutral
conductor terminal 34. Therefore, the neutral conductor terminal 34 remains
30 open and, due to the absence of measuring current, the zero-crossing
detection member 42 detects no zero-crossing and, after actuation of the
pushbutton 20, the microcontroller 16 applies a control voltage to the magnet
coil 22 independently of the zero-crossing of the alternating voltage.

Thus, the current impulse switch 10 constructed in accordance with the invention is distinguished by a circuit arrangement of structurally simple design and therefore by relatively low cost of manufacture, wherein the
5 installer is given the option of whether the switching operations should be performed dependently or independently of the zero-crossing of the alternating voltage present at the alternating voltage terminal 30. If a zero
crossing-dependent switching operation is desired, the installer connects the neutral conductor of the alternating voltage system to the neutral conductor
10 terminal. Where such a dependency of the switching operation is not desired, the neutral conductor terminal remains open.

Patentkrav

- 5 1. Elektrisk koblingsindretning med en styreelektronik, der kan påvirkes med et styresignal, hvilken styreelektronik er forbundet med et koblingsrelæ, hvis koblingskontakter er koblet mellem mindst en vekselspændingstilslutning, til hvilken der kan tilsluttes en spændingsførende leder af et vekselspændings- system, og mindst en belastningstilslutning, til hvilken der kan tilsluttes en elektrisk forbruger, **kendetegnet ved, at** koblingsindretningen (10) har en neutralledertilslutning (34), som kan tilsluttes en neutralleder af et veksel- spændingssystem, og at styreelektronikken (16) styrer koblingsrelæet (24) afhængigt af nulgennemgangen af en målestrøm, der flyder fra vekselspæn- dingstilslutningen (30) til neutralledertilslutningen (34), såfremt neutralleder- tilslutningen (34) er forbundet med neutrallederen.
- 15 2. Elektrisk koblingsindretning ifølge krav 1, **kendetegnet ved, at** koblings- indretningen (10) har et nulgennemgangsdetektionsmiddel (42) og en måle- ledning (36), som forbinder vekselspændingstilslutningen (30) med neutralle- dertilslutningen (34), hvor måleledningen (36) optisk, induktivt eller kapacitivt er koblet med nulgennemgangsdetektionsmidlet (42).
- 20 3. Elektrisk koblingsindretning ifølge krav 1 eller 2, **kendetegnet ved, at** sty- reelektronikken omfatter en mikrocontroller (16) med et integreret nulgen- nemgangsdetektionsmiddel (42).
- 25 4. Elektrisk koblingsindretning ifølge krav 1, 2 eller 3, **kendetegnet ved, at** måleledningen (36) via en optokobler (40) er koblet med nulgennemgangsde- tektionsmidlet (42).
- 30 5. Elektrisk koblingsindretning ifølge krav 4, **kendetegnet ved, at** koblingsre- læet (24) og optokobleren (40) har en isolationsspænding på mindst 3500 V.
- 35 6. Elektrisk koblingsindretning ifølge krav 4 eller 5, **kendetegnet ved, at** kob- lingsrelæet (24) og optokobleren (40) har en krybestrækning på mindst 5 mm.

7. Elektrisk koblingsindretning ifølge et af kravene 2 til 6, **kendetegnet ved, at** der i måleledningen (36) er koblet mindst et strømbegrænsningselement (39).
- 5 8. Elektrisk koblingsindretning ifølge et af kravene 2 til 7, **kendetegnet ved, at** der i måleledningen (36) er koblet en beskyttelsesdiode (38).

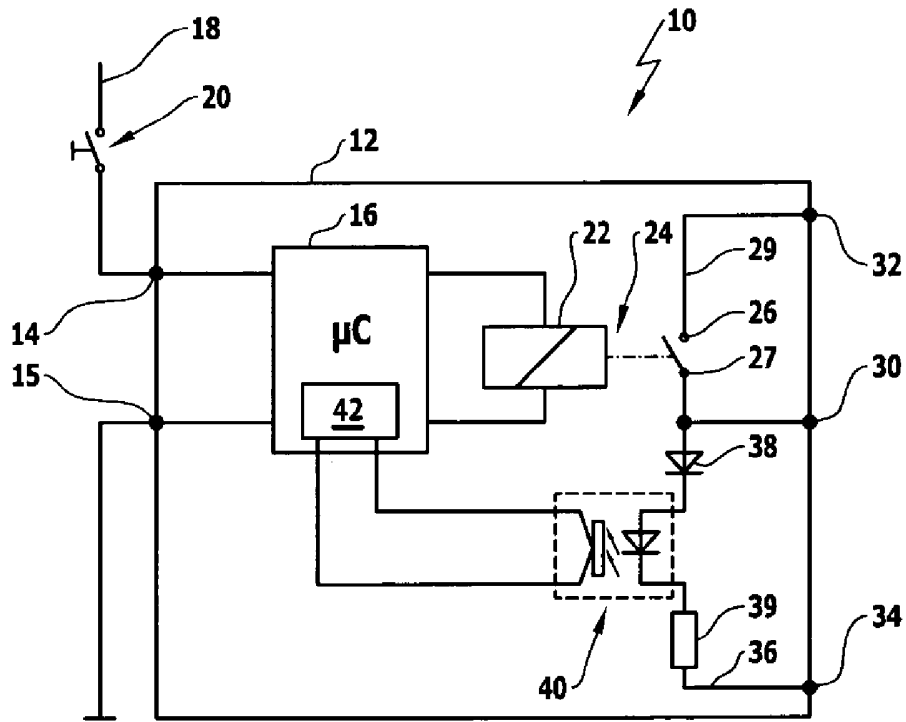


FIG.1