(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 550 927 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **92203845.0**

(22) Date of filing : **09.12.92**

(51) Int. Cl.[5] : **H01H 71/10,** H01H 71/44

(30) Priority : **10.12.91 NL 9102057**

(43) Date of publication of application :
14.07.93 Bulletin 93/28

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE IT LI LU NL PT SE

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(54) Selective automatic safety switch.

(57) Safety switch for the selective protection of electrical installations, comprising a self-closing first switching unit (12) and a first actuation device (13) interacting with the latter for undelayed opening of the first switching unit (12) in the case of a short-circuit current, a second switching unit (17) connected in series with the first switching unit (12) and a second actuation device (20) interacting with the second switching unit (17) for delayed opening of the second switching unit (17) in the case of an overload current, and a third actuation device (24) interacting with the second switching unit (17) for delayed opening of the second switching unit (17) in the case of the occurrence of a short-circuit current, which third actuation device (24) is connected to a shunt path (26) which comprises current-limiting means (27) and which bridges at least the first switching unit (12). Because the first switching unit (12) is provided with delay means (28) for keeping said first switching unit (12) open for an adjustable period of time, the switch-selective action of the safety switch can be accurately set.

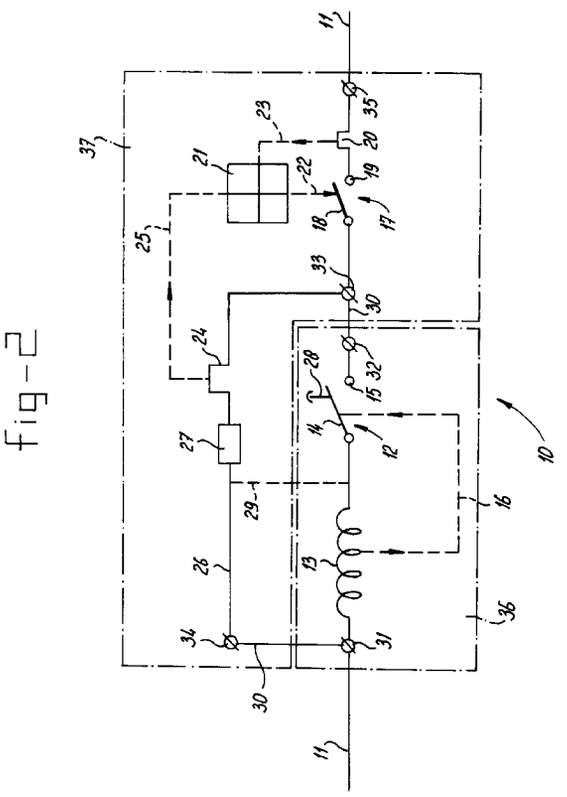

fig-2

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The invention relates to a safety switch for the selective and automatic protection of electrical installations in houses, commercial buildings and the like.

As is known, electrical distribution installations must be protected against short-circuit currents, overload currents and fault currents to earth.

In addition to the known fuses, automatic safety switches are also used as protection against short-circuit and overload currents. In this context, the requirement for selective disconnection of faulty parts of the electrical installation is an important factor. This means that when a fault condition occurs in a certain part of the electrical installation, only the faulty part has to be disconnected, without the other, non-faulty parts of the electrical installation becoming currentless, for example as a result of the response of a safety switch disposed in the main supply line of the electrical installation.

German Patent Application 2,854,711 (Fig. 7) discloses a safety switch for selectively protecting electrical installations, which has a primary current path (18) with, incorporated therein, a self-closing first switching unit (70) and a first actuation device (72), which interacts with the latter, for the as far as possible undelayed opening of the contacts of the first switching unit (70) in the case of the occurrence of a short-circuit current, a second switching unit (no reference numeral) incorporated in the primary current path (18) and connected in series with the first switching unit (70), and a second actuation device (48) interacting with the second switching unit for the delayed opening of the contacts of the second switching unit in the case of the occurrence of an overload current, a third actuation device (50) interacting with the second switching unit, which third actuation device is connected to a shunt path which comprises current limiting means (74) and which bridges at least the contacts of the first switching unit (70), for the delayed opening of the contacts of the second switching unit in the case of the occurrence of a short-circuit current, and the second switching unit being provided with a latching device (54) for keeping the contacts of said second switching unit in the open position after opening.

In this case, the second actuation device (48) which interacts with the second switching unit is incorporated in a section of the primary current path (18) which can be bridged by the shunt path. The delay time of the second actuation device (48) is greater than that of the third actuation device (50). Moreover, the first actuation device (72) also acts on the second switching unit for opening the contacts thereof on the occurrence of a short-circuit current. This known safety switch operates as follows:

During the normal, faultless operating state, the contacts of the first (70) and second switching unit are closed and it is possible for a current to flow via the primary current path (18). In the case of an overload current in the primary current path (18), said current path will be interrupted via the second switching unit after a predetermined period of time which is dependent on the second actuation device (48), which consists, for example, of a bimetallic relay. The primary current path (18) remains interrupted by means of the latching device (54) which acts on the second switching unit until the latching is released, either manually or by remote control, and the contacts of the second switching unit close or can be closed again.

When a short-circuit current occurs, the contacts of the first (70) and second switching unit are separated via the first actuation device (72), which consist of an electromagnetically operated relay, as a result of which the primary current path (18) is interrupted completely. As a consequence of the electric arc occurring during the opening of the contacts of the first switching unit (70), a portion of the short-circuit current will flow via the shunt path, as a result of which the third actuation device (50), which also consists, for example, of a bimetallic relay, is excited. As the second switching unit is also opened, the current flowing through the third actuation device (50) and consequently the excitation of the latter will also depend on the electric arc occurring between the contacts of the second switching unit. When the electric arc which occurs during opening of the contacts of the second switching unit has been extinguished, there is no longer any current flowing through the circuit (i.e. the primary current path and the shunt path).

By interrupting the primary current path (18) via the second switching unit, the first actuation device (72) becomes currentless, with the result that the contacts of the first (70) and second switching unit automatically close again. If, in the meantime, the short-circuit current has been disconnected by, for example, another safety device forming part of the faulty part of the electrical installation concerned, the contacts of the first (70) and second switching unit will remain closed and there will be no final interruption of the primary current path (18). However, if the short-circuit current remains present, the first (70) and second switching unit will be repeatedly switched on and switched off, with pulsed excitation of the third actuation device (50). After the first (70) and second switching unit have been switched twice or more, sufficient energy will have been passed to the third actuation device (50), as a result of which the primary current path (18) will eventually be finally interrupted via the second switching unit, under the influence of the third actuation device (50) which acts on said second switching unit, and the latching device (54).

However, the third actuation device (50) is only energised via an electric arc current path every time the contacts of the first (70) and second switching unit are opened. Because of the stochastic nature of the electric arcs which occur between the switch contacts, the disconnection time after the occurrence of

a short-circuit current is not fixed and, in such a case, it may take a relatively long time before the primary current path (18) is finally interrupted. At worst this may lead to an excessive thermal load of the system, consisting of the safety switch itself and the electrical installation, to which an amount of energy which is dependent on the short-circuit current and the interruption speed of the switches is constantly fed in a pulsed manner, causing a fire hazard or other damage. This because it is in particular in the first portion of the short-circuit current curve which has to be traversed that most energy is dissipated in the system.

In the first instance, the object on which the invention is based is to provide a safety switch of the kind described above, in which the amount of electric energy (I^2t) which is dissipated in the system as a result of the occurrence of a short-circuit current is limited because the disconnection time, after the occurrence of a short-circuit current, is fixed more accurately and is better defined than in the prior art safety switch.

According to the invention, this is achieved in that the first switching unit comprises delay means for holding the contacts of the first switching unit in the open position for a period of time to be set

In the case of the safety switch according to the invention, the first actuation device is only actuated for opening the contacts of the first switching unit as the result of a short-circuit current. After opening, the contacts of the first switching unit are held in the open position for a set period of time with the aid of the delay means according to the invention acting on the first switching unit. In this case, a limited short-circuit current flows through the shunt path and the third actuation device is excited. It should be noted that the circuit does not become completely currentless by the activation of the first actuation device.

If the short-circuit state continues during the time the contacts of the first switching unit are open, the primary current path will finally be made currentless, via the second switching unit, after a delay which has been set by means of the third actuation device has elapsed. If, however, the short-circuit state ceases within the delay time of the third actuation device, there is no current interruption in the primary current path and the shunt path is bridged as a result of the eventual automatic closure of the contacts of the first switching unit, and the normal operating state is established again, in which the contacts of the first and second switching units are closed. It will be clear that the time during which the contacts of the first switching unit are open has to be greater than the delay of the third actuation device.

In the case of the safety switch according to the invention, during a short-circuit state there is no pulsed supply of short-circuit energy to the electrical installation to be protected. Consequently, said safety switch is extremely suitable for the intended selective disconnection of the faulty parts in an electrical installation, because a primary safety switch, for example if used as a group safety switch and connected in series in the primary supply line, will not respond to a pulsed short-circuit current. By contrast, the safety switch according to the prior art can indeed give rise to such a response. In addition, the total amount of short-circuit current energy supplied in the system will be appreciably smaller with the safety switch according to the invention than with the known safety switch.

The point in time at which, or the total amount of energy supplied through the shunt path in a short-circuit situation at which the second switching unit is actuated via the third actuation device, can be accurately set in the circuit according to the invention, as the current flowing in the shunt path, especially in the case of a complete short-circuit , is determined solely by the current limiting means, which can be accurately defined, and the standardised and constant supply voltage of the installation.

By contrast, in the case of the said German Patent Application 2,854,711 and for example also in the case of the safety switch according to German Patent Application 2,854,616, the current through the third actuation device is dependent both on the current limiting means (current limiting resistor) and the electric arc impedances which are difficult to characterise or define because the opening of the contacts is dependent on time. Moreover, with this known safety switch, the entire circuit will be currentless as a result of the opening of the contacts of the second switching unit when the same situation as in the invention occurs, i.e. when the limited short-circuit current flows only through the shunt path, with the result that an accurately determined excitation of the third actuation device and therefore an accurately defined amount of "shortcircuit current" supplied or an accurately definable switch-selective operation is completely impossible.

It is pointed out that a safety switch of the type mentioned above for selectively protecting electrical installations is also disclosed in German Patent Application 3,133,200 (Fig. 4, 6); in this case, however, the contacts of the first switching unit (3) are kept in the open position electromagnetically by the action of a short-circuit current, by means of a fourth actuation device (13) which is connected in the shunt path (8), for example via an electromagnetic relay acting on the first switching unit (3) or via a magnet winding which is connected to the first actuation device (6).

With this safety switch, it is not inconceivable that, during a short-circuit situation, there is a chance of undesirable closing of the contacts of the first switching unit in the case of a short-circuit situation with contact resistance, i.e. the short-circuited circuit represents a certain impedance. Because this impedance, speaking in electrical terms, is added to the

current limiting means (14) in the shunt path, a threshold may arise in which the contacts of the first switching unit barely can or cannot be held open via the third actuation device. If the latter is the case, a situation arises which corresponds to the said German Patent Application 2,854,711, where the first switching unit (3) is repeatedly switched on and off and the third actuation device (7) is energised only in a pulsed manner.

A situation of this kind may also arise, for example, in the case of short-circuits with fluctuating impedance, for example shortcircuits in a motor where a part of the current-carrying winding shortcircuits periodically with the earthed motor housing by rotation of the rotor. Depending on the rotary speed of the motor, the period of time between the short-circuits will vary, and it is possible for said period of time to be so long that the contacts of the first switching unit (3) can close again automatically and are subsequently opened again by the short-circuit occurring.

A repeated switching-on and switching-off of a short-circuit current, a has been mentioned before, results in a relatively large amount of energy dissipated in the system. This contributes to a large degree to the undesirable erosion of contacts, which has an adverse effect on the service life of the switch.

The undesired repeated switching-on and switching-off of the contacts of the first switching unit, or the primary current path, cannot occur in the safety switch according to the invention, because in this case the period of time during which the contacts remain open is fixed and set, regardless of the mains conditions. This period of time may, for example, be chosen so that it is optimum with a view to expected fluctuating short-circuit situations.

It should also be pointed out that switches which close automatically and with a delay regardless of the mains conditions are known per se from the state of the art. European Patent Applications 0,371,419 and 0,350,826, respectively, relate to an automatic switch provided with a delay device which acts on said switch and can be actuated electromagnetically, and to a delay device which is especially suited for use in such a switch.

The switch described in EP-A-0,371,419 comprises a first switching unit (14) and a second switching unit (not shown), which switching units are connected in parallel according to the description. This is in contrast to the switch according to the invention, in which the two switching units are connected in series. A first actuation device (60), provided with latching means (16) and the delay means (12) mentioned above, acts on the first switching unit (14) concerned.

A short-circuit current causes the actuation of the first actuation device (60), by the action of which the contacts of the first switching unit (14) are opened, and the delay means (12) to become operational. In addition, it can be concluded from the description of the operation of the switch that by opening the first switching unit (14), both the current through the first actuation device (60) and the current through the delay means (12) are interrupted, which delay means (12) subsequently return slowly to their rest position. If the short-circuit current is maintained after renewed excitation of the delay means (12), final opening of the first (14) and second switching unit takes place.

In departure from the above, in the switch according to the invention only the second switching unit is latched in case of final disconnection. This is advantageous when a short-circuit current is switched on (manually), as the first switching unit is then not subjected to the switching-on action and can therefore respond immediately. In the switch according to the said European patent application, the amount of electrical energy supplied in a short-circuit situation depends on the setting of the delay means (12). By contrast, in the switch according to the invention, the amount of energy supplied in a short-circuit situation can be accurately set via the third actuation means, independently of the delay means which act on the first switching unit. The associated advantages, in particular the intended accurately adjustable switch-selective operation, have been described in detail above.

Swiss Patent 249,242 also discloses an automatic safety switch for electrical installations, which is provided with a first switching unit (1,2) having delay means (8) which act on said unit for delayed closing of the contacts of the first switching unit (1,2), and with a first actuation device (9) which acts on said first switching unit (1,2). A plurality of second switching units (a, b) are connected in series with the first switching unit (1,2), which second switching units (a,b) are provided with second actuation devices acting on the latter.

Neither said Swiss patent, nor for example German Patent Application 2,854,711 or for example European Patent Application 0,371,419 use the object on which this invention is based for accurately and reliably setting of the amount of electrical energy supplied by the switch in the event of a short-circuit current situation.

In the preferred embodiment of the safety switch according to the invention, the first actuation device comprises an electromagnetic relay, whereas the second and third actuation devices each comprise an electrothermal bimetallic relay.

Although it is readily possible to set a delay by means of a bimetallic relay, it may nevertheless be difficult in some cases to construct a bimetallic relay which both heats up and opens out rapidly enough and also supplies sufficient energy to actuate the relevant switching unit. In yet a further embodiment of the safety switch according to the invention, to prevent moreover the contacts of the second switching

unit from opening in a short-circuit situation while the contacts of the first switching unit have just been closed again, the second and third actuation devices do not act directly on the second switching unit but operate via a blocking device. Said blocking device then ensures the eventual final opening of the contacts of the second switching unit and prevents opening thereof if, in a short-circuit current situation, the first switching unit is closed. If bimetallic relays are used as actuation devices and in combination with the use of such a blocking device, said bimetallic relays will, moreover, remain mechanically virtually unloaded and consequently they can be light structures which can be heated up relatively quickly, a fact which is of particular importance with regard to the third actuation device. The latching and blocking devices can advantageously be combined to form a single device which acts on the second switching unit.

Preferably mechanically operating delay means are used, as a current-independent delay can thus be achieved. Mechanically operating delay means also have the advantage that they produce a negligible amount of heat, or no heat at all, and therefore the heat does not have to be taken into account when constructing a housing for the safety switch, nor the influence on additional components, for example semiconductor components in the housing itself or in its immediate vicinity.

The delay means used may, for example, consist of a mass which can be coupled to the movable contact of a switching unit, which mass is coupled to the movable contact in the direction in which the delay is desired, and is disengaged in the other direction. A pneumatic or hydraulic damper which is known per se may also be used as delay device.

Of course it is also possible to use electromagnetic delay means, whose delaying action is based on the reduction of residual magnetism in plates of soft magnetic material following previous magnetisation thereof. See also, for example, European Patent Application 0,406,130 or the delay means disclosed in said European Patent Application 0,350,826.

Because the first actuation device only acts on the first switching unit and the second and third actuation devices each only act on the second switching unit, the safety switch according to the invention is particularly suitable for installation by means of standard modules which can easily be assembled to form a constructional unit, wherein the required interconnections can be restricted to electrical connecting points.

Correspondingly, in an embodiment of the safety switch according to the invention the first switching unit, the delay means acting on the latter, and the first actuation device form a first, separate switching module provided with electrical terminals, and in which the second switching unit, the second and third actuation devices, the latching device and, where appropriate, the blocking device and the current limiting means form a second, separate switching module, likewise provided with electrical terminals, and in which the safety switch is constructed by mutually and suitably connecting the terminals of the first and second switching modules. It will be obvious that the possibility of producing and assembling standard modules is advantageous from an economic as well as from a constructional point of view.

The invention also relates to a first and a second switching module as described above.

The first switching module can, for example, comprise a switch, such as described in European Patent Application 0,322,987, and the second switching module can comprise a switch such as described in, for example, European Patent Application 0,322,986, both of which patent applications are in the name of the Applicant and must be considered as incorporated in this patent application by reference.

The invention is described below in more detail by means of an embodiment which is shown schematically in the drawing.

Figure 1 shows the circuit diagram of an electrical distribution installation for use in houses and the like.

Figure 2 schematically shows an embodiment of the safety switch according to the invention.

Figures 3a, b schematically show embodiments of mechanical delay means for use in the safety switch according to the invention.

Figure 1 shows the circuit diagram of a distribution device disclosed in European Patent Application 0,345,851 for an electrical installation in a house, comprising an installation box 1, intended for the connection of four groups g1, g2, g3 and g4. The supply line 2 is connected in a conventional manner via a main connecting point 3, a main fuse 4 and a power consumption meter (kWh) 5, via a central current limiting switch 6, to a branch line having four branches with terminals a1, a2, a3 and a4. By means of an auxiliary switch 7 which is protected against earth fault currents and overload currents, each of the terminals a1, a2 and a3 is connected to the terminals of the groups g1, g2 and g3. The group g4 is connected to the terminal a4 only by means of an auxiliary switch 8 which is protected against overloading.

In the event of a fault in one of the groups g1, g2, g3 and g4, for example a short-circuit current, the contacts of the central current limiting switch 6 will open and consequently an electrical impedance 9 is switched in the supply line 2. This leads to a limitation of the short-circuit current, which limited short-circuit current is disconnected from the faulty group by means of its auxiliary switch 7 or 8. This subsequently leads to the automatic closing of the contacts of the central current limiting switch 6, without interruption of the energy supply to the non-faulty groups. The main fuse 4 must be of such dimension that in the first instance one of the auxiliary switches 7 or 8 can be

actuated in conjunction with the central current limiting switch 6 for the selective disconnection of a fault current which has occurred. Only if for some reason the short-circuit current has not been disconnected after a certain period of time, does the main fuse 4 have to respond. This selective way of protecting prevents the complete installation from being immediately rendered currentless in the event of a fault occurring in one of the groups.

It is also possible, for example, to use an automatic safety switch instead of a fuse 4, which automatic safety switch is provided with switching units according to the invention which respond to shortcircuit currents and overload currents.

Figure 2 schematically shows an embodiment of a safety switch 10 according to the invention, consisting of a primary current path 11 with a first switching unit 12 having a movable contact 14 and a fixed contact 15 incorporated therein. In the primary current path 11 and connected in series with the first switching unit 12 is a winding 13 of an electromagnetic relay or of an electromagnetic control device, which acts on the movable contact 14 of the first switching unit 12. This as indicated by means of the broken line 16. When a short-circuit current occurs in the primary current path 11, the contacts 14, 15 of the first switching unit 12 are opened virtually undelayed by the action of the electromagnetic energy generated in the winding 13.

A second switching unit 17 having a movable contact 18 and a fixed contact 19 is incorporated in the primary current path 11 in series with the first switching unit 12. The primary current path 11 also comprises a second actuation device 20 in the form of a bimetallic element which can be heated directly or indirectly and which is indicated symbolically by an open square. In the event of an overload current, said second actuation device 20 is designed to actuate the second switching unit 17 in due course, so that the current in the primary current path 11 is interrupted. A latching and blocking device 21 has been provided for actuating the second switching unit 17, on which device 21 the second actuation device 20 acts so as to actuate the second switching unit 17, indicated schematically by broken lines 22 and 23, respectively.

Furthermore, a third actuation device 24 acts on the latching and blocking device 21, indicated schematically by a broken line 25, which third actuation device 24 is also constructed as an electrothermal bimetallic relay which can be heated directly or indirectly and which is indicated symbolically by an open square. In practice, bimetallic relays and latching and blocking devices which are suitable for this purpose are known per se.

The third actuation device 24 is incorporated in a shunt path 26 comprising an electric impedance 27, for example a resistor, which shunt path 26, in the diagram shown, bridges the series circuit of the first actuation device 13 and the first switching unit 12.

The contacts 14, 15 of the first switching unit 12, which are closed in the normal operating state, will open by the action of the first actuation device 13 when a short-circuit current occurs in the primary current path 11. When the contacts 14, 15 open, an electric arc develops, which represents a particular value of resistance. The short-circuit current in the primary current path 11 will now flow partly via said electric arc and partly via the shunt path 26 and, as a result, the third actuation device 24 is energised. When this electric arc has been extinguished, the limited short-circuit current will only flow via the shunt path 26. The result of the interruption of the primary current path 11 by the first switching unit 12 is that current no longer flows through the first actuation device 13, as a result of which the mechanical force of the first actuation device 13, which acts on the movable contact 14 of the first switching device 12 and is illustrated by the broken line 16, will cease and the contacts 14, 15 close again, the interruption of the primary current path 11 being thereby discontinued.

As has been described above, both the current in the shunt path 26 and in the primary current path 11 is affected by the repeated opening and closing of the first switching unit 12 and the electric arc appearing between the contacts 14, 15 thereof. As the occurrence of said electric arc is of a stochastic nature, the point in time at which the amount of energy for actuating the second switching unit 17 is fed to the third actuation device 24 is influenced in a stochastic manner, starting from the occurrence of the short-circuit current.

In order to achieve as accurately as possible the intended selective action of the safety switch when it is used in an electrical installation, in particular when a short-circuit current occurs, it is necessary to set the switch-off time as accurately as possible via the third actuation device 24. For this purpose, the first switching unit 12 according to the invention is provided with delay means 28, which are indicated schematically by the symbol of an arrow. Said delay means are designed such that they can hold the movable contact 14 of the first switching unit 12 in the open position for a predetermined period of time, after said contact has been opened by the first actuation device 13.

Preventing the limited current in the shunt path 26 and the primary current path 11 from being influenced during the set delay time as a result of the opening and closing of the first switching unit 12 is now achieved with the aid of said delay means 28. During this time, the third actuation device 24 is energised. In this situation, the amount of energy supplied to the third actuation device 24 corresponds precisely with the amount of electrical energy supplied via the shunt path 26. In other words, when a short-circuit current occurs, the amount of electrical energy to be

supplied to the installation can be set accurately by means of the third actuation device 24, for example the minimum amount of energy required to actuate a further safety switch of the faulty part of the electrical installation, for example one of the auxiliary switches 7 or 8 in Figure 1. It is obvious that, if this amount of energy is exceeded, no disconnection of the short-circuit current has taken place and that this will need to be done by interrupting the primary current path 11 via the safety switch 10.

If a short-circuit current is disconnected before the maximum amount of energy supplied is reached, a current lower than the limited short-circuit current will flow in the shunt path 26, and thus less energy will be supplied to the third actuation device 24. By suitably choosing the delay time of the delay means 28, it can be ensured that in this case, the contacts 14, 15 of the first switching unit 12 close before the third actuation device 24 responds.

Only if the short-circuit current ceases to exist before the point in time at which the amount of energy required for actuating the third actuation device 24 has been supplied to the same, for example because it is disconnected by means of a further safety switch of the relevant faulty part of the installation, will the second actuation device 17 not be actuated. However, if the short-circuit current continues to flow, then the primary current path 11 is finally interrupted by the third actuation device 24, when this has received the required amount of actuation energy, in conjunction with the latching and blocking device 21 by means of the second switching unit 17.

The latching and blocking device 21 is designed in such a way that the contacts 18, 19 of the second switching unit 17 can not open until the contacts 14, 15 of the first switching unit 12 have also been opened, i.e. when the limited short-circuit current flows through the second switching unit 17 via the third actuation means 24 incorporated in the shunt path 26. Consequently, the second switching unit 17 can be of a lighter construction than the first switching unit 12 and is preferably likewise equipped with means for extinguishing the electric arc occurring between the contacts 14, 15. The impedance 3 can be, for example, a 1 ohm resistor, as a result of which a short-circuit current is limited to 220 A in a 220 volt AC installation. The closing of the contacts 18, 19 of the second switching unit 17 can be carried out manually or by remote control by unlatching the latching and blocking device 21.

It can clearly be seen from the diagram according to Figure 2 that the second actuation device 20 is energised by a current through the shunt path 26 and also by a current via the first switching unit 12. In the event of a short-circuit current, the second actuation device 20 is mainly energised via the shunt path 26. It will be obvious that the second actuation device 20 can also be incorporated in the section of the primary current path 11 which is connected to the contact 18 instead of in the section of the primary current path 11 which is connected to the contact 19 of the second switching unit 17, or in the shunt path 26, all this depending on the requirements made.

When the primary current path 11 is restored after the delay time set by the delay means 28 has elapsed and the fault causing the short-circuit current is still present, the contacts 14, 15 of the first switching unit 12 will be reopened via the first actuation device 13 and the third actuation device 24 will be energised again.

I the event of a short-circuit current, the advantages of the second actuation device 20 from the point of view of switching will be retained because, if the third actuation device 24 does not disconnect a short-circuit current after the delay time of the delay means 28 has elapsed, the second actuation device 20 is also energised again via the first switching unit 12. The mutual tuning of the delay time of the third actuation device 24, the delay means 28 and the second actuation device 20 is dependent on the specific use, i.e. the position of the safety switch 10 in an electrical installation. A safety switch 10 in the supply line 2 will have to respond later than a safety switch 10 in a group g1, g2, g3 or g4, for example, in the electrical installation according to Figure 1.

In the embodiment shown, the latching and blocking device 21 contains the latching device for holding the contacts 18, 19 of the second switching unit 17 in open position. Said latching device may of course also act independently on the second switching unit 17, in this case the movable contact 18 thereof.

As indicated by the broken line 29 in Figure 2, the shunt path 26 can also be switched in such a manner that it only bridges the contacts 14, 15 of the first switching unit 12. The limited short-circuit current through the shunt path 26 then also flows through the first actuation device 13. In order to prevent undesired influencing of the duration of opening of the contacts 14, 15 of the first switching unit 12 via the first actuation device 13, however, it is preferable to bridge both the first actuation device 13 and the contacts 14, 15 of the first switching unit 12 by the shunt path 26.

Because in the safety switch 10 according to the invention, the first actuation device 13 only acts on the first switching unit 12, and the second and third actuation devices 20, 24 both only act on the second switching unit 17, the safety switch according to the invention is particularly suitable for a construction with separate switching modules. To this end, a first switching module consisting of the first switching unit 12 and the first actuation device 13, comprising delay means 28 acting on the first switching unit 12, and having electrical terminals 31 and 32 can be constructed. The second switching module will then have

to comprise the second switching unit 17, the second actuation device 20, the latching and blocking device 21 and also the third actuation device 24 and the current limiting means 27, as well as electrical terminals 33, 34 and 35. The safety switch 10 can then easily be constructed by connecting the terminals 31 and 34 and the terminals 32 and 33, as indicated by reference numeral 30. If desired, the current limiting means 27 can be accommodated in the first switching module, the electrical terminal 34 consisting of an end of the second actuation device 24. Preferably the first switching module comprises means for extinguishing an electric arc occurring between the contacts 14 and 15 of the first switching unit 12 during opening thereof.

In Figure 2, the relevant switching modules are indicated schematically by dot-dash lines, the first switching module being indicated by the reference numeral 36 and the second switching module by the reference numeral 37. It will be clear that the invention is not restricted to electromagnetic or electrothermal actuation devices. Essentially, various kinds of actuation devices may be used for the purpose of the invention, i.e. for undelayed actuation of the first switching unit in the event of a short-circuit current, and for delayed actuation of the second switching unit using different delay times.

The delay means 28 may be constructed as a mass which can be coupled to the movable contact 14 of the first switching unit 12 in the direction of movement in which the delay is desired. A damper which is known per se, such as a pneumatic or hydraulic damper, may also be used, which damper also acts on the movable contact in the direction of movement in which the delay is desired.

Figure 3a shows an embodiment of a device for delayed closing of the contacts 14, 15 of the first switching unit 12 by mechanical means. As is indicated schematically, the movable contact 14 is located at the end of a switching arm 39 which is rotatable about a supporting point 38. The other end 40 of the switching arm 39 acts on a delay device 41 which comprises a movable rod 42 provided with a mass. A tension spring 44 acts on the one end of the rod 42, whereas the other end of the rod 42 is provided with a so-called run-on side 45. Said run-on side 45 possesses a run-on edge 46 along which the end 40 of the switching arm 39 can slide, and a stop edge 47 against which the end 40 of the switching arm can be latched. In addition, a tension spring 48 which is accommodated so as to be movable acts on the rod 42 in order to keep the end 40 of the switching arm 39 against the stop 47, and the rod 42 rests on a movably mounted supporting point 49.

The operation of this delay device 41 is such that when the contacts 14, 15 are opened, the switching arm 39 slides with its end 40 along the run-on edge 46 and is latched behind the stop 47 of the run-on side 45, as shown. In order to close the contacts 14, 15, the mechanical energy stored in the switching arm 39 when this is openend not only has now to move the mass of the switching arm 39 itself, but also the rod 42 and the mass 43 against the spring action of the tension spring 44, which has a decelerating and therefore delaying effect.

In order to disengage the switching arm 39 and the rod 42, provision can be made, for example, for a (semicircular) run-on cam 50 which is coupled to the rod 42, and a fixed stop 51, as shown. If the run-on cam 50 acts on the stop 51 as a result of the displacement of the rod 42, the rod 42, as viewed in the drawing, will move in the clatchwise direction, whereby the latching of the end 40 of the switching arm 39 against the stop 47 of the run-on side 45 is released and the switching arm 39 moves to the closed position of the contacts 14, 15, anticlatchwise as viewed in the drawing. Disengagement can for example also be effected by suitably dimensioning the run-on side 45 and the switching arm 39 in such a manner that when the pointed end of the run-on side 45 touches the circumference of a circle 52 defined by the end 40 of the switching arm 39, the rod 42 and the switching arm 39 become disengaged. Suitable spring means (not shown) may act on the switching arm 39. The delay is essentially determined by the weight of the mass 43.

Figure 3b shows a delay device 53 according to the embodiment of Figure 3a, in which, however, a fixedly mounted rotatable mass is used instead of a mass 43 which can be displaced by the rod 42. Said rotatable mass, for example a disc 55 rotatable about the point 54, comprises an arm 56 which can act on a stop 57 coupled to the rod 42. If the stop 57 acts on the arm 56 of the disc 55 by displacement of the rod 42, the movement of the switching arm 39 will be delayed in a manner similar to the one discussed for Figure 3a. The delay can be set by means of the mass of the disc 55 and of the mutual position of the stop 57 of the rod 42 and the arm 56 of the disc 55. In order to disengage the rod 42 and the switching arm 39, the same principles as shown for Figure 3a may be used.

Both in the embodiment according to Figure 3a and in that in 3b, the relevant mass is actuated by the movement of the switching arm 39. The energy for actuating this mass is withdrawn from the short-circuit current by means of the first actuation device 13. Of course other embodiments of delay means for the purpose of the invention are suitable and may be used.

Claims

1. Safety switch for the selective protection of electrical installations, comprising:
   - a primary current path (11) with, incorporat-

ed therein, a self-closing first switching unit (12) and a first actuation device (13), which interacts with the latter, for the as far as possible undelayed opening of the contacts (14, 15) of the first switching unit (12) in the case of the occurrence of a short-circuit current;

- a second switching unit (17) incorporated in the primary current path (11) and connected in series with the first switching unit (12), and a second actuation device (20) interacting with the second switching unit (17) for the delayed opening of the contacts (18, 19) of the second switching unit (17) in the case of the occurrence of an overload current;
- a third actuation device (24) interacting with the second switching unit (17), which third actuation device (24) is connected to a shunt path (26) which comprises current limiting means (27) and which bridges at least the contacts (14, 15) of the first switching unit (12), for the delayed opening of the contacts of the second switching unit (17) in the case of the occurrence of a short-circuit current;
- and the second switching unit (17) being provided with a latching device (21) for keeping the contacts (18, 19) of the second switching unit (17) in the open position after opening, characterised in that the first switching unit (12) comprises delay means (28) for holding the contacts (14, 15) of the first switching unit (12) in the open position for a period of time to be set.

2. Safety switch according to Claim 1, wherein mechanically operating delay means (28) have been used.

3. Safety switch according to Claim 2, wherein the delay means (28) comprise a mass (43; 55) which can be coupled to a movable contact (14) of the first switching unit (12) in the direction of movement in which the delay is desired.

4. Safety switch according to Claim 2, wherein the delay means (28) comprise a damper, such as a pneumatic or hydraulic damper, which acts on a movable contact (14) of the first switching unit (12) in the direction of movement in which the delay is desired.

5. Safety switch according to one or more of the preceding claims, wherein the second switching unit (17) comprises a blocking device (21) for opening the contacts (18, 19), the second (20) and third (24) actuation devices each acting on said blocking device (21).

6. Safety switch according to Claim 5, wherein the blocking device (21) is designed such that the contacts (18, 19) of the second switching unit (17) can only be opened if the third actuation means (24) carry current.

7. Safety switch according to Claim 5 or 6, wherein the latching and blocking device (21) is combined to form a single device which acts on the second switching unit (17).

8. Safety switch according to one or more of the preceding claims, wherein the first actuation device (13) comprises an electromagnetic relay and each of the second and third actuation devices (20; 24) comprises a bimetallic relay.

9. Safety switch according to one or more of the preceding claims, wherein the first switching unit (12), the delay means (28) acting on the latter, and the first actuation device (13) form a first, separate switching module (36) provided with electrical terminals (31, 32), and the second switching unit (17), the second (20) and third (24) actuation device, the latching and, if necessary, the blocking device (21) and the current limiting means (27) form a second, separate switching module (37), likewise provided with electrical terminals (33, 34, 35), and the safety switch (10) is constructed by mutually and suitably connecting the terminals (31, 34; 32, 33) of the first (36) and second (37) switching module.

10. First and/or second switching module (36; 37) for use in a safety switch (10) according to Claim 9.

Fig-1

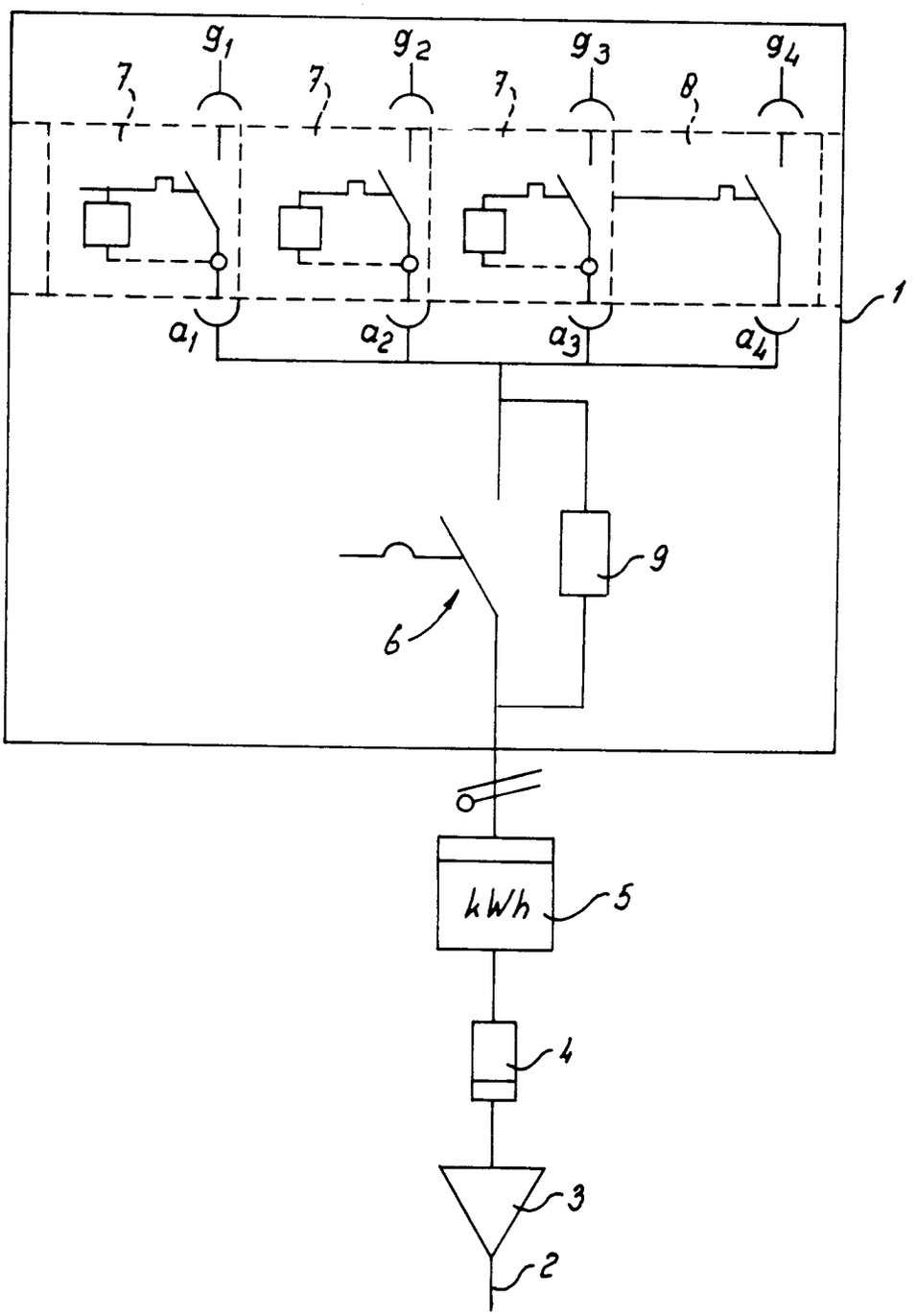

fig-2

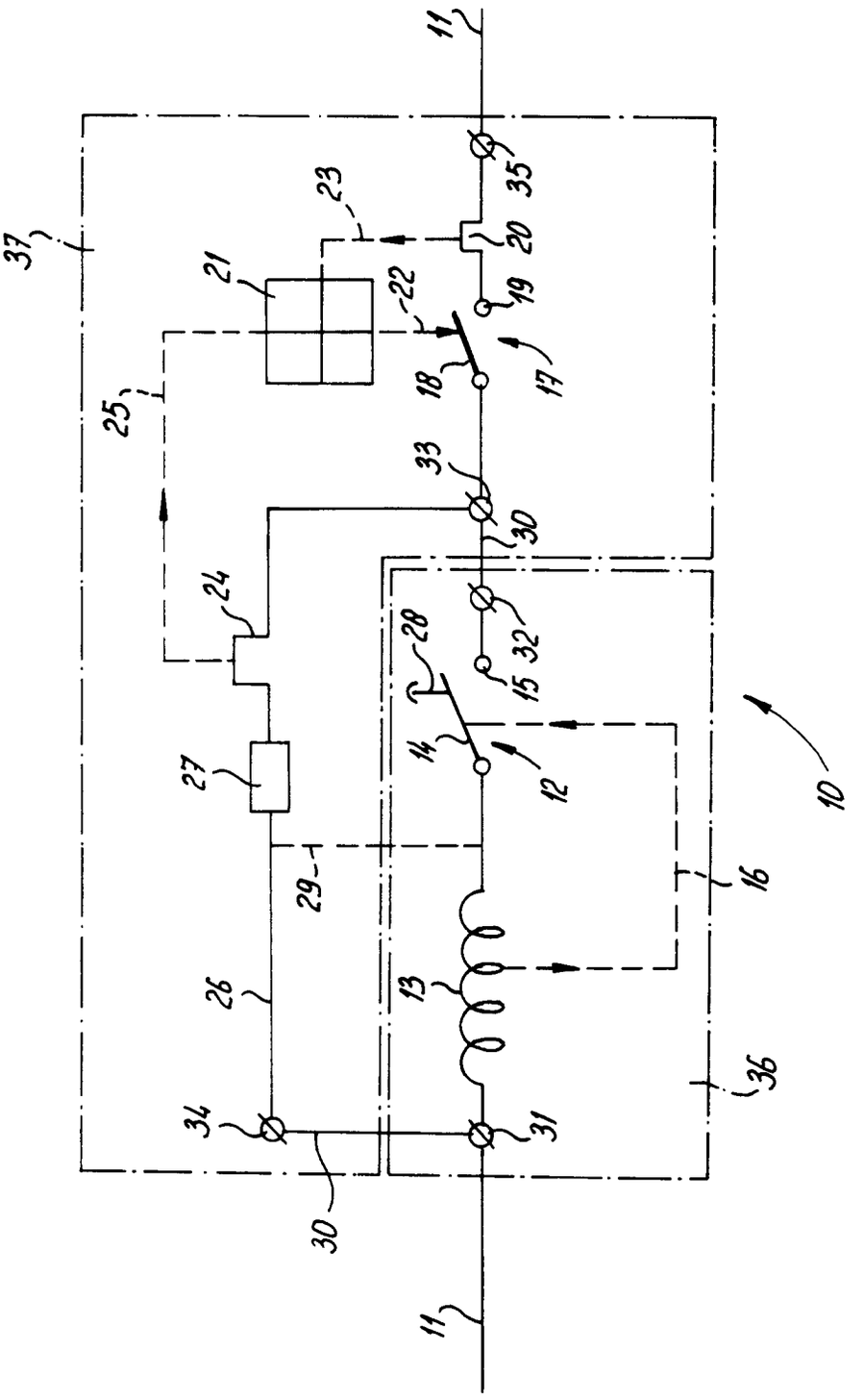
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fig - 3a

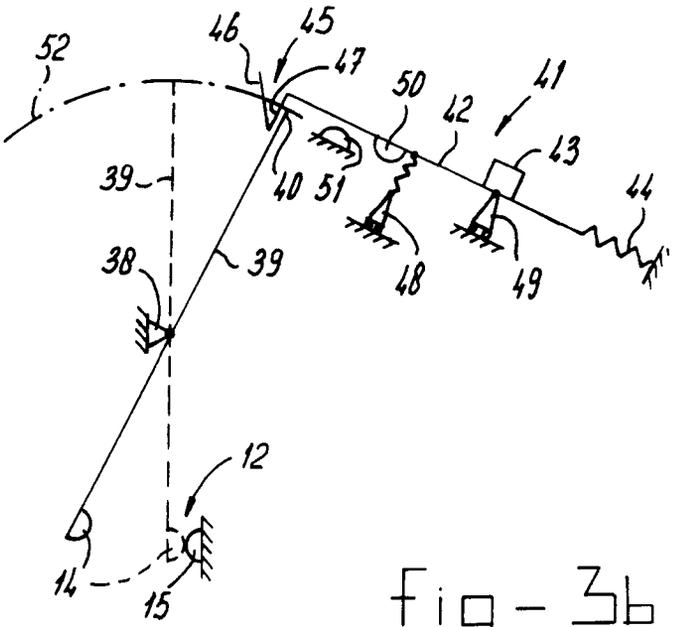
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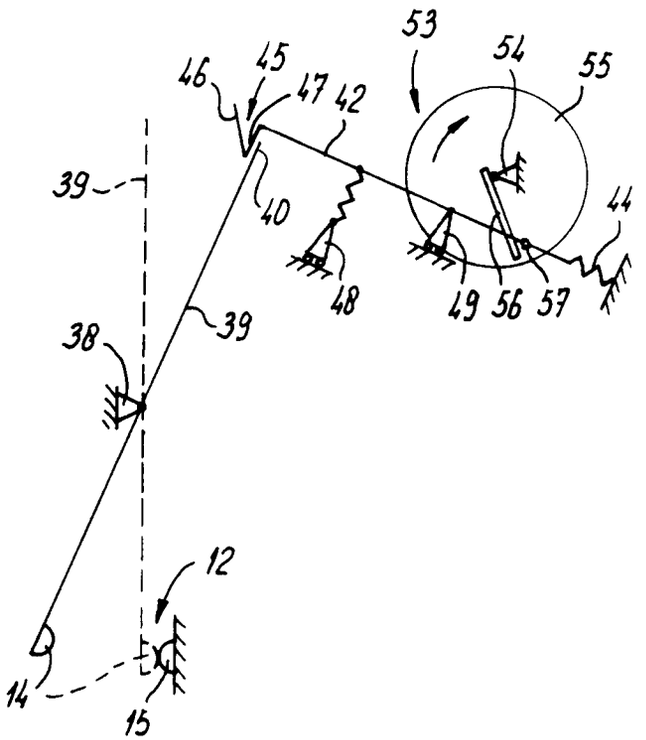
fig - 3b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EUROPEAN SEARCH REPORT

Application Number
EP 92 20 3845

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y,D	EP-A-0 371 419 (ASEA BROWN BOVERI) * column 1, line 33 - line 43 * * column 2, line 8 - line 20 * * column 5, line 49 - line 54 *	1-10	H01H71/10 H01H71/44
D,A	EP-A-0 350 826 (ASEA BROWN BOVERI) * abstract *	1-6	
D,Y	DE-A-2 854 711 (BROWN BOVERI) * page 16, paragraph 2; figure 7 *	1-10	
D,Y	CH-A-249 242 (FRANÇOIS-JEAN-MARIE THEUNISSEN) * page 2, line 10 - line 31 *	1-10	
Y D	EP-A-0 012 451 (BROWN,BOVERI) * the whole document * & DE-A-2 854 616	1-10	
D,A	DE-A-3 133 200 (SIEMENS) * claim 1 *	1	
A	GB-A-2 025 138 (MERLIN GERIN) * page 2, line 80 - line 117 *	3	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H01H H02H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 JUNE 1993	LIBBERECHT L.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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