

The invention relates to an electrical switching apparatus according to the precharacterizing clause of Claim 1.

Electrical switching apparatuses for snapping
5 onto profiled supporting rails are in widespread use in low-voltage installation distribution boards and are used there to protect individual circuits. In this case, line protection circuit breakers are normally provided for each circuit to be protected, the phases of which line
10 protection circuit breakers are passed via a common residual current device for switching off if fault currents occur. In this case, it may in individual cases be necessary to protect individual circuits separately and against overcurrents and short-circuit currents as
15 well as against fault currents. In such cases, it is provided that a separate residual current device covers the phases of the relevant circuit and interrupts the circuit without delay in the event of a response, that is to say if a fault current occurs.

20 The available space in low-voltage distribution boards, in particular in meter mounting boards, is frequently constrained and thus requires the best possible utilization of space. Known residual current devices (DE-OS 2,508,428), which are provided for snapping onto
25 supporting rails and can be provided with one pole or a plurality of poles, have housing dimensions for which space must be kept free on the supporting rail, which space is normally adequate for at least two apparatuses which are installed in a row and are of modular narrow
30 construction, for example line protection circuit breakers (EP 0 144 799 B1).

An electrical switching apparatus of the type mentioned initially has been disclosed in FR-A 2,409,592. The residual current tripping device in this switching
35 apparatus operates the switching mechanism via a leaf spring, so that the tripping device itself need use only that force which is required for tripping. Furthermore, the residual current part does not have its own contact point.

A residual current device in the case of which a contact point is provided has been disclosed in FR-A 2,553,572. However, nowhere is it specified how this switching apparatus is intended to be combined with a
5 line protection circuit breaker.

The object of the invention is to create an electrical switching apparatus of the type mentioned initially which also requires a relatively small residual current tripping device while occupying as little space
10 as possible and being capable of cost-effective production.

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

With the aid of the existing coupling between the
15 two main switching mechanisms of the line protection circuit breaker and of the residual current device, the adjacent line protection circuit breaker pole is also acted on, and its contact point opened, when the residual current pole trips.

The accommodation provided according to the invention of the residual current device in a housing having the same width as a conventional circuit breaker module (17.5 mm) is made possible in that a residual current tripping device is used which is particularly
20 compact in comparison with known residual current devices and whose external dimensions allow it to be accommodated in such a housing. The residual current tripping devices which have been used until now in conventional residual current devices all have relatively large dimensions in
25 each case which do not allow such a narrow housing to be provided for accommodating all the necessary switch components. The physical size of the known residual current tripping devices depends on the required tripping force which is necessary to operate the switching con-
30 tacts. Instead of a residual current tripping device which is dimensioned to be correspondingly large, in the case of the invention another route is taken in order to achieve the opening of the contact points without any reduction in the opening speed of the contact elements.
35

The size and hence the tripping force of the residual current tripping device are compensated for according to the invention in that an auxiliary switching mechanism is connected between the tripping device and the main
5 switching mechanism, absorbs the pulse of the tripping plunger, which operates in the event of a response, of the residual current tripping device and passes it on in an amplified manner to the main switching mechanism.

A preferred refinement of the invention provides
10 that the auxiliary switching mechanism be provided with a tripping lever which supports a latching pawl on which an energy store acts and which interacts, by means of a transmission lever, with a latching lever of the main switching mechanism. The tripping lever is constructed as
15 a rocker which can pivot about a rotation point. The shorter lever arm of the switching or tripping rocker interacts with the latch, while its longer lever arm is acted on by the tripping plunger of the residual current tripping device. In addition, the auxiliary switching
20 mechanism has a resetting spring with overcompression to reset the tripping cam of the residual current tripping device. With the aid of this resetting spring, the tripping lever and, with it, a moving armature which is arranged in the residual current tripping device are
25 reset to their original position once tripping has been carried out.

According to the invention, the same switching mechanism as that which is used in the line protection pole is provided for the main switching mechanism of the
30 residual current pole. This results in considerable economic advantages, since the production of this switching mechanism is carried out automatically in large batches on suitable machines, which leads to favourable production costs and allows largely automated manufacture
35 of the combined electrical switching apparatus.

According to a particularly advantageous refinement of the invention, it is provided for the auxiliary switching mechanism to be positioned together with the residual current tripping device closely adjacent to the

main switching mechanism in order thus to make available sufficient space in the housing of the residual current device, which space is required to accommodate the evaluation unit as well as the contact point and the arc extinguishing device allocated thereto.

In an advantageous refinement of the invention, it can furthermore be provided for the small number of individual parts of the auxiliary switching mechanism to be arranged together with the residual current tripping device on a common board, which simplifies assembly of the tripping unit and increases its functional reliability. However, on the other hand, it is also possible to fix the abovementioned individual parts of the auxiliary switching mechanism and the residual current tripping device with the aid of attachments, pins and supports which are integrally formed on the housing wall in a suitable manner. The possibility for producing such a housing in one operation as an extruded part is in favour of this variant.

These and further advantageous refinements of the invention are specified in the subclaims.

Advantageous refinements and particular advantages of the invention are intended to be explained and described in more detail with reference to an exemplary embodiment which is illustrated in the drawing, in which:

- Figure 1 shows a switching apparatus according to the invention (residual current device/line protection circuit breaker) in a three-quarter view
- Figures 2 to 5 show an auxiliary switching mechanism having the residual current tripping device of the switching apparatus according to the invention, in a schematic illustration
- Figure 2 shows a switched-on position
- Figure 3 shows an intermediate position
- Figure 4 shows an intermediate position with the moving contact element raised and resetting of the auxiliary switching mechanism

and of the residual current tripping device

Figure 5 shows switched-off position

Figure 1 illustrates a switching apparatus 10 according to the invention which is composed of in each case one line protection circuit breaker 12 and one residual current device 14, which are arranged in separate modular housings 13, 15 which are arranged side-by-side. The two housings 13, 15 are virtually identical externally, this statement relating to both their external dimensions - the thickness of the housing corresponds to the specified module size of 17.5 mm - and to their shape, with the exception of a test button 16 by means of which the operation of the residual current pole 14 can be checked. In other respects, the two individual circuit breakers 12, 14 in each case have connecting terminals which are not shown, can be operated through operating openings 18 and can be reached via input openings 20 for the connection of input and output conductors.

On the front side, which points upwards in Figure 1, the switching apparatus 10 according to the invention has two switching handles 22 which are coupled to one another by means of a connecting part 23 placed thereon, as a manual operating device by means of which the contact points, which are not shown in this illustration, of the switching apparatus 10 can be operated manually. On its rear side, which points downwards in Figure 1, the switching apparatus 10 has a recess 24 which is used for accommodating a supporting rail which is not illustrated, preferably a DIN-standard top-hat rail. The recess 24, which is open towards the flat sides, is bounded on one side towards the narrow sides by a fixed-position latching tab 26 which is used for supporting one edge of the supporting rail. Towards the other narrow side, the recess 24 is bounded by a lateral edge 25 through which there passes, in a known manner, a moving latching slide 28 which engages behind the other edge of the supporting rail. However, only the end of the latching slide 38 having an operating opening 29 can be

seen in Figure 1.

The switching apparatus 10, which, as already mentioned, is composed of two individual circuit breakers 12, 14, is held together by connecting elements 17 and thus forms an integral block which, in addition, is also combined in its function by means of a coupling part, which cannot be seen in this illustration and is used for mechanical coupling of the switching devices of the two individual circuit breakers 12, 14. The individual circuit breakers 12, 14, which are combined to form the switching apparatus 10 according to the invention each have a main switching mechanism in the interior of their housings 13, 15, which main switching mechanism is on the one side connected to the switching handle 22 and on the other side [lacuna] for operating a contact point, which is likewise provided in each individual circuit breaker 12, 14 and is in each case formed from a moving contact element and a stationary contact element. Such a main switching mechanism is disclosed in EP-B1 0,144,799, which relates to a line protection circuit breaker as is used in the case of the invention. Such a main switching mechanism is likewise provided in the residual current protection pole 14 of the switching apparatus 10, which main switching mechanism is likewise connected to the manual switching handle 22 on one side but is acted on, on the other side, by an auxiliary switching mechanism 30, which is explained in Figures 2 to 5. Figures 2 to 5 provide a schematic illustration of the individual switching positions of the auxiliary switching mechanism 30.

Figure 2 illustrates the switched-on position of the residual current protection pole 14 whose contact point 31, which is formed from a moving contact element 30 and a stationary contact element 32 which is indicated only symbolically, is closed. The moving contact element 30 is attached to a contact arm 34 which is supported such that it can pivot about a rotation point 35. Arranged above the rotation point 35 of the contact arm 34, that is to say on its lever arm 341 facing

away from the moving contact element 30, is a spring 36 which is supported at one end on the housing 15 and at the other end on the lever arm 341 of the contact arm 34. Articulated at the end of the lever arm 341 of the contact arm 34 is a switching rod 38 whose other end is connected to a latching lever 40, where it is guided in an elongated hole 401. The latching lever 40 has a latching tab 402 which is supported in a recess 421 in a tripping lever 42. The tripping lever 42 is guided at one end such that it can pivot on a rotation shaft 43 and is acted on in the clockwise direction by a rotation spring which is not illustrated. The rotation shaft 43 is at the same time also used to support the switching handle 22, which is not shown in this illustration and is connected in an articulated manner via a connecting lever, which is likewise not illustrated, to the hinged joint 381 [sic], which is guided in the elongated hole 401, of the switching rod 38. The previously mentioned and described parts in Figure 2 belong to the already mentioned main switching mechanism. These parts have been discussed to the extent that they interact, in a mutually acting manner, with the auxiliary switching mechanism 44 which will now be described below.

The parts which are dealt with in the following text belong to the auxiliary switching mechanism 44 which makes the invention possible and has a switching rocker 46 with a rotation point 45, a force store 48 with a rotation point 47, a latching lever 50 likewise with the rotation point 47, a tripping rod 52, which is guided in an articulated manner in a rotation point 51 in the latching lever 50, as well as a resetting spring 54 which has a rotation point 53, and a return spring 56 which acts on the short lever arm 461 of the tripping rocker 46 in the clockwise direction. A residual current tripping device 60 having a tripping plunger 61 is arranged directly adjacent to the auxiliary switching mechanism 44.

In the switched-on state, both the main switching mechanism and the auxiliary switching mechanism 44 are in

force balance. In this case, the contact arm 34 of the moving contact element 30 is supported on the latching lever 40 via the switching rod 38. As a result of the special position, shown in Figure 2, of the latching lever 40, in which position its rotation point 41, which is partially covered by the latching lever 50, is located underneath the connecting straight line from the supporting edge 421 of the tripping lever 42 to the other hinged-joint point 382, which is arranged in the contact arm 34, of the switching rod 38, its hinged-joint point 381 is fixed at that end of the elongated hole 401 which faces away from the latching tab 402. As already mentioned, as a result of being acted on by a spring, the latching tab 402 of the latching lever 40 is supported on the supporting edge 421 in the tripping lever 42.

In the illustration shown in Figure 2, the auxiliary switching mechanism 44 is also in balance. The short lever arm 461 of the tripping rocker 46 is pressed by the spring 56 into the latching lever 50, so that a latching pawl 501, which is integrally formed thereon, is supported on the end of the tripping rocker 46. The force store 48, which is designed as a rotation spring is supported by means of its one lever arm on the housing 15 or on the guide of the auxiliary switching mechanism 44 and is articulated by means of its other lever arm on the rotation journal 51, which is integrally formed on the latching lever 50 and on which the tripping rod 52 is articulated.

As long as no external influences act on this lever system, which is formed by the main switching mechanism and the auxiliary switching mechanism 44, the described state is maintained and the contact point 31 is closed.

Figure 3 shows an intermediate position between the switched-on position and the switched-off position of the switching mechanism system, which is formed by the main switching mechanism and the auxiliary switching mechanism 44, of the residual current protection pole 14, in the case of which intermediate position, the residual

current tripping device 60 has been activated as a consequence of a fault current occurring, and its switching plunger 61 has pivoted the switching rocker 46 out of its normal position in the anticlockwise direction. In
5 consequence, the short lever arm 461 of the tripping rocker 46 also pivots in the anticlockwise direction, so that the latching pawl 501 of the latching lever 50 loses its support and likewise pivots in the anticlockwise direction about the rotation shaft 47, under the
10 influence of the force store 48. The pivoting of the tripping rocker 46 tensions the return spring 56.

Along with the pivoting movement of the latching lever 50 about the rotation shaft 47, the rotation joint 51 of the tripping rod 52 is also displaced in the
15 direction of the tripping lever 42. In consequence, the tripping lever 42 also experiences a pivoting movement in the anticlockwise direction about its rotation shaft 43. In consequence, the support on the supporting edge 421 is taken away from the latching tab 402 and can pivot in the
20 clockwise direction corresponding to the action of the spring 36 via the switching rod 38. This process is illustrated in Figure 4.

Figure 4 shows a further intermediate position of the previously described switching mechanism arrangement.
25 As already mentioned in the description of Figure 3, the latching lever 40 has carried out a pivoting movement through approximately 30°. In consequence, the switching rod 38 can slide to the right in the direction of the latching tab 402 of the latching lever 40 with its
30 hinged-joint point 381 [sic] in the elongated hole 401 of the latching lever 40, this movement being assisted by the spring 36 which acts on the upper lever arm 341 of the contact arm 34. Along with this axial displacement of the switching rod 38, the contact arm 34 completes a
35 pivoting movement in the clockwise direction about the rotation shaft 35, as a result of which the moving contact element 30 is lifted off the stationary contact element 32 and the contact point 31 is opened. At the same time as this pivoting movement, the lever arm 341 of

the contact arm 34 presses with its end, which is constructed as a shoulder 342, against the latching lever 40, as a result of which this in turn completes a pivoting movement in the clockwise direction about the pivoting shaft 47.

During this pivoting movement of the latching lever 40 two things are completed. Firstly, the force store 48 is once again tensioned by the rotation journal 51. At the same time, the latching pawl 501 is also pivoted in the clockwise direction, so that the short lever arm 461 of the switching rocker 46 also slides back into its normal position as a result of the action by the return spring 56, and can thus use its end again as a support for the latching pawl 501. Furthermore, during this pivoting movement of the latching lever 40, the tripping rod 52 is also pulled back into its normal position.

During its pivoting movement in the clockwise direction about its rotation point 41, which is covered by the latching lever 50 in Figure 4, the free end of the latching lever 40, which free end supports the latching tab 402, acts on the return spring 54 in such a manner that the latter, by pivoting about the rotation point 53, returns the tripping plunger 61 of the residual current tripping device 60 to its quiescent position.

The return spring 54 is constructed as a sprung flexible lever, the design shown in the example being a forked lever. The sprung flexibility is necessary in order to ensure that the moving armature, which is connected to the tripping plunger, in the residual current tripping device 60 also actually rests, in its quiescent position, on the magnetic yoke of the residual current tripping device and thus assumes its quiescent position. In this case, the sprung flexibility of the resetting spring 54 allows a certain amount of over-compression which at the same time makes it possible to compensate for tolerances resulting from manufacture or wear.

Finally, Figure 5 shows the switched-off position

of the residual current pole 14 in which the moving contact element 30 is lifted off the stationary contact element 32, but the auxiliary switching mechanism 44 is already fully tensioned again. In this case, it must be noted that the shoulder 342 of the contact arm 34 is in contact with the latching lever 50, as before, and acts on it in the clockwise direction, so that its latching pawl 501 is at a certain distance from the end of the switching rocker 46. In the same way, the free end of the tripping rod 52 is also not resting directly on the tripping lever 42 but on an attachment 422 which is used for guiding the tripping rod 52.

The latching tab 402 of the latching lever 40 has once again occupied its position in the recess with the supporting edge 421 in the tripping lever 42. Only the switching rod 38 is located with its hinged-joint point 381 inside the elongated hole 401 above the position which it occupies in the switched-on state.

The following summary is intended to be used to clarify the operation of the auxiliary switching mechanism 44, which is used in the residual current protection pole 14 of the switching apparatus 10 according to the invention and has a compact residual current tripping device 60. The residual current protection pole 14 of the switching apparatus 10 according to the invention has a main switching mechanism which is identical to that of the adjacent line protection circuit breaker 12. Whilst an overcurrent tripping device and a short-circuit current tripping device are provided in the line protection circuit breaker for operation, that is to say for tripping, of the switching mechanism in a known manner, the tripping forces of which tripping devices being adequate to trip the switching mechanism which is acted on by a powerful force store for the purpose of rapid opening, such a space is not available in the residual current protection pole 14 of the switching apparatus 10 for the reasons mentioned initially, but only one residual current tripping device 60, which is matched to the module dimensions, can be used. However,

as a result of its size, this residual current tripping device 60 is not able to release enough energy to trip the main switching mechanism in a comparable manner to that in the case of the line protection circuit breaker

5 12.

In consequence, it is provided according to the invention to connect inbetween an auxiliary switching mechanism 44 which is used to increase the small tripping force of the residual current tripping device 60

10 virtually without any delay and to transmit said force to the main switching mechanism in the event of response, in order to cause it to trip. In this case, the invention makes use of the interaction between the lever arms and force stores.

15 The tripping rocker 46 has a long and a short lever arm 461 and can pivot about the rotation point 45. In the event of response, the tripping plunger 61 of the residual current tripping device 60 acts on the long lever arm of the tripping rocker 46 in such a manner that

20 the rocker carries out a pivoting movement in the anticlockwise direction about the rotation shaft 45 and, at the same time, the short lever arm 461 loses its supporting function for the latching lever 50 which, for its part, is acted on by a force store 48. In consequence, as

25 a result of being acted on by the force store 48, the latching lever 50 completes a pivoting movement in the anticlockwise direction and, in this case, via a tripping rod 52, presses the tripping lever 42 of the main switching mechanism out of its quiescent position so that the

30 latching lever 40, which is supported therein, is unlatched and likewise carries out a pivoting movement in the clockwise direction, following the action by a spring. In consequence, the hinged-joint point 381, which until this point has been fixed in the elongated hole

35 401, of the switching rod 38 slides along therein, guided by the elongated hole 401. The spring 36, which is supported on the housing 15 or on the guide of the auxiliary switching mechanism 44 and acts on the upper lever arm 341 of the contact arm 34 on which the switching rod 38

is articulated, assists the movement of the switching rod 38, as a result of which the contact arm 34 at the same time carries out a pivoting movement in the clockwise direction about the rotation point 35. In this case, the
5 moving contact element 30, which is mounted on the contact arm 34, is lifted off the stationary contact element 32, so that the contact point 31 of the residual current protection pole 14 is opened.

For completeness, it must also be mentioned that
10 the rotation shaft 43 of the tripping lever 42 at the same time also represents a rotation shaft for the manual switching handle 22, which couples both main switching mechanisms via the connecting part 23, so that manual operation of the contact points is also possible.

15 Furthermore, the residual current protection pole 14 has a test button 16 by means of which a fault-current signal can be produced artificially which leads to the residual current tripping device responding, as a result of which the tripping of the switching mechanism is
20 brought about, likewise in the manner described above.

Furthermore, the residual current protection pole 14 is connected to the adjacent line protection circuit breaker 12 via a coupling part which is not shown in more detail for likewise causing one circuit breaker pole to
25 trip whenever the other circuit breaker pole trips, so that the two individual circuit breakers 12, 14 are caused to trip in every response case, irrespective of whether this is an overcurrent, short-circuit current or fault current, so that the circuit which is protected by
30 the switching apparatus 10 according to the invention is switched such that no current flows.



Patent Claims

1. Electrical switching apparatus for snapping onto
profiled supporting rails having a single-pole line
protection circuit breaker (12) and residual current
5 device (14) which are arranged in housings (13, 15) which
are separate but connected to one another and have a
module width (of, for example, 17.5 mm), in each case
having tripping means for operating moving contact
elements (30) which form contact points (32) by means of
10 stationary contact elements, and having manual switching
handles (22) which in each case allow manual operation of
the moving contact elements (30) via at least one switch-
ing mechanism having a latching point, the residual
current device (14) and the line protection circuit
15 breaker (12) in each case having a main switching mecha-
nism, which main switching mechanisms are connected by
means of a coupling, are of identical design and operate
the moving contact elements (30), characterized in that
both the line protection circuit breaker (12) and the
20 residual current device (14) each have a contact point
with a stationary contact element (30) and a moving
contact element (32), and in that the residual current
device (14) additionally has an auxiliary switching
mechanism (44) which interacts with a residual current
25 tripping device (60) and amplifies its tripping pulse,
which is transmitted by a tripping plunger (61), trans-
mits it to the tripping lever (42) of the main switching
mechanism and thus brings about its unlatching, which
results in the opening of the associated contact points
30 (31).

2. Electrical switching apparatus according to
Claim 1, characterized in that the auxiliary switching
mechanism has a latching lever (50) which is acted on by
a force store (48), is for its part connected via a
35 tripping rod (52) to the tripping lever (42) of the main
switching mechanism and is supported on a tripping rocker
(46) which is acted on by the tripping plunger (61) of
the residual current tripping device (60).

3. Electrical switching apparatus according to



Claim 2, characterized in that, in the event of a response, the tripping plunger (61) of the residual current tripping device (60) causes the tripping rocker (46) to pivot in the anticlockwise direction, as a result of which the latching lever (50) loses its support and, under the influence of the force store (48) and via the tripping rod (42), moves the tripping lever (42) of the main switching mechanism out of its quiescent position and in consequence brings about the unlatching of a latching lever (40) which is connected via a switching rod (38) to a contact arm (34) which supports the moving contact element (30) and thus causes the opening of the contact point (31).

4. Electrical switching apparatus according to one of the preceding claims, characterized in that the force store (48) is constructed as a rotation spring which is supported on the one side on the housing (15) or on a guide for an auxiliary switching mechanism 44 [sic] and on the other side on a rotation journal (51) which is integrally formed on the latching lever (50).

5. Electrical switching apparatus according to one of the preceding claims, characterized in that a return spring (56) is provided for resetting the tripping rocker (46), which return spring (56) acts on the tripping rocker (46) such that it tries to latch with the latching lever (50).

6. Electrical switching apparatus according to one of the preceding claims, characterized in that a resetting spring (54) is provided with whose aid the tripping plunger (61) of the residual current tripping device can be reset to its quiescent position.

7. Electrical switching apparatus according to Claim 6, characterized in that, once tripping has been carried out, the resetting spring is acted on by the latching lever (40) of the main switching mechanism in order to reset the tripping plunger (61).

8. Electrical switching apparatus according to one of the preceding claims, characterized in that the contact arm (34) has a shoulder (342) which resets the



latching lever (50) to its quiescent position while the moving contact element (30) is being lifted off, and at the same time tensions the force store (48).

5 9. Electrical switching apparatus according to one of the preceding claims, characterized in that the resetting spring is constructed as a leaf spring which is bent in a U-shape and is arranged such that it can pivot about a rotation journal (53).

10 10. Electrical switching apparatus according to one of the preceding claims, characterized in that the switching rocker (46) is provided as a cross member having a pivoting support (45) which is arranged eccentrically with respect to its longitudinal rotation.