

Description

The invention concerns a protective circuit breaker with thermal tripping in accordance with the introductory part of claim 1.

Such circuit breakers are known for example from the DE-A 25 02 579. This known circuit breaker operates according to the principle of thermal tripping by means of a bimetallic strip.

In this arrangement, the bimetallic strip has a bend at right angles and is mounted with slight play by two bulge projections formed on a switch casing. On the bimetallic strip, there is formed at a suitable distance next to the bulge projections, a contact projection laterally projecting in the direction towards the contact component of a rectangular contact bridge. In the "on" position, a tripping spring presses the contact bridge with its contact piece against the contact projection. If any over-current occurs, the bimetallic strip is bent by heating in such a way that the contact bridge is released from the contact projection and is pressed by the force of the compression spring into its "off" position.

The tripping sensitivity of the circuit breaker is set by means of a setscrew. The setscrew acts according to the tension-compression principle by virtue of a prestressing and deformation on a connecting arm rigidly connected to the bimetallic strip. In this adjustment, there is the drawback that the setscrew is unstable in its final adjusted state. The prestressing force acting on the screw changes over the range of the adjustment. Moreover, the prestressing force is only acting point-wise on the centre of the shank of the setscrew.

This instability presents a drawback, since such protective circuit breakers are preferentially installed as replacements for conventional fuses in electrical circuits of vehicles. Due to the operation of the vehicles, the circuit breakers are exposed to the most varied conditions of use. They have to withstand abrupt climatic changes and also extreme stresses of shocks and vibrations. In particular with small prestressing forces, such an adjustment is inadequate to meet these climatic and mechanical stresses.

For the use of protective circuit breakers in vehicles, only a very limited instalment space is available, so that provision is made for plug panels into which such circuit breakers are inserted. For this purpose, the circuit breakers have contact elements in the form of blade tags. To allow as many such circuit breakers as possible to be placed side by side in as narrow a space as possible in a plug panel, a very narrow design of the individual circuit breakers is required. For space saving reasons, the circuit breaker depth must, for the same reason, be kept as small as possible. On the other hand, the height of the circuit breaker permits greater play.

In the necessary, progressively continuing miniaturisation of design, these blade tags lie very close to each other, so that the available instalment space for a setscrew is minimal. Yet for its part, the size of the setscrew must not fall below certain dimensions, since it must be designed for the operating prestressing force. Moreover, a manipulation of the setscrew, for example by means of a screwdriver, from the outside must be ensured. Thus the size of the setscrew is an essential parameter which limits any further miniaturisation of such a setscrew.

There is, moreover, the drawback that such setscrews are made of metallic, and hence conductive materials, and that in the case of a sandwich arrangement, the risk of short circuits increases between blade tags disposed closely side by side. There is also the risk that the blade tags will be damaged by the adjusting screwdriver.

From the US-A-3 265 832, a bimetal-controlled protective circuit breaker is known which is adjusted by means of an adjustment cam acting on the bimetallic strip. For this purpose, the adjustment cam can be adjusted from the outside. In this protective circuit breaker, there is the drawback that the overall design consisting of many individual parts is expensive and unstable.

The invention is based on the problem of improving a protective circuit breaker of the kind indicated at the outset and to adapt its overall design to the requirements of an automated manufacture.

This problem is solved by a combination of the features of claim 1.

The tripping mechanism of the circuit breaker corresponds in principle to the circuit breaker known from the DE-A-25 02 579. However, its tripping sensitivity is set by means of a rotary body bearing with its cylindrical surface on the connecting arm.

The rotary body is eccentrically mounted round its axis of rotation in a switch casing and acts on the connecting arm with a given prestressing force. Because of its eccentric mounting, this prestressing force changes as the rotary body is being rotated. Under the effect of the prestressing force, the connecting arm becomes deformed. Because of the special kinematic connection of the connecting arm to the bimetallic strip, the deformation of the connecting arm is transmitted to the bimetallic strip. As a consequence, the tripping characteristics determining the tripping behaviour of the protective circuit breaker is altered in such a way that the connecting arm, and hence the bimetallic strips, are subjected to a defined prestressing.

In the initial adjustment position, that zone of the rotary body bears with its flattened portion on the connecting arm which has

in the tripping direction the smallest radial distance from the axis of rotation, so that the rotary body acts with a minimum prestressing force on the connecting arm. The flattened portion fixes the rotary body in its installed position secured against rotation at its zero position.

The simple and always precisely defined zero position permits an automated and hence particularly economical manufacture of the circuit breaker. With an automated or robotized manufacture, it is first of all possible to mount the protective circuit breaker in a completely automated mode. In this connection, it does not matter in which position the rotary body is installed. After the manufacture has been completed, the rotary body is rotated until a perceptible resistance has been overcome. After this resistance has been overcome, the rotary body bears with its flattened portion on the connecting arm, and thus has reached its zero position.

From this zero position, the adjustment of the bimetallic strip is effected in a further step. By rotation of the rotary body, the radial distance of the zone of the peripheral surface bearing on the connecting arm increases from the axis of rotation in such a way that the prestressing force acting on the connecting arm continuously increases and reaches a maximum after a rotation through 180°.

The deformation of the bimetallic strip produced in this way ensures that its prestressing acting in the zone of the contact projection in the direction towards the contact bridge decreases and that its tripping sensitivity is thus increased. In operation, this increase of the tripping sensitivity produces a reduction of the maximum tripping time.

Because of the insertion of the connecting arm in the manner of a fixed bearing in the switch casing on the one hand, and the use of an adjustment cam-type rotary body on the other hand, it is possible to transmit high prestressing forces to the connecting arm, and hence to the bimetallic strip. By means of a large diameter of the rotary body, it is possible to design the circuit breaker in such a way that its tripping characteristic is adjustable over a large range. The scope for a continuous adjustment by means of the adjustment eccentric presents a further advantage.

Because the adjustment eccentric does not have to be manipulated from the connection side of the circuit breaker, but the adjustment of the rotary body is effected from the casing side, it is possible to place the contact elements very close to each other.

The mounting of the rotary body in the switch casing between the contact elements favours the compact design of the circuit breaker. Moreover, by means of the components designed in accordance with the invention, it is both possible to give the circuit breaker a narrow design in the horizontal direction and

to keep the height of its narrow sides extending in the fixing direction very low.

5 The contact elements flank the rotary body and form with their recesses an installation well for the rotary body. Thereby, the installation space for the rotary body is increased. In the zones not flanking the rotary body, the connecting contacts are designed with a wider shape in the horizontal direction, so as to create, in particular in the zone projecting out of the switch casing, large contact surfaces for the connection in the connecting sockets of the plug-in panel.

15 The use of spring catches according to claim 4 ensures a particularly secure and durable engagement of the circuit breaker in the plug-in panels during highly stressed use in motor vehicles.

20 Claims 5 to 8 teach a particularly favourable design of the whole circuit breaker mechanism as far as its operation is concerned. The circuit breaker shaped in this way rises in particular in the vertical direction, which favours the space saving design in the horizontal direction, as well as in the direction of the narrow sides.

25 Because of the large distance in the horizontal direction between the contact surface of the connecting arm and the bimetallic strip on the one hand, and the mounting of the bimetallic strip on the bulge projections on the other hand, a relatively long adjustment lever arm is obtained for the bimetallic strip, whereby its potential for an easy and precise adjustment is promoted. Moreover, the design of the bimetallic strip in conjunction with the contact projections ensures the occurrence of high tensile force components, with at the same time, the occurrence of low bending force components in the bimetallic strip, whereby the bimetallic strip is protected against wear in use.

35 The integral design of the contact bridge, the supporting base 540 and of the push-button switch as one assembly favours the automated manufacture of the circuit breaker. This is because the prefabricated assembly can be mounted in the circuit breaker by means of a single operating step by insertion into one of the half-shells forming the switch casing. The use of such assemblies favours the modular, building block-type structure of the circuit breaker. It is, moreover, possible to prefabricate the assemblies in large quantities with constant accuracy.

45 Claims 9 to 15 teach advantageous designs of the switch casing, by means of which the fitted components are mounted particularly advantageously in the switch casing. These favourable mounting properties are further advantageously affected by the integral design of the connecting arm and bimetallic strip on one side, and of the connecting arm, connecting contact and spring catches on the other side. Because of the integral design, the above mentioned components cooperate both mechanically and electrically in a very secure and reliable manner. Moreover, the in-

tegral structure of the above mentioned components is very simple as far as their design is concerned, and therefore advantageous as far as the manufacturing technology is concerned.

5 Because of the multiple mounting with a form-fit of the integral module consisting of the above mentioned components, it is possible to fix the assembly by simple insertion into one of the casing half-shells in the casing. This advantageously favours the scope for an automated mounting of the circuit breaker in
10 accordance with the invention. Moreover, the multiple mounting of the integral assembly favours the operational reliability and durable service life of the circuit breaker. Because of this durable mounting, in particular of the connecting arm, particularly high forces can be transmitted by the rotary body onto the
15 connecting arm. The multiple mountings provided on the circuit breaker are therefore suitable for absorbing very high pre-stressing forces acting on the connecting arm.

Moreover, the end pieces, the rib, the trough-type receiving
20 means for the rotary body and the bulge projections are designed in such a way on the switch casing that the deformation acting on the bimetallic strip can be controlled particularly accurately and that the bimetallic strip can thus be deformed, being controlled by the rotary body.

25 Claims 16 to 18 teach advantageous further developments of the rotary body which make it possible to injection mould the switch casing with the mounting elements formed thereon from a synthetic material. Any defects in the manufacturing tolerances possibly occurring in the injection moulding process can in a circuit breaker according to this mode of embodiment be simply compensated by an adjustment movement of the rotary body designed as a disk-shaped adjustment eccentric. Because of its facility
30 for continuous adjustment, it is thus possible both to compensate defects in the manufacturing tolerances and to set the desired tripping characteristic.

The peripheral surface of the rotary body is delimited by two end faces of the rotary body. From each of these two end
40 faces, there projects one journal each in such a way that the median longitudinal axis of the journal is congruent with the axis of rotation of the rotary body. These journals, preferably designed as cylinders, thus mount the rotary body eccentrically in the switch casing. For this purpose, mounting openings are
45 formed in the casing which are traversed by the journals. By means of recesses formed in the end face of the journals, in particular as hexagonal sockets, it is possible to manipulate the rotary body from the outside when the switch casing has been assembled. Thus the rotary body is an adjusting eccentric acting
50 on the connecting arm.

In a special mode of embodiment according to claims 19 to 21, the journals have a substantially star-shaped cross-sectional form. The peripheral surfaces of the journals carry a tooth

system corresponding to this star-shaped cross-sectional form. In this special mode of embodiment, provision is made for a catch projection which meshes with the tooth system on the peripheral surface of the journals and engages therein. By this conjugate engagement in the tooth system, the rotary body is additionally mechanically secured in its respective relative position.

A particular advantage of the invention lies in the fact that the force vector acting between the connecting arm and the adjusting eccentric always intersects the adjusting eccentric - axis of rotation perpendicularly. Consequently, the effective direction of this force acting on the axis of rotation is constant.

The prestressing force acting between the connecting arm and the adjusting eccentric does not only deform the connecting arm, but secures the respective position of the adjusting eccentric by self-locking. This particularly advantageous effect prevents any unintended rotation of the eccentric due to the effect of vibrations or shocks.

The position of the eccentric between the contact elements, but outside the plug-in zone wherein the contact elements are designed as blade tags, is particularly advantageous. The hexagonal socket preferably used for manipulating the adjusting eccentric does not come into contact with live electrical parts, in particular with the blade tags. Thereby any damage to the blade tags during the adjustment is precluded from the outset.

For the further miniaturisation of the protective circuit breaker, the adjusting eccentric is preferably designed as a narrow space-saving disk. Because of the perpendicular course of the force vector through the axis of rotation described above, the resultant forces can still be absorbed even with an extremely narrow design, so that the desired self-locking is always preserved.

Moreover, the design of the bimetallic strip, in particular as a meander-type bimetal in a second mode of embodiment of the circuit breaker according to claims 22 to 24 is particularly advantageous. In such a design, several webs lie side by side being electrically disposed in series, whereby a relatively high resistance is obtained. In electrical circuits with relatively low resultant currents, or with low current intensities, the heat output necessary for the thermal tripping can be easily achieved because of this enlarged resistance area of the bimetallic strip. For obtaining the same mechanical behaviour as in an integral bimetallic strip, the bimetal webs are held together in the manner of a bandage by a clip surrounding them.

The invention will be described in greater detail with reference to some examples of embodiments represented in the drawings.

There are shown in:

- Fig. 1 an overall view of the protective circuit breaker in its assembled state,
- Fig. 2 an internal view of the protective circuit breaker in the "on" position according to Figure 1, when the upper shell has been removed,
- Fig. 3 an internal view of the protective circuit breaker in the "off" position according to Figure 1, when the upper shell has been removed,
- Fig. 4 an exploded representation of a mode of embodiment of the protective circuit breaker with a normal bimetallic strip according to Figure 1,
- Fig. 5 an exploded representation of a mode of embodiment of the protective circuit breaker with a meander-type bimetallic strip according to Figure 1,
- Fig. 6 an exploded representation of the detail of the meander-type bimetallic strip according to Figure 5,
- Fig. 7 a particular mode of embodiment of the rotary body with a journal carrying a tooth system.

The protective circuit breaker 10 is disposed in a switch casing 40 consisting of an upper half-shell 20 and a lower half-shell 30. The bottom narrow side of the switch casing 40 forms the connection side 50. The upper narrow side of the switch casing 40 remote from the connection side 50 forms the switch side 60. The connection side 50 and the switch side 60 extend parallel to the horizontal direction 70. The vertical direction 80 runs perpendicularly to the horizontal direction 70. The vertical direction 80 is composed of the tripping direction 90 extending in the direction towards the switch side 60, and the switching-on direction 100 extending in the direction towards the connection side 50.

From the switch side 60, a push button 120 disposed approximately on the median longitudinal axis 110 of the protective circuit breaker 10 projects in the tripping direction 90. The connection side 50 and the switch side 60 are connected to each other in the vertical direction 80 by two narrow sides, the right-hand narrow side 130 and left-hand narrow side 130'. A knob 160 formed on a manual trip 150 projects from an edge zone 140 formed by the switch side 60 and the adjoining right-hand narrow side 130.

From the connection side 50, two contact elements designed as blade tags, a right-hand contact element 170 and a left-hand contact element 170', disposed side by side in the horizontal direction 70 and symmetrically to the median longitudinal axis

110, project in the switching-on direction 100. One spring catch 180, 180' each is formed on the outer sides of the contact elements 170, 170' for fixing the protective circuit breaker 10 in a plug-in panel. The contact elements 170, 170' are traversed by one fixing hole 190, 190' each, in a fixing direction 200 extending perpendicularly to the horizontal direction 70, and also perpendicularly to the vertical direction 80. Two fixing studs 210, 210' facing the upper half-shell 20 project on the lower half shell 30 in the fixing direction 200 in the zone of the connection side 50. In the assembled state, the fixing studs 210, 210' pass through the fixing holes 190, 190' and engage in two fixing openings 220, 220' extending on the connection side 50 of the upper half-shell 20 in the fixing direction 200, for securing the contact elements 170, 170' in the switch casing 40.

The upper half-shell 20 and the lower half-shell 30 are traversed by one riveting hole 230 each, extending on the connection side 50 in the fixing direction 200 and disposed in the horizontal direction 70 approximately on a line with the fixing openings 220, 220' or the fixing studs 210, 210'. The left-hand edge zone 140' formed by the left-hand narrow side 130' and the switch side 60 is also traversed by a riveting hole 230 extending in the fixing direction 200. The assembly of the upper half-shell 20 and the lower half-shell 30 for forming the switch casing 40 is obtained by rivets inserted in all the riveting holes 230.

A contact holder 240 extending in the assembled position near the inner side of the left-hand narrow side 130' is formed on the left-hand contact element 170' in the tripping direction 90. A fixed contact 250 pointing in the direction towards the inside of the casing is formed on the free end of the contact holder 240 projecting in the tripping direction 90. A pivoting contact 260 of a vertical arm 270 of a pivotable contact bridge 280 pointing in the direction towards the left-hand narrow side 130' bears on the fixed contact. For its part, the contact bridge 280 consists of a vertical arm 270 extending in the vertical direction 80 and a horizontal arm 290 connected thereto at right angles at its free end pointing in the tripping direction 90. The free end of the horizontal arm 290 remote from the vertical arm 270 forms the contact piece 300.

A compression spring 310 extending in the switch casing 40 approximately congruently with the median longitudinal axis 110 presses with its spring force acting in the tripping direction 90 against the flat side of the horizontal arm 290 facing the connection side 50. In the "on" position, the horizontal arm 290 occupies a horizontal position extending parallel to the horizontal direction 70.

With its upper side facing the switch side 60, the contact piece 300 bears on a contact projection 320 in such a way that it is disposed in engagement therewith. The contact projection 320 is formed on a bimetallic strip 330 to project in the direction to-

wards the compression spring 310. The bimetallic strip 330 extends firstly in the vertical direction 80 along the inner side of the right-hand narrow side 130 approximately from the switch side 60, almost as far as the connection side 50. This vertical portion of the bimetallic strip 330 is followed after a bend 340 approximately at right angles by a horizontal portion of the bimetallic strip 330 extending in the horizontal direction 70. This horizontal portion of the bimetallic strip 330 is mounted with slight play between two bulge projections 350, 350', the bulge projection 350 on the connection side and the bulge projection 350' formed on the switch casing 40.

The free end of the horizontal portion of the bimetallic strip 330 lying opposite the vertical portion of the bimetallic strip 330 has a vertical portion bent up at right angles extending approximately in the vertical direction 80 which forms an area for connection to the connecting arm 370 that is bent up in this zone in the same way.

As viewed in the plane of the drawing of Figure 2, the bimetallic strip 330 is therefore substantially U-shaped, in which arrangement its horizontal portion forms the U-web 331 with the vertical arm as the long U-arm, and the portion bent-up at right angles as the short fixing arm 360. The fixing arm 360 therefore forms the area for connection to the connecting arm 370.

The connecting arm 370 extends from the area for connection to the fixing arm 360 extending in the vertical direction 80, slanting at first horizontally in the direction towards the connection side 50 and during its further course, parallel to this horizontal direction 70. On the contact arm 370 there is formed the right-hand contact element 170 as viewed in the switching-on direction 100, which is designed as a blade tag.

With its free end 371 remote from the area for connection to the fixing arm 360, the connecting arm 370 is mounted for insertion between an end piece 372 on the switch side and an end piece 373 on the connection side. The rib 374 extending in the vertical direction 80 projects in the fixing direction 200 between the right-hand spring catch 180 and the right-hand contact element 170. The right-hand contact element 170 lies for its part between the rib 374 and the trough-shaped recess 380 for receiving the rotary body 390.

The connecting arm 370, the right-hand contact element 170 and the right-hand spring catch 180 are designed as an integral π -shaped assembly, in which arrangement the connecting arm 370 forms the π -crosspiece and the contact element 170 and the spring catch 180 form the π -arms. This π -shaped assembly is inserted between the bulge projection 350 on the connection side, the trough-shaped recess 380, the rib 374 and the end pieces 372, 374 in such a way that the end piece 373 on the connection side, the rib 374 and the trough-shaped recess 380

act as a conjugate fixed mounting against displacement of the π -shaped assembly in the horizontal direction 70. The π -shaped assembly is inserted secured against displacement in the vertical direction 80 between the end pieces 372, 373 and is mounted on the end faces of the rib 374 and the end face of the trough-shaped recess 380, as well as on the bulge projection 350 on the connection side. Thus the π -shaped formation lies between the end pieces 372, 373, the rib 374 and the trough-shaped recess 380, as well as the bulge projection 350 on the connection side with a form fit.

In a portion of the connecting arm 370 extending between the contact elements 170, 170' and the portion extending in the horizontal direction 70 of the connecting arm 370, a recess 380 extending in the fixing direction 200 is formed in the half-shells 20, 30 of the switch casing 40 for a drum-shaped rotary body 390. One cylindrical journal 400 each, pointing in the fixing direction 200 towards the upper half-shell 20 or the lower half shell 30 projects from the end faces of the rotary body 390. Bearing openings 410 pointing in the fixing direction 200 and corresponding in their hollow geometry to the volumic geometry of the journals 400, are worked into the upper half-shell 20 and the lower half-shell 30. The rotary body 390 is thus mounted for free rotation in the bearing openings 410 by means of its journals 400.

The journals 400 have a circular cross-section in the horizontal direction 70, with a centre 420. At their centre 420, the two journals 400 are intersected by an imaginary axis of rotation 430 extending parallel to the upper half-shell 20. The rotary body 390 has in the horizontal direction 70 a cross-section that is also circular, whose centre is, however, in each case disposed outside the centre 420 of the journals 400, and both centres are thus in no way congruent with each other. Like the journals 400, the rotary body 390 also rotates about the axis of rotation 430 extending outside the centre of the rotary body, whereby the rotary body 390 executes an eccentric rotational movement.

Together with a hexagonal recess 440 on the end face of each of the two journals 400, the journals 400 and the rotary body 390 form the adjusting eccentric 450. Through the bearing openings 410 completely traversing the upper half-shell 20 and the lower half-shell 30 in the fixing direction 200, it is possible to insert a hexagonal Allan key into the hexagonal sockets 440 for manipulating the adjusting eccentric 450.

A special mode of embodiment of the adjusting eccentric 450 shown in Figure 7 has modified journals 400. These modified journals 400 each carry a tooth system 401. This tooth system 401 gives the journals 400 a substantially star-shaped cross-sectional shape in the fixing direction 200. A specific mode of embodiment of the bearing openings 410 complements the specifically toothed mode of embodiment of the journals 400.

In this arrangement, a catch projection 402 extending in the horizontal direction 70 reaches into the bearing openings 410.

5 The catch projection 402 engages in the tooth system 401 in such a way that the tooth system 401 can, on the one hand, slide over the catch projection 402 as the adjusting eccentric is being rotated. On the other hand, the conjugate engagement of the catch projection 402 in the tooth system 401 ensures that the adjusting eccentric 450 is secured in its respective relative position. By means of the parallel arrangement of the catch projection 402 to the connecting arm 370, one ensures that the adjusting eccentric is also raised in the adjustment direction and is not laterally displaced in the horizontal direction 70.

15 With a zone of its peripheral surface 460, the adjusting eccentric 450 bears on the connecting arm 370 and is kinematically connected thereto. The zone of the peripheral surface 460 which has the shortest radial distance from the centre 420 is provided with a flattened portion 470 extending parallel to the connecting arm 370. If the peripheral surface 460 bears with the flattened portion 470 on the connecting arm 370, the adjusting eccentric 450 is disposed in one fitted position. In this fitted position, the forces acting between the adjusting eccentric 450 and the connecting arm 370 are at their lowest. By rotating the adjusting eccentric 450 in the right-hand direction in a clockwise direction, the connecting arm 370 bears on one of the zones without the flattened portion 470 of the peripheral surface 460. The greater the radial distance between the zone of the peripheral surface 460 and the centre 420, the greater are the forces acting between the connecting arm 370 and the adjusting eccentric 450.

35 The adjustment of the tripping sensitivity of the bimetallic strip 330 is effected by means of the deformation of the connecting arm 370 due to the forces acting between the connecting arm 370 and the adjusting eccentric 450. In this arrangement, the connecting arm 370 passes on its deformation to the bimetallic strip 330 via the area for connection to the fixing arm 360 in such a way that the vertical portion of the bimetallic strip 330 is, with an increasing force, deformed in the horizontal direction 70 in the direction towards the right-hand narrow side 130.

45 The effective overlap between the contact piece 300 and the contact projection 320 is thereby reduced. If the bimetallic strip 330 is heated further, it is subjected to further deformation in the horizontal direction 70 towards the right-hand narrow side 130, whereby the contact piece 300 and the contact projection 320 pass out of engagement (Figure 3). If, due to an arising overcurrent, the contact piece 300 and the contact projection 320 thus pass out of engagement, a tripping spring 480 extending in a helical configuration approximately round the median longitudinal axis 110 pushes the contact bridge 280 in a catapult mode in the tripping direction 90, in the direction towards the

switch side 60. An inclined stop 490 is formed on the switch side 60 inside the casing, which stop produces a slanting position of the contact bridge 280 in the "off" position.

5 The tripping spring 480 is mounted between a supporting element 510 and a supporting base 540. The supporting element 510 is connected to the free end of the tripping spring facing the switch side 60 by means of a centring stud 530. The centring stud 530 centres the tripping spring 480 approximately round the median longitudinal axis 110. Thus the supporting element 510 lies between the tripping spring 480 and the compression spring 310 positioned next to it in the tripping direction 90, and forms an integral assembly together with the push button 120, the contact bridge 280 and the compression spring 310. This assembly is mounted in the path guides 630 formed in the half-shells 20, 30 of the switch casing 40, for displacement in the vertical direction 80.

20 A screen 620 acting in the direction towards the right-hand narrow side 130 projects in the tripping direction 90. The screen 620 screens the compression spring 310 from the arc occurring between the contact piece 300 and the contact projection 320 during the tripping. The supporting base 540 is formed in the switch casing 40, preferably in the lower half-shell 30, and delimits the tripping spring 480 in the direction towards the connection side 50. The supporting base 540 has a cross-section extending in the horizontal direction 70, whose free side points in the direction towards the switch side 60 and from which the tripping spring 480 projects in the tripping direction 90. In the direction towards the connection side 50, there is formed on the bottom of the supporting base 540, one bulge projection 350 mounting the bimetallic strip 330. The supporting base 540 is traversed by a rivet hole 230 in the fixing direction 200.

35 Above the pivoting contact 260, a safety stop 500 projecting in the direction towards the inside of the casing is formed above the pivoting contact 260 on the vertical arm 270. A dog 520, remote from the screen 620, is formed on the supporting element 510 in the direction towards the left-hand narrow side 130'. Because of the inclined position of the contact bridge 280 on the slanted stop 490, the dog 520 and the safety stop 500 come into engagement in the vertical direction 80 when the push button 120 is pressed in the switching-on direction 100. In this way, a pivoting back of the contact bridge 280 is prevented, even when the push button 120 is kept pressed down by hand, so that the protective effect of the protective circuit breaker 10 is completely ensured, even when the push button 120 is kept pressed down by hand.

50 Only when the bimetallic strip 330 has been reformed into its initial position (Figure 2), can the protective circuit breaker be returned into its switched-on position.

For this purpose, the push button 120 is depressed in the switching-on direction 100. When the push button 120 is released, the contact projection 320 and the contact zone 300 again come into engagement, whereby the contact bridge 280 is positioned straight again, that is to say, its horizontal arm 290 extends parallel to the transverse direction 70 and the dog 520 and the safety stop 500 pass out of engagement.

In addition to the overcurrent tripping described, the protective circuit breaker 10 also permits manual tripping. For this purpose, the manual trip 150 has a rotary arm 550 extending in the "on" position parallel to the horizontal direction 70, and an active arm designed as a switching cam 560 and extending at right angles thereto in the vertical direction 80. Due to their disposition at right angles to each other, the switching cam 560 and the rotary arm 550 form a switching rocker-type toggle switch.

For pivoting in the horizontal direction 70, the manual trip 150 is mounted by means of two journals 570 projecting from its end faces in the fixing direction 200 in corresponding recesses of the switch casing 40. In the switched-on position of the protective circuit breaker 10, the switching cam 560 bears in the manner of a finger on the free end of the bimetallic strip 330 which lies in the tripping direction 90 next to the contact projection 320.

If the knob 160 is pressed in the horizontal direction 70 in the direction towards the push button 120, the switching cam 560 moves at the same time in the horizontal direction 70 in the direction towards the right-hand narrow side 130 and displaces, due to its finger-type bearing, the vertical portion of the bimetallic strip 330 in a driving-type action in the direction towards the right-hand narrow side 130. The contact projection 320 and the contact piece 300 thus pass out of engagement, whereby the contact bridge 280 is catapulted by the tripping spring 480 in the tripping direction 90 into its "off" position according to Figure 3.

In a further mode of embodiment of the protective circuit breaker 10, the bimetallic strip 330 can also be designed as a meander-type bimetallic strip 330' (Figure 5, Figure 6). In this special design, several bimetallic webs extend in the fixing direction 200 parallel to each other. As regards the electrical connection, these adjacent bimetallic webs 580 are connected to each other via turning points 590. As far as the switching arrangement is concerned, one thereby obtains the effect of a very long bimetallic strip 330, 330' with a correspondingly high resistance resulting therefrom. This high resistance ensures that the necessary heat output is obtained for heating the bimetal in the presence of low and very low currents.

To ensure that the mechanical properties required for the adjustment by means of the adjusting eccentric 450 are obtained, metal clips 600, U-shaped in cross-section, (shown as bent-open in Figure 6) are fitted in the zone of the turning points 590 over the bimetallic strip 330' in the fixing direction 200 in a bandage-type arrangement. As far as the electrical conduction is concerned, the metal clips 600 are, for their part, screened from the connecting arm 370 or the compression spring 310 and the tripping spring 480 by insulating clips 610 fitted thereon, which are also U-shaped in cross-section. The metal clips 600 grip the bimetallic strip 330' so tightly that the effect of the force acting on the bimetallic strip 330' is the same as in the case of a "compact" bimetallic strip 330.

List of Reference Numbers

	10	protective circuit breaker
5	20	upper half shell
	30	lower half shell
	40	switch casing
	50	connection side
	60	switch side
10	70	horizontal direction
	80	vertical direction
	90	tripping direction
	100	switching-on direction
	110	median longitudinal axis
15	120	push button
	130	right-hand narrow side
	130'	left-hand narrow side
	140	right-hand edge zone
	140'	left-hand edge zone
20	150	manual trip
	160	knob
	170	right-hand contact element
	170'	left-hand contact element
	180	right-hand spring catch
25	180'	left-hand spring catch
	190	right-hand fixing hole
	190'	left-hand fixing hole
	200	fixing direction
	210	right-hand fixing knob
30	210'	left hand fixing knob
	220	right-hand fixing opening
	220'	left-hand fixing opening
	230	rivet hole
	240	contact hole
35	250	fixed contact
	260	pivoting contact
	270	vertical arm
	280	contact bridge
	290	horizontal arm
40	300	contact element
	310	compression spring
	320	contact projection
	330	bimetallic strip
	330'	meander-type bimetallic strip
45	331	U-web
	340	bend
	350	bulge projection (on the connection side)
	350'	bulge projection (on the switch side)
	360	fixing arm
50	370	connecting arm
	371	free end
	372	end piece (on the switch side)
	373	end piece (on the connection side)
	374	rib

380 recess
390 rotary body
400 journal
401 tooth system
5 402 catch projection
410 bearing opening
420 centre
430 axis of rotation
440 formed-in socket (hexagonal shape)
10 450 adjusting eccentric
460 peripheral surface
470 flattened portion
480 tripping spring
490 inclined stop
15 500 safety stop
510 supporting element
520 dog
530 centring stud
540 supporting base
20 550 rotary arm
560 switching cam
570 journal
580 bimetal web
590 turning point
25 600 metal clip
610 insulating clip
620 screen
630 path guides



PATENT CLAIMS

1. A thermally trippable protective circuit breaker
- with two connecting contact elements (170, 170') projecting in parallel from a narrow connection side (50) of the switch casing (40)
 - with a bimetallic strip (330, 330') as the trip,
 - with a connecting arm (370) rigidly connected to the bimetallic strip (330, 330'), operating as a lever arm and
 - with a rotary body (390) made of an insulating material for adjusting the tripping sensitivity of the bimetallic strip (330, 330') acting on the connecting arm (370) with a prestressing force,
 - that can be moved for rotation from the outside of the circuit breaker and
 - lying in the switch casing (40) without any projection increasing the operating width of the switch,
- characterized by the following features:
- a) the rotary body is eccentrically mounted for rotation in the switch casing (40) and bears with a cylindrical peripheral surface (460) on the connecting arm,
 - b) the connecting arm (370) is inserted with its free end (371) in the switch casing (40) approximately parallel to the prestressing force, in the manner of a fixed bearing;
 - c) the peripheral surface (460) of the rotary body (390) has a flattened portion (470) for the fixing of the zero point;
 - d) the two connecting contact elements (170, 170') extend substantially at right angles to the connecting arm (370);
 - e) the rotary body (390) lies between the contact elements (170, 170') flanking it without contact and the connecting



arm (370), the zones of the contact elements (170, 170') flanking the rotary body (390) being provided with recesses (380) reducing their width.

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2. A circuit breaker according to Claim 1,
characterized in that
the movement planes of the bimetallic strip (330, 330') of the
connecting arm (370) and of the rotary body (390) lie approxi-
mately in the plane formed by the connecting contact elements
(170, 170').

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3. A circuit breaker according to Claim 1 or 2,
characterized in that
the connecting contact elements (170, 170') are flat blade tags.

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4. A circuit breaker according to one or more of the
preceding claims,
characterized in that
for engaging the circuit breaker in a plug-in panel, there
project from the connection side (50) of the switch casing (40)
spring catches (180, 180') which flank the connecting contact
elements (170, 170') on their longitudinal sides facing away
from each other.

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5. A circuit breaker according to one or more of the pre-
ceding claims,

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characterized in that
the bimetallic strip (330, 330') has the shape of a U lying in
its movement plane, with U-arms of different lengths,

- whose U-web (331) extending in the horizontal direction
(70) extends parallel to the connecting arm (370) and

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- whose shorter fixing arm (360) pointing in the vertical
direction (80) is rigidly connected to a bent-up portion of
the connecting arm (370), which is disposed parallel there-
to.

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6. A circuit breaker according to one or more of the pre-
ceding claims,

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characterized in that
an approximately rectangular bridging contact (280) pivotably
mounted in the switch casing (40) in the movement plane of the
bimetallic strip (330, 330') bears in the switched-on position
with its contact piece (300) carried by a horizontal arm (290)
by means of a tripping spring (480) in the tripping direction
(90) against a contact projection (320) formed on the inside of
the longer U-arm of the bimetallic strip (330, 330').

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7. A circuit breaker according to Claim 6,
characterized in that
the bridging contact (280) lies in the space of the switch
casing left free by the shorter U-arm of the bimetallic strip
(330, 330').

8. A circuit breaker according to one or more of the
preceding claims,
characterized in that
the horizontal U-web of the bimetallic strip (330, 330') lies at
the bend (340) of the longer U-arm being held between two bulge
projections (350, 350') on the side of the casing,

- whereof the bulge projection (350') on the switch side
projects in the switching-on direction (100) from a
supporting base (540) formed on the switch casing (40) and
- whereof the bulge projection (350) on the connection side
lies between the bimetallic strip (330, 330') and the
connecting arm (370) as a bearing means.

9. A circuit breaker according to one or more of the
preceding claims,
characterized in that
the connecting arm (370) lies with its free end (371) inserted
between two formed-on end pieces (372, 373) projecting in the
horizontal direction (70) into the circuit breaker.

10. A circuit breaker according to one or more of the preceding
claims,

characterized in that
the switch casing (40) consists of two half-shells (20, 30)
injection moulded from a synthetic material, in which arrange-
ment the end pieces (372, 373) extending in the horizontal di-
rection (70) are added in the injection-moulding process to one
of the half-shells (20, 30).

11. A circuit breaker according to one or more of the preceding
claims,

characterized in that
in both half-shells (20, 30) there are moulded-in one trough-
shaped recess (380) each for the rotary body (390) and shallow
recesses for receiving the contact elements (170, 170').

12. A circuit breaker according to one or more of the preceding
claims,

characterized in that
one of the connection contacts (170), the connecting arm (370),
as well as the spring catch (180) adjoining the connection
contact (170) are integral and that one casing rib (374) lies in



the gap between the connection contact (170) and the spring catch (180).

5 13. A circuit breaker according to Claim 12,
characterized in that
the connecting arm (370), the connection contact (170) formed
thereon and the adjoining spring catch (180) form in the switch
10 plane a π -shaped assembly, with the connecting arm (370) as the
crosspiece of the π .

14. A circuit breaker according to Claim 12 and Claim 13,
characterized in that
15 the trough-shaped recess (380) laterally flanks the connection
contact (170), and the end piece (373) on the connection side
the spring catch (180), and that the trough-shaped recess (380),
the rib (374) and the end piece (373) on the connection side
20 form for the π -shaped assembly a conjugate fixed bearing means
acting in the horizontal direction (70).

15. A circuit breaker according to one of Claims 12 to 14,
characterized in that
25 the end piece (372) on the switch side, the end piece (373) on
the connection side, the front face of the rib (374) and the
bulge projection (350') on the switch side form for the π -shaped
assembly a conjugate fixed bearing means acting in the vertical
30 direction (80).

16. A circuit breaker according to one or more of the preceding
claims,
characterized in that
35 the rotary body (390) carries on both sides eccentrically
attached cylindrical journals (400) which are mounted in the two
half-shells (20, 30) of the casing as the axis of rotation
(430).

40 17. A circuit breaker according to one or more of the preceding
claims,
characterized in that
the front faces of the journals (400) of the rotary body (390)
45 carry moulded portions (440) for the insertion of a tool,
in particular a hexagonal socket.

18. A circuit breaker according to one or more of the preceding
50 claims,
characterized in that
the rotary body (390) is a disk with a small wall thickness.



19. A circuit breaker according to one or more of the preceding claims,

characterized in that
the journals (400) carry on the side of their circumference a
radially projecting tooth system (401) and are formed in the
manner of a gear wheel.

20. A circuit breaker according to Claim 19,

characterized by
a catch projection (402) on the circumference of at least one
bearing opening (410) on the side of the casing for a catch-type
engagement in the tooth system (401) of the gear wheel-shaped
journals (400).

21. A circuit breaker according to one of Claims 19 or 20,

characterized in that
the catch projection (402) projects in the horizontal direction
(70) into the bearing opening (410).

22. A circuit breaker according to one or more of the preceding claims,

characterized in that
the bimetallic strip (330) consists of several adjacent bimetal
webs (580) electrically disposed in series.

23. A circuit breaker according to Claim 22,

characterized in that
the adjacent bimetal webs (580) are combined into an integral
bimetal web part by means of a clip (600) surrounding them.

24. A circuit breaker according to one or more of the preceding claims,

characterized in that
the bimetallic strip (330) is designed as a meander-type bimetal
(330').

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