

CONTACT-SEPARATING DEVICE FOR CIRCUIT BREAKERS

This invention relates to a device for separating a pair of electric contacts which tend to weld and consist of a stationary contact and a contact which is movable away from said stationary contact, particularly in a circuit breaker.

Pairs of contacts in switchgear are desirably made from a homogeneous noble material, preferably silver, in order to achieve good arcing properties and a low voltage drop across the contacts. But during a flow of short-circuit currents having a certain magnitude said material undesirably tends to effect a welding between the contacts. For this reason it is known to make the pairs of contacts from heterogeneous materials, such as sintered contacts, which will not tend to weld if they contain, e.g., carbon.

Such a risk of a welding of contacts will arise during a flow of a current below 400 amperes. During a flow of such a current in conventional switchgear a striking armature cannot yet be effective and the existing kinematic arrangement cannot separate the sticking contacts.

But the use of heterogeneous materials in such pairs of contacts has the disadvantage that they have poorer arcing properties. Besides, their use gives rise to considerable problems during the manufacture, particularly because a contact which has only a low tendency to weld can be mounted only with difficulty on a contact carrier.

It is an object of the invention to provide a device which is of the kind described first hereinbefore and which permits a pair of contacts to be made from homogeneous noble materials although they involve a risk of contact welding.

That object is accomplished in accordance with the invention by the features characterized in claim 1. Preferred features by which the invention is improved further are apparent from the dependent claims 2 to 10.

The device provided in accordance with the invention for separating a pair of electric contacts which tend to weld and consist of a stationary contact and a contact which is movable away from the stationary contact, particularly in a circuit breaker, advantageously comprises a tripping lever, which is biased in the contact-separating direction and is movable from a stand-by position and serves to actuate the movable contact, and means for holding the tripping lever in its stand-by position, and the movement of the tripping lever from its stand-by position involves a displacement of its fulcrum from a position in which increased separating force is exerted on the movable contact.

The displacement of the fulcrum during the movement of the tripping lever preferably permits an initially strong separating force and a succeeding lower force for continuing the separation to be exerted on the movable contact. That displacement of the fulcrum can be effected by various kinematic arrangements, which may comprise, inter alia, suitable cams. The tripping lever preferably comprises a first leg, which is engageable by the holding means, and a second leg for engaging the movable contact, and if the tripping lever is rotatably and displaceably mounted between its two legs and is mounted at its second leg to be pivotally movable at an abutment, a kinematic arrangement will be obtained which is extremely compact and conveniently operable and can be manufactured by simple technology. In that kinematic arrangement the desired relationship of the contact-separating force and the extent of the contact-opening movement can be achieved.

The turning and sliding joint preferably permits a displacement in such a direction that the tripping lever in a first part of its movement from its stand-by position is pivotally movable about its abutting fulcrum at a higher lever ratio and in a second part of its movement is displaceable in the turning and sliding joint either in addition to its rotary movement or in the absence of a simultaneous rotary movement, and in a third part of its movement is pivotally movable about the turning and sliding joint at a relatively lower lever ratio.

It is apparent that the invention desirably provides a tripping lever, which in its make or stand-by position is biased between a fixed abutment point, e.g., in a circuit breaker housing, and holding means, which preferably comprise a detent, in the contact-separating direction by a tripping spring. After the tripping lever has been released, it will first pivot in the contact-separating direction under the action of the tripping spring about its abutting fulcrum, particularly at a stop in the housing. Owing to the lever ratio of the tripping lever the force of the tripping spring is so increased that the separating force exerted on the movable contact is much stronger than it would be if the rotation had been effected from the beginning about the stationary pivot pin, e.g., in the housing.

After the contact has been separated by a strong force, the tripping lever under the action exerted on it by the tripping spring continues to rotate until the slot in the tripping lever strikes against the stationary pivot pin of the housing. At that time the fulcrum is so displaced that the lever ratio is changed in a sense to decrease the force exerted on the movable contact. That effect is assisted by the fact that the pivotal movement of the lever has the result that the changing conditions of action decrease the resulting force exerted on the movable contact. Owing to the gearing up, the movable contact is then moved to the required final OFF position and a strong force is not required during that third part of the movement.

According to a further preferred feature of the invention the position of the abutting fulcrum and the position of the turning and sliding joint for the tripping lever are so selected that the line of action of the force exerted on the movable contact and the direction of the movement of the contact as it is opened coincide and the subsequent pivotal movement then causes said directions to diverge to reduce the force which is exerted.

As has briefly been suggested hereinbefore, the turning and sliding joint preferably comprises a pivot pin, which is stationary or fixed to the housing and is guided in a slot. The tripping spring for biasing the tripping lever is preferably pivoted to the first leg and the line of action of the tripping spring is so selected that the length of the resulting lever arm will be smaller during the pivotal movement of the tripping lever in the third part of its movement than the length of the resulting lever arm during the first part of the movement.

The holding means referred to hereinbefore may be constituted in a particularly simple manner by a releasable detent mechanism, which for use in switchgear comprises a detent lever.

Because the invention permits an effective and reliable separation of contacts which may stick together, a use of heterogeneous contact, such as sintered contacts, is desirably avoided. The design in accordance with the invention desirably avoids a need for additional structural and manufacturing expenditures and permits the contact material to be selected only from electrical and economical aspects.

The invention will now be described in more detail with reference to the accompanying drawings.

Figure 1 is a schematic sketch showing an illustrative embodiment of a device in accordance with the invention in its stand-by position;

Figure 2 is a view that is similar to Figure 1 and shows the movable contact in its final OFF position; and

Figure 3 is a graph illustrating the dependence of the separating force on the extent of the contact-opening movement.

Figures 1 and 2 show a device 10 for separating a pair of electric contacts which tend to weld and consist of a stationary contact 11 and a contact 12, which is movable away from the stationary contact. That device is intended for use in a circuit breaker. The movable contact 12 is arcuate and at its opposite end is pivoted to the housing at 13. The contact-closing force is exerted via a member 14, which is pivoted to the contact 12 and at its other end is supported against the housing by a pressure-applying spring 15. Suitable coatings on the contacts have not been shown for the sake of simplicity.

The arcuate movable contact 12 comprises a vertically rising actuating portion 16, which is engageable by a tripping lever 17.

The tripping lever 17 comprises a first leg 18, which is engageable by holding means 19, and a second leg 20 for engaging the movable contact 12 at its actuating portion 16. Between its two legs 18 and 20 the tripping lever 17 is mounted in a turning and sliding joint 21 so that the tripping lever 17 can be turned and displaced. The turning and sliding joint 21 comprises a stationary pivot pin 22, which is guided in a slot 23.

The second leg 20 is provided at its outer edge at a distance from the turning and sliding joint with a bearing fulcrum 24 at the intersection of two engaging surfaces 25 and

26, which extend at an angle to each other. The tripping lever 17 is pivotally moved about its bearing fulcrum 24 during an initial first part of its movement. The bearing fulcrum 24 bears on a flat surface 27 of the housing; that surface also constitutes a stop for the engaging surface 26 when it has been pivotally moved, see Figure 2.

The first leg 18 of the tripping lever 17 is formed with a detent 28, which together with a detent lever 29 constitutes holding means 19 consisting of a detent mechanism. The detent lever 29 is also pivoted to the housing and from its locked position shown in the drawing can be pivoted to the position illustrated by broken lines in that a force K is exerted on the other end of the detent lever.

A tripping spring 30 is pivoted to the first leg 18 at a distance from the turning and sliding joint 21 and at its other end is secured to the housing.

Figure 1 illustrates the lever ratio of the tripping lever 17 when it is in its stand-by position and is acted upon by the tripping spring 30 and supported at its bearing fulcrum 24 on the flat housing wall 27. Said lever ratio will determine the separating force F which is exerted by the tripping lever 17 on the movable contact 12. A comparison with Figure 2, in which the tripping lever 17 has reached its final OFF position, will reveal that the leverage or lever ratio has changed to  $a':b'$  so that the conditions are different from those determined by the lever ratio  $a:b$ . This is due to the fact that the fulcrum has been displaced during the movement of the tripping lever 17 that included the pivotal movement under a strong force about the bearing fulcrum 24 and a succeeding relative displacement of the pivot pin 22 in the slot 23. At the lever ratio  $a':b'$  the pivotal movement is effected under such conditions that a relatively weaker force  $F'$  is exerted.

Figure 3 clearly shows the change of the separating force  $F$  in dependence on the extent of the contact-opening movement  $S$ . During the first part of the movement, when a strong separating force  $F$  is required, an extremely strong force can be exerted by the device. During an extremely short second part of the movement the displacement of the tripping lever 17 in the turning and sliding joint 21 causes that force to be decreased in steps to a much lower value  $F'$ , which subsequently increases slightly owing to the conditions for the engagement between the second leg 20 and the actuating portion 16.



## CLAIMS

1. A device (10) for separating a pair of electric contacts which tend to weld and consist of a stationary contact (11) and a contact (12), which is movable away from the stationary contact, particularly in a circuit breaker, characterized by  
a tripping lever (17), which is biased in a contact-separating direction and is pivotally movable from a stand-by position and serves to actuate the movable contact (12), and by means (19) for holding the shifting lever (17) in its stand-by position,  
wherein the movement of the tripping lever (17) from its stand-by position involves a displacement of its fulcrum from a position in which an increased separating force is exerted on the movable contact (12).
2. A device according to claim 1, characterized in that the movement of the tripping lever involves a displacement of its fulcrum in such a sense that a strong initial separating force is initially exerted on the movable contact (12) and this is succeeded by the exertion of a lower separation-continuing force on the movable contact (12).
3. A device according to claim 1 or 2, characterized in that the tripping lever (17) comprises a first leg (18), which is engageable by the holding means (19), and a second leg (20) for engaging the movable contact (12), and the tripping lever (17) is movably mounted between its two legs by a turning and sliding joint (21) and is movably mounted by means of an abutting fulcrum (24) of its second leg (20).



4. A device according to claim 3, characterized in that the turning and sliding joint (21) permits a displacement in such a direction that the tripping lever (17) in a first part of its movement from its stand-by position is pivotally movable about its abutting fulcrum (24) at a high lever ratio and in a succeeding second part of its movement is additionally or separately displaceable in the turning and sliding joint (21) and in a third part of its movement is pivotally movable about the turning and sliding joint (21) at a relatively low lever ratio.
5. A device according to claim 3 or 4, characterized in that the position of the abutting fulcrum (24) and the position of the turning and sliding joint (21) are so selected that the line of action of the force exerted on the movable contact (12) and the direction of movement of the contact as it is opened coincide and the subsequent pivotal movement of the tripping lever (17) causes said directions to diverge to reduce the force which is exerted.
6. A device according to any of claims 3 to 5, characterized in that the turning and sliding joint (21) comprises a stationary pivot pin (22), which is guided in a slot (23).
7. A device according to any of claims 3 to 6, characterized in that the tripping lever (17) comprises engaging surfaces (25, 26), which are disposed on both sides of the fulcrum (24) and extend at an angle to each other.
8. A device according to any of the preceding claims, characterized in that the tripping lever (17) is biased by a tripping spring (30), which is pivoted to the first leg (18).



9. A device according to claim 8, characterized in that the line of action of the force of the tripping spring is so selected that the length (a, a') of the resulting lever arm is smaller during the pivotal movement of the tripping lever during the third part of its movement than during the first part of its movement.
10. A device according to any of the preceding claims, characterized in that the holding means (19) comprise a releasable detent mechanism (28, 29).