

DEVICE FOR CURRENT LIMITING AND CIRCUIT BREAKING

The invention relates to a device for current limiting and current breaking comprising :

- a current limiting block having fast opening contacts by electrodynamic effect,
- a protective circuit-breaker block with a molded case having contacts and an automatic contact opening mechanism by an overload and/or short-circuit, said blocks being electrically connected for a series connection of said fast opening contacts and said circuit-breaker contacts and being mechanically joined, so that a wall of the molded case separates the latter from the limiting block,
- a first movable conductor, the word movable being understood with respect to stationary elements, said first movable conductor carrying a movable contact of said fast opening contacts and extending inside said limiting block parallel to said wall in closed position of said fast opening contacts,
- a second stationary conductor extending inside said limiting block parallel to said first conductor in closed position, said first and second conductors being electrically series connected for flowing of currents therethrough, which create an electrodynamic force moving said first movable conductor in the open position of said fast opening contacts,

a third conductor extending inside said circuit-breaker block and being electrically connected in series with said first and second conductors.

The performances of a classical circuit-breaker can be increased by connection in series with a limiting block, aimed at limiting the peak value of a current circuit-breaker and at easing the

action of a classical circuit breaker. These sets of limiting circuit-breakers can be replaced by special circuit-breakers having high breaking capacity and allow the commercialization of a series of apparatus, based on a standard equipment.

We already know a device for current limiting and current breaking with associated circuit-breaker block and limiting block, of the kind mentioned in the preamble of claim 1 (FR-A-2 272 479 publication). The circuit-breaker block and the limiting block are simply placed side by side and any interaction by electromagnetic or electrodynamic effect between the blocks is not exploited. Some components and copper circuits, operating in this known device, are undoubled and the advantage of a limiting circuit-breaker block set, compared to a circuit-breaker having a high breaking capacity is reduced by a higher manufacturing cost.

The invention aims at coping with this disadvantage and realizing an interaction between the circuit-breaker block and the limiting block, more particularly between the circuits of these blocks to generate a fast opening of the contacts of the limiter and/or the circuit-breaker.

The present invention is based on the acknowledgment that the current limiting results from a fast opening of the contacts by electrodynamic effect, due to a repulsion or attraction between conductors for flowing of short-circuit currents, this effect being sensitive on conductors separated by a wall made of insulating material and which could be reinforced by magnetic yokes of flux concentration. An electrodynamic blow-out of the arcs drawn increases the limiting effect wanted.

The device for current limiting, according to the invention, is characterized by the fact that said third conductor extends in a closed position of the circuit-breaker contacts, near said wall parallel to said first and second conductors of the limiting block and that said first and third conductors are electrically

series connected for flowing of currents generating an electrodynamic additionnal force, moving said first movable conductor in the open position of said fast opening contacts. It has already been suggested (publication FR-A-2 039 881) to increase the electrodynamic forces acting on the movable contact of a circuit-breaker by articulating the extremity of the movable contact arm on an L-shaped conductor, a branch of which is parallel to a fixed conductor, in order to generate electrodynamic forces. This device necessitates moving additionnal parts and a mechanical transmission of movements which would be difficult to realize, between the circuit-breaker block and removable limiting block, according to the invention.

The advantages obtained by a favourable disposition of the circuits, according to the invention, consist on one hand in using the circuit-breaker circuit to increase the electrodynamic opening force of the limiting contacts and on the other hand in an increased blow-out of the arc drawn. According to an important development, we expect an action of the limiting block circuit on the movable contact of the circuit breaker to accelerate its opening and generate an additionnal current limiting. The blocks being joined side by side, the conductors are separated by the bottom of the molded case of the circuit-breaker, and eventually the bottom of the limiting block, if this bottom exists, but interactions are sufficient in heavy equipment. For small size equipment, the presence of magnetic yokes in the limiting block and/or the circuit-breaker block allows a draining of the magnetic flux and a compensation of space between the conductors, due to the presence of the bottom of the molded case. The circuit-breaker is preferably cleared out of yokes, in order to keep a standard equipment.

The electric circuit, in limiting and circuit-breaker blocks is advantageously Ψ -shaped, the central stationary conductor being surrounded by movable conductors of the circuit-breaker and of the limiter. The limiting block and the circuit-breaker block can comprise each of them a pair of independent contacts

and the associated arc extinguishing chambers are advantageously opposite. According to a development of the invention, the stationary contact of the circuit-breaker can be replaced by a movable contact supported by an appendix of the movable conductor of the limiting block, which crosses the bottom of the molded case and co-operates with the movable contact of the circuit-breaker. This disposition has the advantage of a fast separation of the two movable conductors of the circuit-breaker and the suppression of the soft connection between the limiting block and the circuit-breaker block.

According to another development of the invention, this set of limiting circuit-breaker comprises a unique pair of contacts, one of them belongs to the circuit-breaker block and the other is supported by an appendix of the movable conductor of the limiting block. In this way, the presence of two series contact areas is avoided, and the risks of temperature rise resulting from this, especially in heavy equipment. The total congestion can be reduced as well.

The conductors, and particularly where current inputs are situated, in order to exert a blow-out effect on the arc, favouring the extension and the arc input in the arc extinguishing chamber. The circuit-breaker block and limiting block association is particularly simple and does not necessitate any noticeable modification of the standard circuit-breaker. This one is limited to the replacing of the conductor of the stationary contact of the circuit-breaker by a connection part or, in some cases, by the suppression of this stationary contact. The φ structure of the electric circuit keeps the classical disposition on the opposite sides of the input and output terminals, which facilitate the connections and the fitting in the boxes and in the standard boards.

In the following text, the invention gives further details, with drawings representing different ways of execution.

- figure 1 is a schematic section of a set of circuit-breaker block and limiting block according to the invention,
- figure 2 is a section according to the line II-II of figure 1,
- figures 3 and 4 are views similar to the one in figure 1, showing two variants of realization,
- on figures 1 and 2, a circuit-breaker block 10 with a molded case 12 is joined to its bottom 14 to a limiting block 16, with a molded case 18, having the same basic dimensions, but with an open bottom. When the cases 12, 18, are joined together, for instance with screws (not represented), the bottom 14 makes a separation wall between the two blocks 10, 16, presenting an opening 20 for the transition of a braid-shaped 22 of a soft connection.

The circuit-breaker 10, of a well known kind, comprises, in its part nearest to the bottom 14, a stationary contact 24 which co-operates with a movable contact 26, supported by an extended arm 28, rotatably mounted on an axis 30, near to the contact 26. A control mechanism 32, schematically represented by a block, controls the opening and closing of the movable contact 26, moving for instance the axis 30, the interaction between the mechanism 32 and the movable contact 26 being schematized on the figures by a double arrow. A releasing block 34 drives the control mechanism 32, to release the circuit-breaker, in case it is faulty and a handle (not represented) allows a manual control. To the pair of contacts 24, 26, is associated an arc extinguishing chamber 36, comprising advantageously de-ionization plates (not represented). The back part of the contact arm 28, opposite to the movable contact 26, with regard to the axis 30, is surrounded by two magnetic yokes 36, 36', joined to the side walls and to the bottom 14 of the case 12. A braid 38 connects this back part of the arm 28 to an output lug 40 and a spring (not represented) pulls the movable contact 26 in a closed position. When the circuit-breaker 10 is used alone, the

stationary contact 24 is connected or ends with a contact lug 42, represented with a dashed line. In combination with the limiting block 16, the lug 42 is suppressed or more exactly the set of contact 24 and lug 42 is replaced by a contact 24 allowing the connection with the braid 22. It is not useful to give a detailed description of the structure and the working of the circuit-breaker, which are well known from specialists.

The limiting block 16 comprises a stationary conductor 44, which carries to one of its ends, opposite to the output lug 40 of the circuit-breaker 10, an input lug 46 and to its other end a stationary contact 48. When the cases 12, 18 are fit together, the stationary conductor 44 is laid on the bottom 14 and extends parallel to the contact 24 and to the contact arm 28 of the circuit-breaker 10. The stationary conductor 48 co-operates with a movable contact 50, supported by a contact arm 52, this latter being hinged on an axis 54, situated near the input lug 46. In a closed position, the arm 52 extends parallel and at short range from the stationary conductor 44. The contact arms 28, 52, move in a same plane, perpendicular to the bottom 14, and containing the stationary conductor 44. A spring 56 pulls the arm 52 in a closed position of the contacts 48, 50, and the end of the arm 52, opposite to the contact 50, is connected to the braid 22. The contacts 48, 50, co-operate with an arc extinguishing chamber 58, situated opposite to the chamber 36. The arm 52 is surrounded by magnetic yokes 60, 60', joined to the side walls of the case 18 and the bottom 14, these yokes being extended to the yokes 36, 36', of the circuit-breaker block 10, and presenting an air-gap where an arm 52 is inserted, in a closed position of the contacts 48, 50.

The device for current limiting according to the invention works as follows :

- in a closed position of the device, represented on figures 1 and 2, the current goes in from the lug 46, crosses the stationary conductor 44, the same way than the arrow, closed contacts 48,

50, the contact arm 52, the braid 22, the contacts 24, 26, the arm 28, the braid 38 and the output lug 40, following a ψ -shaped path, which central branch is formed by the stationary conductor 44 and the side branches respectively by the contact arm 52 and the arm 28. It is easy to see that the running direction of the current in the contact 52, opposite to the running direction of the stationary conductor 44, generating an electrodynamic repulsion force, making the contact arm 52 pivot, in the hourly opening direction of the contact 48, 50 against the spring 56. The running direction of the current in the stationary conductor 44 and the arm 28 is, on the contrary, the same and an electrodynamic attraction force acts between these conductors 44, 28. The back part of the arm 28 is longer than the front part supporting the contact 26 and is situated on the opposite side of the axis 30, so as the resulting of the electrodynamic forces makes the arm 28 pivot in the hourly direction, corresponding to the opening of the contacts 24, 26. When they work normally, the contacts 48, 50 and 24, 26, are kept closed by the contact pressure springs, which play a leading part. When a short-circuit occurs, the electrodynamic forces become important and move, on one hand, the contact arm 52 in the opening position of the contacts 48, 50, and on the other hand the arm 28 in the opening position of the contacts 24, 26, this last opening being confirmed, later on, by the mechanism 32, controlled by the releasing block 34 which saw the short-circuit. After the extinction of the arc drawn between the contacts 24, 26, and 48, 50, these last contacts close, under the action of the spring 56, the circuit being interrupted by the separation of the contacts 24, 26, left opened. The opening of the contacts 24, 26, and 48, 50, is extremely fast and generates an adequate current limiting. The currents of the same direction, running into the stationary conductor 44 and the arm 28, both act on the contact arm 52, run by a current of reverse direction, to move it rapidly and the direction of the current in the conductors 24, 52, 28, and the lug 40 is favourable to a magnetic blow-out of the arc drawn between the contacts 48, 50, in the arc extinguishing chamber 58. The magnetic circuit, formed by the yokes 36, 36', extended by

the yokes 60, 60' collects and concentrates the magnetic flux to increase the action of the electrodynamic forces acting on the contact arm 52. It has to be mentioned that the presence of all, or only some of these yokes 36, 36', 60, 60' is not useful for heavy equipment, in which the generated electrodynamic forces are strong enough to move rapidly the contacts. The action exerted by the current running through the stationary conductor 44 on the arm 28, accelerates the opening of the contacts 24, 26, and contributes to the limitation effect of the limiting block 16. The combination, according to the invention, of the limiting block 16 and the standard circuit-breaker block 10 allows an interaction of the conductors set out in these blocks, which encourages the limiting effect of the current and the blow-out of the arcs. The transformation of the standard circuit-breaker is limited to the replacing or fitting of the stationary contact 24 and the fastening of the braid 22. Most of the time, the yokes 36, 36' are not useful.

Different various realizations are possible and figure 3 illustrates one of them, which has the advantage of removing the braid 22 and an opening of the circuit-breaker contacts, as fast as the opening of the limiting contacts. On figures 3 and 4, the same reference numbers indicate similar parts or identical to those marked with these numbers on figures 1 and 2. The stationary contact 24 of the circuit-breaker 10 is suppressed and replaced by a movable contact 62, supported by an annex 64 of the contact arm 52, which crosses the opening 20, adjusted in the bottom 14. The working of the equipment is the same, of course, but the rapidity of opening of the contacts 62, 26, of the circuit-breaker block 10 is increased. When the contact arm 52 having the annex 64, starts moving, the contacts 62, 26, separate with a speed, increased by the almost simultaneous moving of the two contacts 62, 26, in the opposite direction.

The annex 64 makes easier the combination of the blocks 10, 16, and avoids any additional electrical connection. On figure 3, only the yokes 60, 60' of the limiting block have been kept.

In heavy equipment, the presence of two contact areas 62, 26 ; 48, 50, can originate in an excessive overheating and figure 4 illustrates a variant of realization, derived from the one in figure 3 and using only one pair of contacts 62, 26. The annex 64 of the contact support 62, which co-operates with the movable contact 26 of the circuit-breaker 10, belongs to a contact arm 52', extending in a parallel direction to the stationary conductor 44, in the limiting block 16 and which opposite end is rotatably mounted on an axis 54' and is connected by a braid 66 to the end of the stationary conductor 44. An abutment 68 limits the motion of the arm 52' in the direction of closing of the contacts 62, 26, to allow an opening or a normal switching of the circuit-breaker 10. In case of a short circuit, the contacts 62, 26, separate rapidly, as it is described previously. The structure of the limiting block 16 is notably simplified by the absence of contacts and the associated arc extinguishing chamber.

Other dispositions and connections of conductors or generating electrodynamic forces can of course be conceived.



CLAIMS

1. Device for current limiting and current breaking comprising :

- 5 - a current limiting block (16) having fast opening contacts (48, 50; 62, 26) by electrodynamic effect,
 - a protective circuit breaker block (10) with a molded case having contacts (24, 26) and an automatic contact (24, 26) opening mechanism by an overload and/or short circuit,
- 10 said blocks (10, 16) being electrically connected for a series connection of said fast opening contacts (48, 50; 62, 26) and said circuit breaker contacts (24, 26), and being mechanically joined so that a wall (14) of the molded case separates the latter from the limiting block,
- 15 - a first movable conductor (52), the word movable being understood with respect to stationary elements, said first movable conductor (52) carrying a movable contact (50, 62) of said fast opening contacts (48, 50; 62, 26) and extending insides said limiting block (16) parallel to said wall (14) in closed position of said fast opening contacts (48, 20 50; 62, 26),
 - a second stationary conductor (44) extending insides said limiting block (16) parallel to said first conductor (52) in closed position, said first (52) and second (44) conduc-
- 25 tors being electrically series connected for flowing of currents therethrough which create an electrodynamic force moving said first movable conductor (52) in the open position of said fast opening contacts (48, 50; 62, 26),
 - a third conductor (28) extending insides said circuit
- 30 breaker block (10) and being electrically connected in series with said first (52) and second (44) conductors, characterized in that said third conductor (28) extends in closed position of said circuit breaker (10) contacts (24, 26; 62, 26) near said wall (14), parallel to said first
- 35 (52) and second (44) conductors of the limiting block (16) and in that said first (52) and third (28) conductors are electrically connected in series for flowing of currents therethrough creating an additional electrodynamic force



moving said first movable contact (52) into the open position of said fast opening contacts (48, 50; 62, 26).

2. Device according to claim 1, wherein said third conductor (28) is movable and carries a movable contact (26) of the circuit breaker block (10) and is subjected to an electrodynamic force for movement in the open position of the circuit breaker (10) contacts (24, 26), created by the currents flowing through the third conductor (28) and the second conductor (44) of the limiting block (16).

3. Device according to claim 2, wherein said conductors (28, 44, 52) form a Ψ shaped circuit, the middle branch of which being constituted by the second (44) stationary conductor enframed by the first (52) and third (28) conductors.

4. Device according to one of claims 2 and 3, wherein the currents flowing through the second (44) and the third (28) conductors in same direction create an electrodynamic attractive force of said third movable conductor (28) in the open position of the circuit breaker (10) contacts (24, 26) and wherein the current flows through the first movable conductor (52) in opposite direction of the currents flowing through the second (44) and third (28) conductors, the currents in opposite direction creating an electrodynamic repulsive force of said first conductor (52) in the open position of the fast opening contacts (48, 50; 62, 26).

5. Device according to one of claims 1, 2, 3 and 4, wherein said conductors (28, 44, 52) extend in the same plane corresponding to the plane of displacement of the first (52) and third (28) movable conductors.

6. Device according to any one of the preceding claims, wherein magnetic yokes (36, 36'; 60, 60') are arranged in the circuit breaker block (10) and/or the limiting block (16) to increase the electrodynamic forces acting on the first (52) and third (28) movable conductors.



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7. Device according to claim 6, wherein yokes (60, 60') enframe the second conductor (44) and include an air gap wherein the first conductor (52) is engaged in closed position of the fast opening contacts (48, 50; 62, 26).

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8. Device according to any one of the preceding claims, wherein the second conductor (44) is faced to the separation wall (14) of blocks (10, 16) and ends in a terminal (46) and wherein the stationary contact (24) of the circuit breaker block (10) is electrically connected to the first conductor (52) of the limiting block (16), the third conductor (28) being connected to a terminal (40) of the circuit breaker block (10) located at the opposite side of terminal (46) of the circuit breaker (16).

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9. Device according to any one of the preceding claims, wherein the first conductor (52) carries the movable contact (50) of the limiting block (16) contacts (48, 50) and an extension (64) passing through said wall (14) and carrying a movable contact (62) cooperating with the movable contact (26) carried by the third conductor (28).

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10. Device according to any one of claims 1 to 8, wherein the first conductor (52) is extended by a curved part (64) passing through the wall (14) and carrying a movable contact (62) cooperating with the movable contact (26) carried by the third conductor (28), the limiting block (16) including no contacts.

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