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**FACE-ON-FACE CONTACT PAIR FOR CIRCUIT BREAKERS**

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The invention refers to a contact making and breaking device particularly for high tension circuit breakers and has for its primary object the reduction of the electrodynamic strains which originate in the paths, more or less of loop form, which the currents tend to follow in the vicinity of the contact making and breaking surfaces of the stationary and movable contact pieces with face-on-face contacts. Particularly it is an object of the invention to arrange these contact faces and their vicinity such that attractive forces are produced instead and at the place of the repulsive forces which as a rule obtain in conventional circuit breakers through the propagation of the flux of the currents around the points or surfaces of contact. It is thus an object of the invention to compensate, by means of the attractive forces thus produced, totally or in part the repulsive forces which may still subsist due to other causes such as the arrangement of the conductors more or less in loop form.

These and other objects will be achieved when, in accordance with the invention, the flux of the current in the vicinity of the contact making and breaking surfaces is subdivided into two parallel fluxes which circulate parallel to these contact making and breaking surfaces. This is achieved, on the one hand, by means of a depression or recess shaped into at least one of the contact making and breaking surfaces and disposed along a plane generally parallel to the pivotal axis of the movable contact. The contact making and breaking surface is thus subdivided by the recess, of transversely small depth, into two separate current transmitting portions spaced apart from each other through the recess. Each one of the contact pieces, on the other hand, is shaped within its thickness with a slot of a median plane parallel to the common plane of contact between the contact pieces in the closed position, in proximity to said plane but spaced apart therefrom. These slots are perpendicular to the direction of separation of the contacts and, seen in the projection upon the plane of contact, cover the recess and thus provide two parallel current paths, one path at each side of the recess; the one path confined between the recess and the slot of one of the contact pieces, the other path between the recess and the slot of the other contact piece.

These three discontinuities of the conductive path, recess and slots, owing to their spatial relationship, cause the formation of two parallel paths for the current, perpendicular to the direction of separation of the contacts, and thus the establishment of attractive forces between the contact making and breaking pieces instead of and at the place of the repulsive force which otherwise obtain.

In accordance with a preferred embodiment of the invention, the slots starting from their open top edges, i. e. the edges opposite the bottom of the slots, are extended in the contact pieces in opposite directions and, seen projected on the plane of contact, are overlapping each other to the extent of the length of the recess. The surface area of each slot, referred to the median plane

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thereof substantially corresponds to the total of the surface areas of the recess and of the current transmitting contact face portion adjacent its top edge.

Preferably the two portions of the contact making and breaking surface, when the circuit breaker is closed, are not closed simultaneously but successively. To this purpose, at least one of the contacts is disposed slightly tiltable about an instantaneous axis of rotation parallel to the general axis of rotation of the arm which carries the movable contact. In this way, it may be achieved that the tilting motion sets in as soon as the contact through one of the contact plane portions has been closed and is continued as the general closing motion of the contact apparatus proceeds.

To achieve this purpose, in a further development of the invention, one of the contact pieces is floatingly disposed on its carrier, that means, this piece is freely supported on its arm or carrier without any connecting means other than being elastically guided and under the urge of a spring which causes it to bear against an abutment. This abutment determines in the open position of the disconnecter the position of the contact piece, i. e. a position in which the contact face of the piece is inclined relatively to the common plane of contact in the closed position.

The invention will now be described with reference to the accompanying drawings which form part of this specification and which by way of example illustrate an embodiment of my invention. These drawings are to be understood explicative of the invention but not limitative of its scope. Other embodiments are feasible without departing from the spirit of my appended claims.

In the drawings:

Fig. 1 is a section on a plane perpendicular to the pivotal axis of the movable contact piece, the contact members being shown in side view;

Fig. 2 is a front view of the stationary contact member, seen from line 2—2 of Fig. 1;

Fig. 3 is a rear view of the movable contact piece seen from line 3—3 of Fig. 1; and

Fig. 4 is a view similar to Fig. 1 illustrating the contact pieces in closed position.

In the drawings, the invention, while it may be applied to the principal contact members as well as to the auxiliary or arcing contacts of a high tension circuit breaker, has been illustrated as applied to the auxiliary contacts.

The representation is rather diagrammatic, the conventional structural elements in so far as they are not related to the invention not being shown.

The stationary main contact piece of the circuit breaker is designated by 11. This contact is here in the form of two prongs or jaws designated by 12. This contact is connected over the frame-work or chassis of the circuit breaker, here indicated by 13, to one terminal of the network line to be controlled by the circuit breaker.

The other terminal of the line is connected to the movable contact arm 14 which is pivotal about an axis perpendicular to the plane of the drawing, here, since conventional and not forming part of the invention, not shown.

In the closed position of the circuit breaker, the blade 15 of the movable contact is entered with its chamfered or wedge-shaped edge 16 between the jaws or prongs 12 of the stationary main contact, Fig. 4.

The stationary and movable auxiliary or arcing contacts respectively are 17 and 18. In the embodiment illustrated, the surfaces of both contact pieces 17, 18 are recessed at 19, 20, respectively, so that, when the contact between the pieces 17, 18 is closed, the contact faces proper for the passage of the current are subdivided each into two portions 21, 22 and 23, 24, respectively, sepa-

rated by the recesses 19, 20. These recesses together, when the circuit breaker is closed, form a slot, open at both sides.

By means of this slot 19, 20, the flux of the current is subdivided into two branches, indicated by the arrows  $F_1$  and  $F_2$ , these branches traverse respectively the portions 21, 23 and 22, 24 of the contact making and breaking surface.

Within their thicknesses, the contact pieces are further shaped with slots 27, 28, respectively, which are so directed that their median planes are parallel to the contact making and breaking surfaces of the contact pieces. In this way, when the circuit breaker is fully closed, the flux of the current is subdivided into two fluxes  $F_2'$ ,  $F_2$  and  $F_1$ ,  $F_1'$ , fluxes which are confined between parallel slots 27, 19, on the one hand, and 20, 28, on the other hand.

The slots are so dimensioned that, starting from their top edges, i. e. the edges opposite the bottoms of the slots, they are extended within their contact pieces in opposite directions and, seen projected on the common plane of contact C—C, Fig. 4, are overlapping each other to the extent of the length of the recess 19, 20.

The surface areas of the slots thus are generally so dimensioned that referred to the median plane thereof, the surface or length dimension of the one slot, e. g. 27, corresponds substantially to the total of the surface areas or length dimensions of the recess 19, 20 and the current transmitting contact portion 22, 24, adjacent its top edge, while the surface area of the other slot 28 corresponds substantially to the total of the surface areas or length dimensions of the recess 19, 20 and the current transmitting contact portion 21, 23 adjacent its top edge. By this means the conductivities of both paths for the current fluxes are substantially equal, and thus the magnitudes of the two fluxes.

The two parallel current fluxes produces attractive electrodynamic forces, instead of repulsive forces present in the conventional circuit breakers.

To enhance this effect and in order to concentrate this effect to the zone of contact, the conductive paths leading from the contact zone and also thereto are so disposed within their respective contact pieces, that the current leading conductive paths join the conductive paths between recess and slots substantially perpendicular thereto, and both parallel fluxes after their reunion are deflected by 90°. This may be achieved through proper shaping of the contact pieces, as shown in Figs. 1 and 4 and also by applying a transversal slot 26 between blade 15 and slotted and recessed part of contact piece 18.

In Fig. 1, the contact pieces 17, 18, are illustrated in a position where the mobile contact piece 18 just contacts the stationary contact piece 17 that is the moment when the circuit is about to be closed; or during the opening cycle, when the mobile contact piece is about to leave the stationary piece.

In this moment, the upper contact making and breaking portions 21, 23, are in contact with each other so that the flux  $F_1$  of the current may pass therethrough whereas the passage of the flux  $F_2$  through the lower contact portions is interrupted, in the closing cycle, or has already been interrupted, in the opening cycle of the circuit breaker. The flux  $F_2$  has thus been indicated in Fig. 1 in dashed lines, and in full lines in Fig. 4.

The movable contact piece 17 is floatingly supported in its carrier, that means, it is not integrally joined with the general chassis 13 of the circuit breaker. The sole connections which join it to the chassis are represented primarily by the two guide pieces 30, 31, or prongs, of the fork piece 29. These prongs terminate in hooked portions 32, 33, respectively, which serve as abutments for the projecting ends of a tenon 34 secured in or integral with the contact piece 17. A second connection is provided by a guide slot 35 provided in a bar 36 and closed at its end by an abutment bridge 37. A tongue 38 inte-

gral with and projecting downwards from contact piece 17 may slide within the guide slot 35. The contact piece may thus execute a translatory motion parallel to the plane of the drawing under or against the action of a coil spring 40. Spring 40 is wound about the centering sleeve 41 and bears with its one end against the flange 42 thereof.

Spring 40 with its other end bears against a cup or dish 43 housed within a correspondingly shaped cavity 44 of the stationary contact piece 17 and secured therein by any convenient means.

In the open position of the circuit breaker, contact piece 17 is thus forcibly urged by coil spring 40 to bear with its tenon 34 against hooks 32, 33, and with its tongue 38 against abutment bridge 37 thus to take the inclined position shown in Fig. 1 relatively to the common plane C—C of contact in the closed position, Fig. 4.

Dish 43 is elastically held and guided around its periphery by a cylindric tube 45 held in position relatively to the guide bars 29 and 36 by a spacing sleeve 50. All these members 29, 36, 50, 45, 42 which may be of conductive material, may be secured together and at the chassis 13 of the circuit breaker by any convenient means, means which since they form no part of the invention are here not shown in order not to crowd the representation.

The free end of the cylindric tube 45 is split peripherally into elastic laminae 46. In order to ensure perfect contact conditions for the current passing between the chassis terminal and the stationary contact, the laminae 46 are elastically pressed inwards and against the periphery of the dish or cup 43 by means of an elastic ring 51, such as a circular coil spring embracing the laminae. The conductive connection between dish or cup 43 and the chassis terminal may also be achieved by any other of the classical means for establishing such connection, as for instance, by connecting conductively the floating contact piece 17 to the terminal by means of flexible connectors secured with one end to the chassis member 13 and with the other end to cup 13 or the contact piece 17 itself.

The device operates as follows:

As has been described hereinabove, in the position shown in Fig. 1, the contact pieces 17, 18 have just come into contact with each other, in the closing cycle of the circuit breaker, with the upper portions 21, 23 of their contact faces. As the closing cycle is continued, the upper portion 21 of the tiltable stationary contact piece 17 is pushed rearwards by the movable contact, against the action of the biasing spring 40 while tongue 38 of the tiltable contact piece 17 still bears against but tilts about abutment bridge 37, the tiltable contact piece 17 thus executing during this short interval a tilting motion about a virtual axis parallel to the pivotal axis of the movable contact piece 18. Immediately thereafter, while the cycle is continued, the contact piece 17 is pushed rearwards, towards the left, under the pressure of the movable contact operative on both portions 21 and 22 of its contact surface, until finally the chamfered edge 16 of the blade 15 of the movable contact 18 arrives between the prongs 12 of the stationary main contact 11. This tilting motion is continued until both portions of the contact making surfaces bear against each other thus closing the contact through both contact portions 21, 23, and 22, 24.

The same motions are produced in the reverse order during the opening cycle of the circuit breaker. It will readily be seen that the current breaking arc will establish itself between the upper current passage portions. If, as here illustrated, the slots are so designed that slot 27 is extended as far upwards as recession 19, 20, the arc under the action of the nascent electrodynamic forces will be driven upwards, that is towards the top of the pieces 17, 18 which thus are operative as arc drawing and blow-out contacts.

I claim:

1. Contact making and breaking device with face-on-

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face contacts, particularly for high tension circuit breakers comprising stationary and movable contact pieces and carrier members carrying the same and with at least the face of one of said pieces shaped with a recess disposed within the plane of contact of the contact pieces, thereby subdividing the contact making and breaking surface into two current transmitting portions spaced apart from each other; both said contact pieces being further shaped each with a slot of a median plane parallel to the plane of contact between said pieces, in proximity thereto and perpendicularly of the direction of separation of the contact pieces; said slots being applied to said contact pieces so as, seen in their projection upon said plane of contact, to cover said recess, thereby to provide two parallel paths of the current, one path at each side of said recess, the one path confined between the recess and the slot of the one of said contact pieces, the other path between said recess and the slot of the other contact piece, and thus to subdivide the current flux and conduct and concentrate the same in two parallel branches circulating in the same sense in both contact pieces, and produce between both contact pieces attractive electrodynamic forces for substantially compensating the repulsive forces otherwise obtaining therebetween.

2. Contact making and breaking device as set forth in claim 1 wherein the slots starting from their open top edge are extended in the contact pieces in opposite directions and, seen projected on the common plane of contact in the closed position, are overlapping each other to the extent of the length of the recess.

3. Device as set forth in claim 2 wherein the surface area of the one slot, referred to the median plane thereof, corresponds substantially to the total of the surface areas of the recess and the current transmitting contact portions adjacent its top edge while the area of the other slot substantially corresponds to the total of the surface areas of the recess and the other of the current transmitting contact portions.

4. Device as set forth in claim 1 wherein the stationary contact piece of the pair is mounted as a floating piece, displaceable on its carrier, spring means and abutment means being associated with said floating piece and said carrier, thereby, with the opening movement of the movable contact and through the spring means, to urge and displace the floating piece, in contact with and following the movable contact piece, until said abutment means is reached, said abutment means being disposed relatively to said carrier and said floating piece so as to tilt the floating piece, when bearing against the abutment means, about an axis parallel to the pivotal axis of said movable contact, said spring means for holding said floating contact piece yieldably in the open position of the device with its contact plane inclined relatively to the plane of contact in the closed position, where both the

contact pieces are in contact with each other through both contact portions; thereby to cause, at the closing of the device, first contact with the one of the current transmitting contact portions of each contact piece and thereon, while said floating contact piece yields, contact with both portions; and, conversely, at the opening of the contact pair, first opening of the one contact portions and then opening of both of said contact portions.

5. Device as set forth in claim 4 wherein said tilting axis of the floating contact piece is disposed relatively to said movable contact piece, so that, on pursuance of the closing motion of the contact pieces, the floating contact piece is pushed so as to complete the contact between both contact face portions of the contact pieces and, conversely, during the opening motion, first to open the one contact face portions of the contact pieces and then both of them.

6. Device as set forth in claim 4 wherein said abutment means include two abutments associated with said floating contact piece, said spring means being disposed relatively to said floating piece and its carrier so as to accelerate and displace the floating piece, in contact with the movable contact piece, during the opening motion of the movable contact piece, out of the common plane of contact, referred to the closed position, until the movable contact piece has reached its velocity and the floating piece has reached the first one of said abutments and is tilted thereabout into a position inclined relatively to said common plane of contact, thus opening first one of said portions of the contact surface and thereafter, when the floating piece has reached the second abutment, also opening the second contact surface portion, where then the electrodynamic forces will be operative to assist in the opening movement; and, conversely during the closing motion first close the one contact portion and then urging the floating piece, through the movable contact piece, against the action of the spring, bringing it out of the inclined position into the position parallel to said common contact plane and closing both contact portions, and thus substantially equalizing the contact pressure over the contacting surfaces.

7. Device as set forth in claim 2 wherein both slots are disposed within their respective contact pieces relatively to the current leading paths adjacent thereto so as to join the conductive paths between recess and slots substantially perpendicular thereto; thereby to deflect both parallel fluxes after their reunion by 90°.

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