March 1, 1966 A. BLEIBTREU ETAL 3,238,318

CONTACT BRIDGES FOR RADIAL CONTACTS WITH FULCRUM AND RESILIENT SPRING STRUCTURE

Filed April 2, 1964 2 Sheets-Sheet 1

FIG. 1

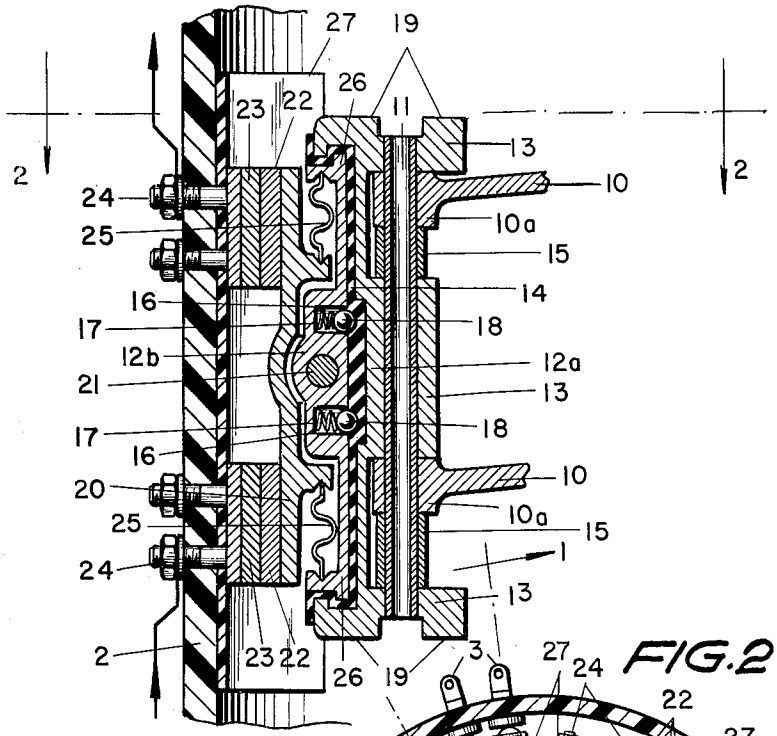

FIG. 2

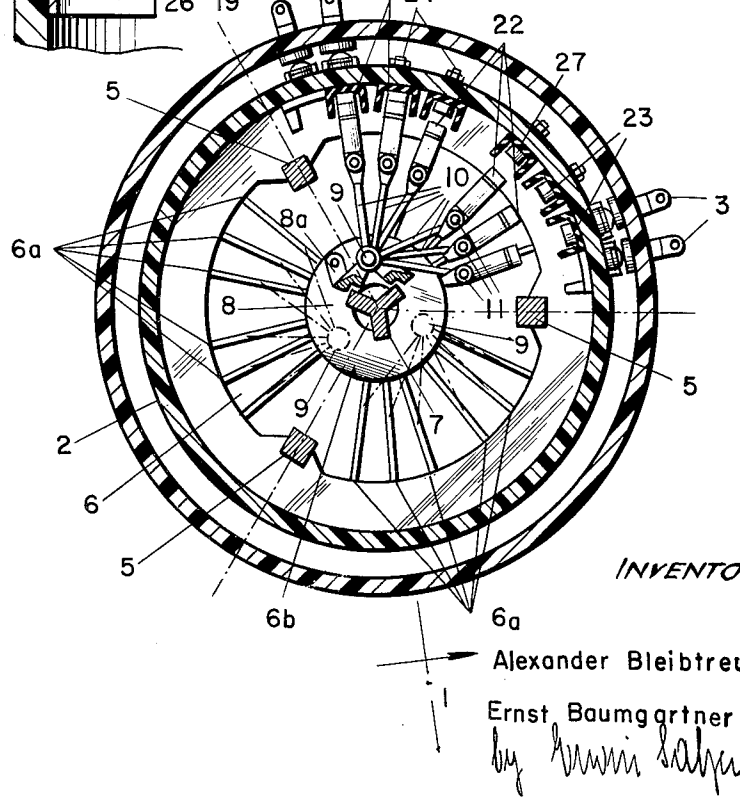

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FIG. 3

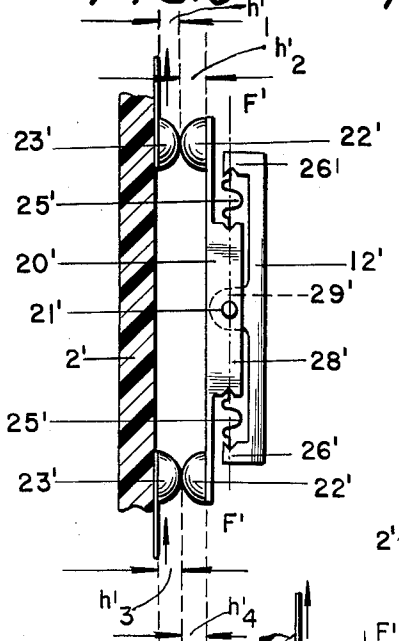


FIG. 4

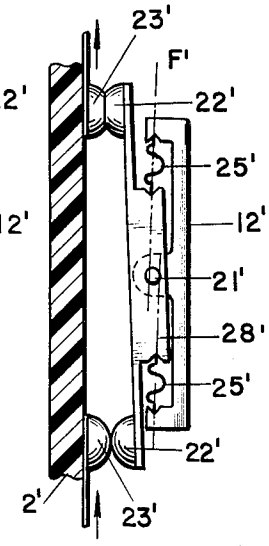


FIG. 5

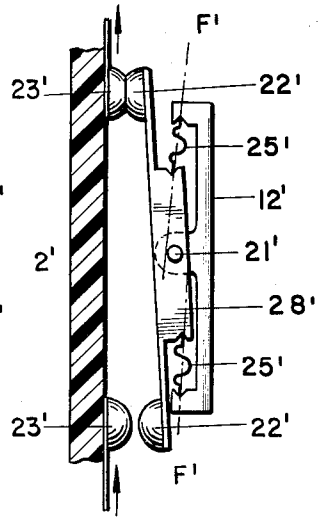


FIG. 6

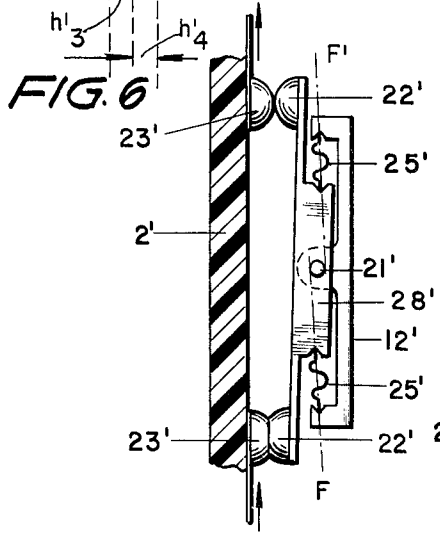
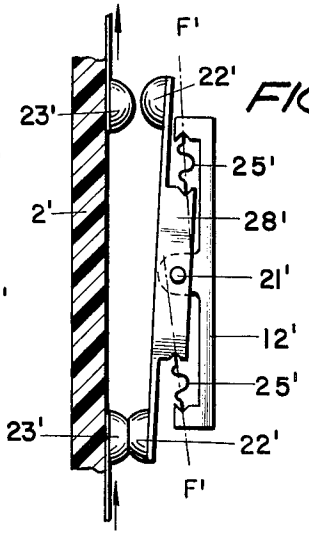


FIG. 7



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3,238,318
CONTACT BRIDGES FOR RADIAL CONTACTS WITH FULCRUM AND RESILIENT SPRING STRUCTURE

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Claims priority, application Germany, May 17, 1963, M 56,864
16 Claims. (Cl. 200—10)

This invention relates to switching devices, and more particularly to transfer switches for tap-changing regulating transformers.

Such transfer switches are preferably adapted to form pairs of series breaks. Transfer switches for tap-changing regulating transformers which are adapted to form series breaks include two pairs of cooperating separable contacts which are serially arranged in an electric circuit. Each of the two pairs of contacts includes a fixed contact and a cooperating movable contact which is separable from the fixed contact. In order to comply with the requirement that the degree of contact erosion due to arcing of both pairs of cooperating contacts be kept even, it is common practice to attempt to cause both movable contacts to part simultaneously from their cooperating fixed contacts. It is, however, impossible to fully, or sufficiently, synchronize the times of parting of pairs of cooperating contacts and the times of arc initiation at pairs of parting contacts. As a result of these conditions the arcing time is longer, and the degree of erosion due to arcing is larger, at the pair of cooperating contacts which parts first.

It is, therefore, a general object of this invention to provide switching devices adapted to equalize the degree of erosion due to arcing occurring at two serially related points of break.

Another object of this invention is to provide transfer switches for tap-changing regulating transformers adapted to equalize the degree of erosion due to arcing occurring at two serially related points of break.

Pairs of movable contacts of transfer switches for tap-changing regulating transformers are often supported by a common contact support, or contact bridge, which is, in turn, supported by a contact bridge support, resilient means such as springs being interposed between the contact bridge and the contact bridge support. In transfer switches of this description there is a tendency for the contact bridges to oscillate relative to their supports, resulting in excessive and unequal erosion of the contacts. This calls for the provision of damping means for suppressing such oscillations and their damaging results. Yet even if oscillations and their damaging results are effectively suppressed, the degree of contact erosion caused by arcing which occurs at serially related points of break is far from reasonably even. This is due to the aforementioned fact that there are no mechanisms in existence capable of fully, or sufficiently, synchronizing the parting times of serially related pairs of contacts.

It is, therefore, another object of this invention to provide switching devices capable of establishing pairs of serially related breaks, which devices include contact bridges each supporting a pair of movable contacts, in which devices each contact bridge is supported by a contact bridge support, in which devices resilient or spring means may be interposed between each contact bridge and its support, and in which devices the degree of contact erosion at both serially related points of break is reasonably, or substantially, equal.

These and other objects of the invention and advantages thereof will become more apparent from the ensuing detailed general description of the invention and of a specific preferred embodiment thereof.

It was, heretofore, the general aim of designers of switching devices of the aforementioned description to synchronize as close as possible the parting times of contacts at serially related points of break to equalize the degree of contact erosion occurring at such points of break. The present invention is predicated upon a departure from the principle of synchronization of contact separation and arc initiation. Structures embodying this invention are predicated on a novel sequence of steps. The pair of serially related contacts which is subject to a relatively small degree of erosion is caused to part first, and the pair of serially related contacts which is subject to a relatively larger degree of erosion is caused to part last. Thus, in the long run, i.e., considering a relatively large number of switching operations, the degree of erosion of both serially related pairs of contacts is maintained reasonably, or substantially, equal.

The invention will more clearly appear from the ensuing particular description thereof, as illustrated in the accompanying drawings wherein:

FIG. 1 is a vertical section of a contact structure embodying this invention taken along **1**—**1** of FIG. 2, this contact structure being intended to form a part of a transfer switch for a tap-changing regulating transformer.

FIG. 2 is in part a section taken along **2**—**2** of FIG. 1 and in part a top plan view of a transfer switch for a tap-changing regulating transformer including the contact structure of FIG. 1, FIG. 2 being drawn on a smaller scale than FIG. 1; and

FIGS. 3–7 are semi-diagrammatic illustrations of the contact structure of FIG. 1 in various operating position thereof.

Referring now to the drawings, and more particularly to FIGS. 1 and 2 thereof, reference character **1** has been applied to indicate a cylindrical tank of insulating materials which may be oil filled. The upper portion of tank **1** accommodates a cylindrical transfer switch housing **2** of insulating material arranged in coaxial relation to tank **1**. The lower portion of tank **1** may be used to accommodate switch-over resistors forming part of the transfer switch of FIG. 2. These resistors are not shown in FIG. 2. For details relating to the arrangement of these resistors in tank **1** as well as for details relating to the structure of FIG. 2, but not immediately relevant to the present invention, reference may be had to the copending patent application of Alexander Bleibtreu, Serial No. 255,291; filed January 31, 1963, now Patent No. 3,174,097, for Transfer Switch for Tap Changers for Regulating Transformers. Terminals **3** integral with tank **1** are intended to connect the transfer switch of FIG. 2 to the neutral point of a regulating transformer.

The structure of FIG. 2 further comprises three vertical bars **5** rectangular in cross-section of which the upper ends and the lower ends are attached to spaced horizontal guide plates **6**. FIG. 2 has been drawn assuming the upper guide plate to be removed and thus exposing to view the axially inner surface of the lower guide plate **6**. Both guide plates are provided with a central aperture or bore *6b*. As shown in FIG. 2 the aperture or bore *6b* exposes to view portions of the structure situated at a bore *6b*. As shown in FIG. 2 the aperture or bore *6b* exposes to view portions of the structure situated at a lower level than lower guide plate **6**. Both guide plates **6** define radial contact guiding grooves *6a* at the juxtaposed surfaces or sides thereof. Pivotable shaft **7** extends along the common axis of tank **1** and of switch housing **2** and operates a pair of spaced horizontal end plates **8** of which but one is shown in FIG. 2, i.e., the end plate **8** arranged below the lower guide plate **6**. The shaft is made up of a central portion including three arms enclosing angles of 120

deg. and cylindrical end portions intended to be received by bearings (not shown). Each end plate 8 is provided with bearing means 8*a* for three vertical operating rods or shafts 9 angularly displaced 120°. Each of the three operating rods or shafts 9 is intended to operate a set of six movable contacts pertaining to one phase of a three-phase transfer switch. In FIG. 2 the movable and fixed contact means of but one single phase have been shown in detail and the movable and fixed contact means of the two other phases have been omitted. Each vertical rod or shaft 9 pivotally supports the axially inner ends of a plurality of contact operating arms 10. The axially outer ends of each contact operating arm 10 form a bearing 10*a* for a pivot pin 11. As shown in FIG. 1 pivot pins 11 are in the form of short lengths of tubing. Reference numeral 12*a* has been applied to indicate a radially inner contact bridge support member and reference numeral 12*b* has been applied to indicate a radially outer contact bridge support member. The radially inner contact bridge support member 12*a* is provided with three bearings 13 supported by pivot pin 11. The radially outer contact bridge support member 12*b* is supported by the radially inner contact bridge support member 12*a*, and both support members 12*a*, 12*b* are electrically insulated from each other by a barrier 14 of insulating material conforming to the shapes of support members 12*a*, 12*b*. Cylindrical spacers 15 space the central bearing 13 of each support member 12*a* from the adjacent bearings 10*a* of operating arms 10. Each radially outer support member 12*b* is provided with a pair of transverse passageways 16 each accommodating a helical spring 17 and a steel ball 18 resting against insulating barrier 14. The upper and lower surfaces 19 of the radially inner support members 12*b* are shaped to fit into contact guiding grooves 6*a* in guide plates 6. The structure of FIGS. 1 and 2 further comprises a plurality of contact bridges or contact carriers 20 each supported on support member 12*a* by a horizontal pivot pin 21. Each contact bridge or contact carrier 20 supports movable contacts 22 on the upper end and on the lower end thereof. Movable contacts 22 are in engagement with fixed contacts 23 supported by the cylindrical housing 2 of the transfer switch. FIG. 1 shows contacts 22 and 23 in the engaged or closed positions thereof, thus establishing the following current path: lower terminal 24, lower fixed contact 23, lower movable contact 22, contact bridge 20, upper movable contact 22, upper fixed contact 23, upper terminal 24. The radially outer contact bridge support member 12*a* is provided with a central projection receiving pivot pin 21 which is a fulcrum for pivotal motions of contact bridge 21 and the movable contacts 22 which are supported by support member 12*a*. In addition thereto the radially outer contact bridge support member 12*a* is provided with an upper end and a lower forward projection 25. Projections 25 define knife-edge bearings each receiving one edge or end of a sinusoidally shaped compression leaf spring 26. The opposite edge or end of each leaf spring 26 rests in a knife-edge bearing defined by a rear projection of contact bridge 20 juxtaposed to projections 25 on member 12*a*. Each pair of aligned fixed contacts 22 is arranged inside of a channel-shaped insulating barrier 27 and thus insulated from the immediately adjacent pair of fixed contacts 23 which is at a somewhat different potential. Each pair of fixed contacts 23 is arranged along a vertical line. The vertical lines along which pairs of fixed contacts 23 are arranged are angularly displaced generatrices of cylindrical housing 2. Because of the presence of barriers 27 the angular spacing between contiguous aligned pairs of fixed contacts 23 may be small, and yet flashovers between such pairs of contacts are effectively precluded.

The transfer switch of FIGS. 1 and 2 comprises six pairs of fixed arcing contacts 23 and six pairs of cooperating movable arcing contacts 22 per phase of a three-phase circuit. In other applications the number of pairs of fixed arcing contacts 23, of movable arcing contacts 22, and consequently that of contact bridges 20 and that of contact bridge supports 12*a*, 12*b* may be changed to conform with specific requirements. If desired the structure of FIGS. 1 and 2 may be provided with fixed and movable main current carrying contacts in addition to cooperating arcing contacts 22, 23. The provision of main current carrying contacts is optional and has been shown in detail in the aforementioned patent application Serial No. 255,291.

When shaft 7 is pivoted clockwise, as seen in FIG. 2, end plates 8 and operating rods or shafts 9 follow the pivotal motion of shaft 7. Therefore contact operating arms 10 operate pivot pins 11, and the ends 19 of members 12*a* slide radially inside of grooves 6*a* in guide plates 6. Whenever a pair of support members 12*a*, 12*b* and the contact bridge 20 supported by the latter is moved radially inwardly, the pair of movable contacts 22 supported and conductively interconnected by bridge 20 are caused to part from the pair of fixed contacts 23 which cooperates with them. Similarly, when a pair of support members 12*a*, 12*b* and the contact bridge supported by the latter is moved radially outwardly, the pair of movable contacts 22 supported and conductively interconnected by bridge 20 are caused to engage the pair of fixed contacts 23 which cooperates wtih them. Thus a limited rotary motion of parts 7, 8, 9 in clockwise direction as seen in FIG. 2 results in a sequential radial motion of all pairs of movable contacts 22 and the respective contact bridges 20 thereof. As shown in FIG. 2 the fixed and movable contacts 22, 23 to the left are in engagement and the fixed and movable contacts 23, 22 to the right are out of engagement. The situation is reversed after parts 7, 8, 9 have been moved a predetermined angle in clockwise direction, i.e., then the fixed and movable contacts 23, 22 to the right of FIG. 2 are in engagement and the fixed and movable contacts 23, 22 to the left of that figure are out of engagement.

Both fixed contacts 23 and both movable contacts 22 associated with one of bridges 20 and one of supports 12*a*, 12*b* are identical. As long as upper arcing contacts 22, 23 and lower arcing contacts 22, 23 are not eroded by arcing, contact bridge 20 supporting contact 22 remains in its vertical position, i.e., it will not pivot about fulcrum pin 21 whether both contacts 22 are in engagement or out of engagement with both contacts 23. Such a pivotal motion may and will take place when the erosion due to arcing of an upper pair of cooperating arcing contacts 22, 23 and of a lower pair of cooperating arcing contacts 22', 23' is unequal, and such pivotal motion tends to equalize the contact erosion at the upper and lower pair of arcing contacts. How this is being achieved will now be set forth in detail in connection with FIGS. 3–7 which show, in a simplified fashion, substantially the same structure as FIG. 1 in different operating position thereof.

In FIGS. 3–7 the same reference characters with a prime added have been applied to indicate like parts as in FIG. 1. Thus reference character 2' has been applied to indicate a common support of insulating material for a pair of identical fixed arcing contacts 23' whose centers are arranged along a vertical straight line parallel to the surface of insulating support 2'. A pair of movable contacts 22' supported by contact bridge 20' are adapted to engage, and to be separated from, fixed contacts 23'. Contact bridge 20' has a projection 28' on the side thereof remote from fixed arcing contacts 23'. In the structure of FIGS. 3–7 a single contact bridge support 12' takes the place of the two bridge support members 12*a*, 12*b* in the structure of FIG. 1. Bridge support 12' has a central projection 29' and projections 26' at the ends thereof. A horizontal pivot pin 21' extends transversely through projection 28' of contact bridge 20' and projection 29' of bridge support 12'. Projections

26' of bridge support 12' define a pair of knife-edge bearings each receiving one edge or end of a sinusoidally shaped compression leaf spring 25'. Projection 28' of contact bridge 20' defines a pair of knife-edge bearings juxtaposed to the knife-edge bearings defined by projections 26'. Each knife-edge bearings defined by projection 28' of contact bridge 20' are engaged by one end or edge of sinusoidally shaped compression leaf springs 25'. As long as arcing contacts 22', 23' are not, or not significantly eroded, or not unevenly eroded, the straight line which may be drawn through the centers of contacts 22' is a vertical line extending parallel to the surface of contact support 2' and parallel to the line which may be drawn through the centers of fixed contacts 23'. This is true whether the pair of contacts 22', 22' is in engagement with the pair of contacts 23', 23' or not. As long as the above conditions regarding contact erosion prevail the direction of the equal and opposed forces exerted by springs 25' upon contact bridge 20' extends transversely across pin or fulcrum 21'. Therefore contact bridge 20' and movable contacts 22' are not subject to any torque tending to pivot these parts about pin 21'. FIG. 3 refers to such a condition.

FIG. 4 shows the same structure as FIG. 3, but in drawing FIG. 4 it was assumed that the upper cooperating contacts 22', 23' had undergone a higher degree of erosion than the lower cooperating contacts 22', 23'. As a result, engagement of the lower arcing contacts 22', 23' caused a counterclockwise pivotal motion of contact bridge 20' and of contacts 22' about pin or fulcrum 21'. Consequently, the direction of the forces exerted by over-center springs 25' is not any longer transversely across pin 21' or, in other words, springs 25' impart a torque to contact bridge 20' tending to cause a counterclockwise pivotal motion thereof about horizontal pin or fulcrum 21'. As long as the upper and lower contacts 22', 23' are in engagement, contact bridge 20' is not free to pivot about pin 21' beyond the position shown in FIG. 4.

Assuming now that contact bridge support 12' is moved from left to right, or in other words, from the position shown in FIG. 4 to the position shown in FIG. 5. This makes it possible for contact bridge 20' to turn about pivot 21' in counterclockwise direction by virtue of the torque resulting from the presence of the two bridge-biasing leaf spring 25'. Therefore parting of the lower or less eroded arcing contacts 22', 23' precedes parting of the upper or more eroded arcing contacts 22', 23'. This has been clearly shown in FIG. 5. Continued motion of bridge support 12' from the position thereof shown in FIG. 5 farther to the right results in separation of the upper or more eroded pair of arcing contacts 22', 23'. Projections 26' of contact bridge support 12' form abutments limiting the pivotal motion of bridge 20' about horizontal pin 21' in clockwise direction as well as in counterclockwise direction.

FIG. 6 refers to the same structure as FIG. 3 and has been drawn under the assumption that the degree of erosion of the lower cooperating pair of arcing contacts 22', 23' exceeds the erosion of the upper pair of cooperating arcing contacts 22', 23'. Therefore contact bridge 20' is tilted in clockwise direction upon engagement of the upper and the lower cooperating pair of arcing contacts 22', 23'. As a result, over-center springs 25' subject contact bridge 20' to a torque in clockwise direction. As long as both pairs of contacts 22', 23' are in engagement and bridge support 12' is in the position shown in FIG. 6, bridge 20' cannot pivot clockwise beyond the position thereof shown in FIG. 6. However, when contact bridge support 12' is moved from the position shown in FIG. 6 to the right—as shown in FIG. 7—contact bridge 20' is free to pivot under the action of springs 25' about pin or fulcrum 21'. This results in a separation of the upper arcing contacts 22', 23' which are less eroded, or less worn out, than the lower arcing contacts 22', 23'. FIG. 7 shows the contact structure in a position subsequent to parting of the upper pair of arcing contacts 22', 23', but prior to parting of the lower arcing contacts 22', 23'. Parting of the lower arcing contacts 22', 23' showing a greater degree of erosion, or wear, occurs upon continued horizontal movement of contact support 12' in the direction from left to right.

It will be apparent from the foregoing that the pair of arcing contacts 22', 23' showing a lesser degree of erosion, or wear, parts first, be it the upper pair of arcing contacts or the lower pair of arcing contacts. Since arcing is initiated at the pair of contacts which parts first, the arcing time and the amount of contact erosion at the pair of contacts which parts first exceed the arcing time and the amount of contact erosion at the other pair of contacts. This tends, in the long run, to equalize the amount of erosion, or wear, on the upper and on the lower pair of arcing contacts 22', 23'.

It will also be apparent that the pair of arcing contacts 22', 23' which separates last at an opening operation engages first at a closing operation. In other words, the pair of contacts which opens first is the pair of contacts to close last.

In FIGS. 3–7 the directions in which over-center biasing springs 25' act upon projection 28' of contact bridge 20' have been indicated by dash-and-dot lines to which reference character F' has been applied. The presence of lines F' makes it more convenient to ascertain the direction of the torque or couples to which contact bridges 20' and movable contacts 22' are subjected.

While FIGS. 3–7 illustrate movable and fixed contacts whose contact surfaces are round or spherical, the invention is not limited to contacts having such a geometry. This is readily apparent from a consideration of the structures of FIGS. 1 and 2 having arcing contacts 22, 23 substantially in the shape of prisms having flat abutting contact surfaces.

In drawing FIGS. 3–7 the difference in the degree of erosion of the two pairs of cooperating contacts has been greatly exaggerated to facilitate an understanding of the mode of operation of contact structures constructed according to the present invention. Actually there will hardly ever be exactly a condition such as that shown in FIG. 3 wherein both springs 25' act exactly along the same line F', or wherein both springs 25' act exactly in one and the same plane. Any slight deviation from that condition subjects contact bridge 20' to a torque resulting in sequential rather than simultaneous parting of upper and lower arcing contacts 22', 23'. The greater degree of erosion to which the pair of arcing contacts 22', 23' which parts first is subjected tends to reverse the direction of the torque to which contact bridge 20' is subjected. This play continues as the transfer switch performs its normal operating or switching duty, i.e., for some time contact bridge 20' will be spring biased in clockwise direction, and then its spring bias will tend to be counterclockwise, etc. The continuous or frequent change in the direction of the spring bias of contact bridge 20' depends upon the respective degree of erosion of the upper pair and of the lower pair of arcing contacts 22', 23'. Thus the substitution of a precisely controlled sequence of the times of parting of the upper pair of arcing contacts 22', 23' and of the lower pair of arcing contacts 22', 23' for the practice attempted heretofore of causing these contacts to part simultaneously results in the long run in equal degrees of erosion, or wear, of both pairs of contacts, i.e., their erosion, or wear, remains equal when considering a relatively large number of switching operations.

In FIG. 3 reference character h_1' has been applied to indicate the height of the upper fixed contact 23' and reference character h_2' has been applied to indicate the height of the upper movable contact 22' engaging the first mentioned contact and separable from the first mentioned

contact. In a similar fashion reference character h_3' has been applied to indicate the height of the lower fixed contact **23'** and reference character h_4' has been applied to indicate the height of the lower movable contact **22'** engaging the first-mentioned contact and separable from the first-mentioned contact. As long as

$$h_1'+h_2'=h_3'+h_4'$$

the forces exerted by springs **25'** on contact bridge **20** extend transversely through horizontal pin **21** as shown in FIG. 3. If due to contact erosion

$$(h_1'+h_2')\gtrless(h_3'+h_4')$$

contact bridge **20'** is subject to a torque tending to tilt contact bridge **20'** about pivot **21**. FIGS. 4 and 5 refer to this particular case and show contact bridge **20'** to be spring biased in counterclockwise direction. If due to contact erosion

$$(h_1'+h_2')>(h_3'+h_4')$$

contact bridge **20'** is again subject to a torque. The above case is illustrated in FIGS. 6 and 7 which show contact bridge **20'** as being biased in clockwise direction by springs **25'**.

The term center of contacts **22'**, **23'** as used in this context is the center of mass within the meaning in which this term is being used in kinematics.

Having disclosed a preferred embodiment of our invention it is desired that the same not be limited to the particular structure disclosed. It will be obvious to any person skilled in the art that many modifications and changes may be made without departing from the broad spirit and scope of the invenion. Therefore it is desired that the invention be intrepreted as broadly as possible and limited only as required by the prior state of the art.

We claim is our invention:

1. An electric switching device comprising in combination:

(a) two pairs of cooperating relatively movable contacts having engaged positions and disengaged positions, said two pairs of contacts including two fixed substantially identical contacts having a predetermined height and being arranged in spaced relation along a straight line, and said two pairs of contacts further including two movable substantially identical contacts having a predetermined height;

(b) a contact bridge supporting said two movable contacts;

(c) a contact bridge support having fulcrum means pivotally supporting said contact bridge, said fulcrum means being spaced from said straight line and having a geometrical axis at right angles to said straight line;

(d) operating means for moving said contact bridge support in a direction substantially at 90 degrees to said straight line and substantially at 90 degrees to said geometrical axis of said fulcrum means; and

(e) means interposed between said contact bridge and said contact bridge support for causing a force to act upon said contact bridge, said means being arranged to exert a force upon said contact bridge directly transversely across said geometrical axis of said fulcrum means when said two pairs of contacts are in said engaged positions thereof and the aggregate height of each of said two pairs of contacts is substantially equal and to subject said contact bridge to a torque when said two pairs of contacts are in said engaged positions thereof and the aggregate height of each of said two pairs of contacts is unequal.

2. An electric switching device comprising in combination:

(a) a pair of substantially identical spaced fixed contacts arranged in registry along a vertical line;

(b) a pair of substantially identical spaced movable contacts each cooperating with one of said pair of fixed contacts;

(c) a contact bridge supporting adjacent the ends thereof said pair of movable contacts and conductively interconnecting said pair of movable contacts, said contact bridge having horizontal pivot means adjacent the center thereof and said contact bridge having a vertical position and slanting positions;

(d) a horizontally movable contact bridge support pivotally supporting said contact bridge; and

(e) spring means interposed between said contact bridge and said contact bridge support and arranged to exert vertical forces upon said contact bridge extending transversely through said pivot means as long as said contact bridge is in said vertical position thereof.

3. An electric switching device comprising in combination:

(a) two pairs of cooperating relatively movable contacts having engaged positions and disengaged positions, said two pairs of contacts including two fixed substantially identical contacts having a predetermined height and being arranged in spaced relation along a straight line, and said two pairs of contacts further including two movable substantially identical contacts having a predetermined height;

(b) a contact bridge supporting said two movable contacts;

(c) a contact bridge support having fulcrum means pivotally supporting said contact bridge, said fulcrum means being spaced from said straight line and having a geometrical axis at right angles to said straight line;

(d) operating means for moving said contact bridge support in a direction substantially at 90 degrees to said straight line and substantially at 90 degrees to said geometrical axis of said fulcrum means; and

(e) spring means interposed between said contact bridge and said contact bridge support, said spring means being arranged to exert a force upon said contact bridge directed transversely across said geometrical axis of said fulcrum means when said two pairs of contacts are in said engaged positions thereof and the aggregate height of each of said two pairs of contacts is substantially equal and to subject said contact bridge to a torque when said two pairs of contacts are in said engaged positions thereof and the aggregate height of each of said two pairs of contacts is unequal.

4. An electric switching device comprising in combination:

(a) two pairs of cooperating relatively movable contacts having engaged positions and disengaged positions, said two pairs of contacts including two fixed substantially identical contacts having a predetermined height and being arranged in spaced relation along a straight line, and said two pairs of contacts further including two movable substantially identical contacts having a predetermined height;

(b) a contact bridge supporting said two movable contacts;

(c) a contact bridge support having fulcrum means pivotally supporting said contact bridge, said fulcrum means being spaced from said straight line and having a geometrical axis at right angles to said straight line;

(d) operating means for moving said contact bridge support in a direction substantially at 90 degrees to said straight line and substantially at 90 degrees to said geometrical axis of said fulcrum means; and

(e) a pair of over-center springs interposed between said contact bridge and said contact bridge support and arranged to opposite sides of said fulcrum means so as to exert opposite forces transversely across said geometrical axis of said fulcrum means when said two pairs of contacts are in said engaged posi-

tions thereof and the aggregate height of each of said two pairs of contacts is substantially equal.

5. An electric switching device comprising in combination:
(a) a contact support of insulating material;
(b) a pair of spaced fixed contacts supported by said contact support;
(c) a pair of spaced movable contacts each adapted to engage one of said pair of fixed contacts and to be separated from one of said pair of fixed contacts;
(d) a contact bridge supporting said pair of movable contacts and having a pair of knife-edge bearings equally spaced from said pair of movable contacts;
(e) a movable contact bridge support having fulcrum means pivotally supporting said contact bridge, said contact bridge support further including a pair of knife-edge bearings each juxtaposed to one of said pair of knife-edge bearings on said contact bridge; and
(f) a pair of compression leaf springs each resting with one end thereof in one of said pair of knife-edge bearings on said contact bridge and each resting with the other end thereof in one of said pair of knife-edge bearings on said contact bridge support.

6. An electric switching device comprising in combination:
(a) a pair of spaced fixed contacts;
(b) a pair of spaced movable contacts each adapted to engage one of said pair of fixed contacts and to be separated from one of said pair of fixed contacts;
(c) a contact bridge supporting said pair of movable contacts and having a rear projection arranged midway between said pair of movable contacts;
(d) a contact bridge support having a forward center projection and a pair of forward end projections;
(e) a pivot pin projecting transversely through said rear projection of said contact bridge and said forward center projection of said contact bridge support; and
(f) a pair of contact bridge biasing springs each interposed between said rear projection of said contact bridge and one of said pair of forward end projections of said contact bridge support.

7. An electric switching device comprising in combination:
(a) a pair of spaced fixed contacts;
(b) a pair of spaced movable contacts each adapted to engage one of said pair of fixed contacts and to be separated from one of said pair of fixed contacts;
(c) a contact bridge supporting said pair of movable contacts and having a rear projection arranged midway between said pair of movable contacts and defining a pair of knife-edge bearings spaced equidistantly from said pair of movable contacts;
(d) a contact bridge support having a center region and defining a pair of knifie-edge bearings spaced equidistantly from said center region;
(e) a pivot pin projecting transversely through said rear projection of said contact bridge and through said center region of said contact bridge support; and
(f) a pair of sinusoidal leaf compression springs each resting with one end thereof in one of said pair of knife-edge bearings defined by said contact bridge and each resting with the other end thereof in one of said pair of knife-edge bearings defined by said contact bridge support.

8. An electric switching device comprising in combination:
(a) a pair of spaced fixed contacts;
(b) a pair of spaced movable contacts each adapted to engage one of said pair of fixed contacts and to be separated from one of said pair of fixed contacts;
(c) a contact bridge supporting said pair of movable contacts and having a rear projection arranged midway between said pair of movable contacts and defining a pair of knife-edge bearings spaced equidistantly from said pair of movable contacts;
(d) a contact bridge support providing at the center thereof a pivotal support for said contact bridge and having at the ends thereof a pair of abutment members limiting the pivotal motion of said contact bridge relative to said contact bridge support, each of said pair of abutment members defining one of a pair of knife-edge bearings; and
(e) a pair of sinusoidal leaf compression springs, each of said pair of springs resting with one end thereof in one of said pair of knife-edge bearings defined by said contact bridge and each of said pair of springs resting with the other end thereof in one of said pair of knife-edge bearings defined by one of said pair of abutment members.

9. An electric switching device comprising in combination:
(a) a pair of spaced fixed contacts;
(b) means for conductively interconnecting said pair of fixed contacts including a pair of spaced movable contacts each cooperatively related to one of said pair of fixed contacts and a contact bridge supporting said pair of movable contacts;
(c) a movable contact bridge support having fulcrum means pivotally supporting said contact bridge;
(d) spring means interposed between said contact bridge and said contact bridge support exerting a force upon said contact bridge extending through said fulcrum means when and as long as said contact bridge is in a predetermined position and subjecting said contact bridge to a torque when said contact bridge is in a position other than said predetermined position; and
(e) cooperating abutment means on said contact bridge and on said contact bridge support for limiting pivotal motions of said contact bridge relative to said contact bridge support.

10. An electric switching device comprising in combination:
(a) a contact support of insulating material;
(b) a pair of substantially identical fixed contacts arranged in spaced relation along a vertical line and supported by said contact support;
(c) means for conductively interconnecting said pair of fixed contacts including a pair of spaced substantially identical movable contacts and a contact bridge supporting said pair of movable contacts;
(d) a movable contact bridge support having horizontal pivot means supporting said contact bridge allowing said contact bridge to assume a vertical position and to assume slanting positions;
(e) a first over-center spring interposed between said contact bridge and said contact bridge support exerting a first vertical force upon said contact bridge intersecting said pivot means at right angles when contact bridge is in said vertical position thereof; and
(f) a second over-center spring interposed between said contact bridge and said contact bridge support exerting a second vertical force upon said contact bridge intersecting said pivot means and being opposite to said first force when said contact bridge is in said vertical position thereof.

11. An electric switching device comprising in combination:
(a) two pairs of contacts including a first and second fixed contact and a first movable contact cooperating with said first fixed contact and a second movable contact cooperating with said second fixed contact;
(b) a contact bridge supporting said first and second movable contact;
(c) a contact bridge support having fulcrum means pivotally supporting said contact bridge;

(d) operating means for jointly moving said contact bridge support and said contact bridge relative to said first and second fixed contacts; and

(e) torque imparting means responsive to the difference between the degree of erosion of said first fixed contact and said first movable contact and the degree of erosion of said second fixed contact and said second movable contact to selectively tilt said contact bridge about said fulcrum means in either of two different directions upon joint movement of said contact bridge support and of said contact bridge relative to said first and second fixed contacts.

12. An electric switching device comprising in combination:

(a) a contact support of insulating material;

(b) two pairs of cooperating separable contacts adapted to form series breaks, said two pairs of contacts including two substantially identcal fixed contacts arranged in spaced relation along a vertical line and supported by said contact support, and said two pairs of contacts further including two substantially identical movable contacts;

(c) a contact bridge supporting said two movable contacts;

(d) a contact bridge support having horizontal pivot means pivotally supporting said contact bridge adjacent the center thereof and allowing said contact bridge to assume a vertical position and slanting positions;

(e) operating means for said contact bridge support to move said contact bridge and said two movable contacts away from said two fixed contacts; and

(f) a pair of contact bridge biasing springs interposed between said contact bridge and said contact bridge support, said springs being arranged to exert equal and opposing forces extending transversely through said pivot means as long as said contact bridge is maintained in said vertical position thereof and to subject said contact bridge to a torque when said contact bridge is moved to one of said slanting positions thereof.

13. An electric switching device comprising in combination:

(a) a substantially cylindrical contact support of insulating material;

(b) a pair of substantially identical fixed contacts arranged in spaced relation along a generatrix of said contact support;

(c) a pair of substantially identical movable contacts each cooperating with one of said pair of fixed contacts to form two pairs cooperating separable contacts;

(d) a contact bridge supporting and conductively interconnecting said pair of movable contacts;

(e) a contact bridge support including a first portion having pivot means spaced from and extending at right angles to said generatrix and pivotally supporting said contact bridge adjacent the center thereof, a second portion supporting said first portion, and electric insulating means interposed between said first portion and said second portion;

(f) spring means biasing said first portion away from said second portion to cause resilient engagement of said two pairs of cooperting contacts;

(g) operating means for selectively moving said contact bridge support radially in opposite directions to move said pair of movable contacts to closed positions and to open positions; and

(h) a pair of contact bridge biasing springs interposed between said first portion of said contact bridge support and said contact bridge, said pair of springs being arranged to exert upon said contact bridge opposite forces extending transversely through said pivot means when said movable contacts are in said closed position thereof and the degree of erosion of said two pairs of contacts is substantially equal, said pair of contact bridge biasing springs subjecting said contact bridge to a torque when the degree of erosion of said two pairs of contacts is unequal.

14. An electric switching device comprising in combination:

(a) a substantially cylindrical contact support of insulating material;

(b) a pair of substantially identical fixed contacts arranged in spaced relation along a generatrix of said support at the inner surface thereof;

(c) a pair of substantially identical movable contacts each cooperating with one of said pair of fixed contacts to form two pairs of cooperating separable contacts;

(d) a contact bridge supporting and conductively interconnecting said pair of movable contacts;

(e) a contact bridge support including a radially outer portion having pivot means extending at right angles to said generatrix and pivotally supporting said contact bridge adjacent the center thereof, a radially inner portion supporting said radially outer portion, and electric insulating means interposed between said radially outer portion and said radially inner portion;

(f) spring means interposed between said radially inner portion and said radially outer portion biasing said radially outer portion radially outward away from said radially inner portion;

(g) operating means for selectively moving said contact bridge support radially inward and radially outward to move said pair of movable contacts to contact open positions and contact closed positions; and

(h) a pair of contact bridge biasing compression leaf springs interposed between said radially outer portion of said contact bridge support and said contact bridge, said pair of springs having ends resting in knife-edge bearings and said pair of springs being arranged to exert upon said contact bridge opposite forces extending tranversely through said pivot means when said pair of movable contacts are in said closed positions thereof and the degree of erosion of said two pairs of contacts is substantially equal, said pair of contact bridge biasing springs subjecting said contact bridge to a torque when the degree of erosion of said two pairs of cooperating contacts is unequal.

15. A transfer switch for tap-changing regulating transformers comprising in combination:

(a) a substantially cylindrical contact support of insulating material;

(b) a plurality of substantially identical pairs of fixed contacts supported by said contact support, each of said plurality of pairs of fixed contacts being arranged along one of a plurality of angularly displaced vertical generatrices of said contact support;

(c) a plurality of substantially identical pairs of movable contacts, each pair of said plurality of pairs of movable contacts cooperating with one pair of said plurality of pairs of fixed contacts;

(d) a plurality of contact bridges each supporting one pair of said plurality of pairs of movable contacts and each conductively interconnecting said one pair, each of said plurality of contact bridges having a pair of spring bearings each being pivotally supported adjacent the center thereof and each having a vertical position and slanting positions;

(e) a plurality of contact bridge supports, each of said plurality of contact bridge supports including a first portion having a horizontal pivot means for pivotally supporting one of said plurality of contact bridges and having a pair of spring bearings, a second portion supporting said first portion, and insulating means electrically insulating said first portion from said second portion;

(f) spring means for biasing said first portion of each of said plurality of contact bridge supports in radial direction away from said second portion thereof;

(g) a plurality of operating linkages each operatively related to one of said plurality of contact bridge supports for selectively moving each of said plurality of contact bridge supports and each of said plurality of contact bridges radially in opposite directions to closed positions and open positions;

(h) a pivotable shaft arranged along the geometrical axis of said contact support and operatively related to said plurality of linkages for operating said plurality of contact bridges;

(i) a plurality of pairs of contact bridge biasing springs, each pair of said plurality of pairs of springs having ends resting in said pair of spring bearings of one of said plurality of contact bridges and each pair of said plurality of pairs of springs having ends resting in one of said pair of spring bearings of said first portion of each of said plurality of contact bridge supports, each pair of said plurality of pairs of springs being arranged to exert upon one of said plurality of contact bridges opposite forces extending transversely through said pivot means of one of said plurality of contact bridge supports when said one of said plurality of contact bridges is in said vertical position thereof and subjecting said one of said plurality of contact bridges to a torque when said one of said plurality of contact bridges is in one of said slanting postions thereof; and

(j) a plurality of pairs of abutment means, each of said pairs of abutment means being integral with one of said plurality of contact bridge supports for limiting the pivotal motion of each of said plurality of contact bridges relative to one of said plurality of contact bridge supports.

16. A transfer switch for tap-changing regulating transformers comprising in combination:

(a) a substantially cylindrical fixed contact support of insulating material;

(b) a plurality of substantially identical pairs of fixed contacts supported by said contact support on the inner surface thereof, each pair of said plurality of pairs of fixed contacts being arranged in spaced relation along one of a plurality of angularly displaced generatrices of said contact support;

(c) a plurality of substantially identical pairs of movable contacts arranged inside of said contact support, each pair of said plurality of pairs of movable contacts cooperating with one pair of said plurality of pairs of fixed contacts;

(d) a plurality of contact bridges each supporting adjacent the ends thereof one pair of said plurality of

pairs of movable contacts and each conductively interconnecting said one pair, each of said plurality of contact bridges defining a pair of knife-edge bearings, each being pivotally supported adjacent the center thereof and each having a vertical position and slanting positions;

(e) a plurality of contact bridge supports each including a radially outer portion having horizontal pivot means supporting one of said plurality of contact bridges and defining a pair of knife-edge bearings, a radially inner portion supporting said radially outer portion, and insulating means electrically insulating said radially outer portion from said radially inner portion;

(f) helical spring means arranged between said radially outer portion and said radially inner portion of each of said plurality of contact bridge supports;

(g) a plurality of operating linkages each operatively related to one of said plurality of contact bridge supports for selectively moving each of said plurality of contact bridge supports and each of said plurality of contact bridges radially inward toward the geometrical axis of said contact support and radially outward away from the geometrical axis of said contact support;

(h) a pivotable shaft arranged along the geometrical axis of said contact support and operatively related to said plurality of linkages for operating said plurality of contact bridges;

(i) a plurality of pairs of contact bridge biasing compression leaf springs, each pair of said plurality of pairs of springs having ends resting in said pair of knife-edge bearings defined by one of said plurality of contact bridges and each pair of said plurality of pairs of springs having ends resting in said pair of knife-edge bearings defined by said radially outer portion of one of said plurality of contact bridge supports, each pair of said plurality of pairs of springs being arranged to exert opposing vertical forces extending transversely through said horizontal pivot means for one of said plurality of contact bridges as long as said one of said plurality of contact bridges is substantially in said vertical position thereof; and

(j) a plurality of pairs of abutment means each integral with one of said plurality of contact bridge supports for limiting pivotal motions of each of said plurality of contact bridges relative to one of said plurality of contact bridge supports.

No references cited.

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