ELECTRICAL SWITCHING DEVICE HAVING SELF-CLEANING CONTACTOR ELEMENTS

Inventor: James D. Brandlein, Indianapolis, Ind.
Assignee: Western Electric Company, Incorporated, New York, N.Y.
Filed: Mar. 1, 1973
Appl. No.: 337,266

U.S. Cl. ... 200/164, 200/242, 200/253, 200/277
Int. Cl. ... H01h 1/36
Field of Search ... 200/164, 242, 253, 277, 200/166

References Cited
UNITED STATES PATENTS
1,304,377 5/1919 Kohne ... 200/164
1,876,874 9/1932 Douglas ... 200/166 BB
2,951,130 8/1960 Mason ... 200/166 BB X
3,168,627 2/1965 Gilley ... 200/164 UX
3,384,850 5/1968 Cameron et al. ... 200/164 X
3,486,143 12/1969 Wilkes ... 200/166 B

FOREIGN PATENTS OR APPLICATIONS
956,565 4/1964 Great Britain ... 200/164

Primary Examiner—G. Harris
Attorney, Agent, or Firm—D. D. Bosben

ABSTRACT
An electrical switching device which is capable of effecting continuous self-cleaning of its contactor elements, each time it is operated, includes a plurality of arcuate contactor elements and respective opposed linear contactor elements, for accomplishing make, break and transfer switching functions. The arcuate contactor elements are mounted on a carrier member and have a first preselected radius. In effecting a switching operation, the carrier member is moved linearly and is simultaneously rotated about a second preselected radius which is different from the first preselected radius, to cause simultaneous rotation and sliding movement of the arcuate contactor elements relative to the linear contactor elements, thereby to effect a continuous controlled wiping and cleaning action between the contactor elements, and thus the establishment of good electrical contact therebetween. Either the arcuate contactor elements or the linear contactor elements may be independently resilient in nature.

10 Claims, 11 Drawing Figures
ELECTRICAL SWITCHING DEVICE HAVING SELF-CLEANING CONTACTOR ELEMENTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a contact making device having self-cleaning contactor elements, and more particularly to an electrical switching device capable of reliably effecting make, break or transfer switching functions as a result of opposed electrical contactor elements of the switch producing a continuous sliding and cleaning action relative to one another as the switch is moved between its different operating positions.

2. Description of the Prior Art

A frequent problem in the manufacture of electrical devices which are to be capable of effecting switching functions, is the inability to establish good electrical contact between contactor elements of the device as the result of dirt and/or oxide formations on the surfaces of the contactor elements. The dirt and oxide formations function as insulators and increase the resistance between the contact surfaces so as to prevent their associated electrical circuits from closing, or at least from performing properly. This is particularly true in electronic circuits which are designed to operate at a relatively low power level.

Roller-type contact members which are engageable and disengageable with associated contact members or elements for effecting switching functions are undesirable because of the accumulation of dirt and oxide formations on the contact surfaces, as discussed hereinabove. Further, the use of sliding-bar contact members to provide a cleaning action between the bar contact members and associated linear contact members, is disadvantageous because of the excessive wear between the contact members, and is particularly undesirable in instances where the contact members are of relatively thin material. Similarly, in the British pat. No. 1,093,067, issued Nov. 29, 1967, as a roller-type contact member is moved between its operating positions, it initially rolls during a first portion of its movement, and then the rolling movement of the contact member is interrupted so that it slides on associated linear contact members during the latter portion of its movement. As in the case of the sliding-bar contact members, however, this arrangement will produce excessive wear on the contact members.

SUMMARY OF THE INVENTION

In accordance with this invention, a contact making device includes an arcuate contactor element for making contact with a substantially linear contactor element. In operation, a linear translating motion and a rotary motion are simultaneously imparted to the arcuate contactor element, to rotate and slide the arcuate contactor element simultaneously and continuously on the linear contactor element, to effect contact between the contactor elements while cleaning the contactor elements.

More specifically, in an electrical switching device a plurality of arcuate contactor elements are mounted on a carrier member and have a first preselected radius. In effecting a switching operation, the carrier member is moved linearly and is simultaneously rotated about a second preselected radius which is different from the radius of the arcuate contactor elements, to cause simultaneous rotation and sliding movement of the arcuate contactor elements on respective opposed linear contactor elements, thereby effecting cleaning of the contactor elements and the establishment of good electrical contact therebetween. Establishment of good electrical contact between the contactor elements also is facilitated by making at least one of each of the opposed contactor elements independently resilient in nature.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of an electrical switching device in accordance with the invention, partially in cross-section, with the device shown in a position intermediate first and second operating positions thereof;

FIG. 2 is a cross-sectional view taken along the line 2—2 in FIG. 1;

FIG. 3 is a cross-sectional view of the electrical switching device shown in FIG. 1 taken along the line 3—3 and showing the first and second operating positions of the device;

FIG. 4 is a cross-sectional view taken along the line 4—4 in FIG. 1, with the switching device in its first operating position;

FIG. 5 is a plan view as seen along the line 5—5 in FIG. 2;

FIG. 6 is a schematic view illustrating a principle of the invention;

FIG. 7 is a schematic view similar to FIG. 6 and further illustrating the principle of the invention;

FIG. 8 is a plan view of an alternate embodiment of an electrical switching device in accordance with the invention, with the device shown in a position intermediate first and second operating positions thereof;

FIG. 9 is a partial cross-sectional view as seen along the line 9—9 in FIG. 8;

FIG. 10 is an elevational view showing first and second operating positions of the switching device in FIG. 8;

FIG. 11 is another alternate embodiment of the invention similar to the embodiment of the invention shown in FIGS. 8, 9 and 10.

DETAILED DESCRIPTION

FIGS. 1-6 illustrate a self-cleaning electrical switching device 16 having a contactor assembly 17 capable of effecting make, break and transfer switching functions when it is moved between a first operating position as shown in solid lines in FIG. 3, and a second operating position as shown in broken lines in this figure. The switching device 16 also includes a bottom wall in the form of a printed circuit board 18, and a plastic housing 19 which forms top and side walls for the device and which is molded as an integral unit. The printed circuit board 18 is suitably secured to the plastic housing 19, such as by screws.

As is best shown in FIG. 5, a top surface 18a of the printed circuit board 18 has a pair of linear "make" contactor members or elements 21, a pair of linear "break" contactor members or elements 22 and a set of linear "transfer" contactor members or elements 23-1, -2 and -3, formed thereon in a suitable manner. The pairs of "make" contactors 21 and break contactors 22 extend from adjacent respective opposite sides of the printed circuit board 18 approximately to its center, so that only one of the pairs of contactors is engaged by the movable contactor assembly 17 when it is in respective ones of its operating positions. Similarly,
the transfer contactors 23-1 and 23-2 extend from adjacent respective opposite sides of the printed circuit board 18 to approximately the center thereof, while the transfer contactor 23-3 extends on opposite sides of the center of the board so as to be capable of completing an electrical circuit with one or the other of the transfer contactors 23-1 and 23-2 through the movable contactor assembly 17 when it is in respective ones of its operating positions. Respective leads 24 extend through the bottom of the printed circuit board 18 and are electrically connected to the contactors 21, 22 and 23 in a suitable manner, such as by soldering.

The movable contactor assembly 17 includes a carrier member 26 of a suitable insulating material, such as plastic, and which has flanges 26a at each end thereof. Mounted on the carrier member 26 is a make electrical contactor 27, a break electrical contactor 28 and a transfer electrical contactor 29. When the carrier member 26 is in its solid line position, its make contactor 27 is disengaged from the linear make contactor elements 21 on the printed circuit board 18, its break contactor 28 is engaged with the linear break contactor elements 22 to complete a circuit therethrough, and its transfer contactor 29 is engaged with the linear transfer contactor element 23-1 and the relatively long transfer contactor element 23-3, to establish an electrical circuit therebetween. When the carrier member 26 is moved to the position shown in broken lines in FIG. 3, its make contactor 27 engages the linear make contactor elements 21, its break contactor 28 disengages from the linear break contactor elements 22, and its transfer contactor 29 disengages from the linear transfer contactor element 23-1 and engages with the linear transfer contactor element 23-2, while remaining in contact with the relatively long transfer contactor element 23-3, thus performing a make, break and transfer switching function.

The make, break and transfer contactors 27, 28 and 29 effect their corresponding switching functions with the linear contactor elements 21, 22 and 23 on the printed circuit board 18 as the result of arcurate contactor elements 27a, 28a and 29a moving or rotating about the radius R2, while the arcuate contactor elements 27a, 28a and 29a rock or rotate about the radius R1. Further, since the flanges 26a and the arcuate contactor elements 27a, 28a and 29a must move together, the arcuate contactor elements also continuously slide relative to the linear contactor elements 21, 22 and 23, as is illustrated in FIG. 6.

More specifically, in FIG. 6 the carrier member 26 is depicted as a semi-circular rocker member having a hub portion of the relatively small radius R1, and corresponding to the arcuate contactor elements 27a, 28a and 29a, and having toothed arcuate flanges of the relatively large radius R2 and corresponding to the flanges 26a. The toothed flanges 26a rock or rotate on an apertured planar surface corresponding to the bottom surfaces 18a of the recesses in the printed circuit board 18, and the hub portion 27a, 28a and 29a rocks or rotates on a planar surface comparable to the top surface 18a of the printed circuit board 18 and the electrical contactor elements 21, 22 and 23. Thus, as the rocker member 26 rocks or rotates clockwise 60°, from the solid line position to the broken line position in FIG. 6, it is seen that a point 26p-1 on the inner periphery of each of the toothed flanges 26a will move to a position 26p-2 on the surface 18b. Similarly, if the hub portion 27a, 28a, 29a could be rotated independently of the flanges 26a through the same arc, a point 27p-1 on the periphery of the hub portion and on the same radius line as the point 26p-1, would move a lesser distance to a position 27p-2 on the surface 18a, 21, 22, 23. However, since the hub portion 27a, 28a, 29a must rotate with the flanges 26a, the point 27p-1 actually moves to a position 27p-3 on the surface 18a, 21, 22, 23, with the difference X between the position 27p-2 and 27p-3 representing the distance which the periphery of the hub portion must continuously slide on the surface during the rotation of the rocker member 26 so as to arrive ultimately at the position 27p-3. Thus, it is apparent that by properly varying the two radii R1 and R2, a desired controlled cleaning action between the contactor elements 21, 22, 23, 27a, 28a, and 29a can be achieved with the rocker member 26 therebetween.

FIG. 7 is similar to FIG. 6 except that a radius R'1 of a hub portion 27a', 28a', 29a' on a rocker member 26' is relatively large, whereas a radius R'2 of toothed flanged 26a' of the rocker member is relatively small. In this illustration, as the flanges 26a' are rocked or rotated clockwise 60° on a planar surface 18b', a point 26p-1' on each flange 26a' will move to a position 26p-2' on the surface. While a point 27p-1' on the periphery of the hub portion 27a', 28a', 29a' and the same radius line as the point 26p-1' would have moved forward to a position 27p-2' on a planar surface 18a', 21', 22', 23', if the hub portion were free to rotate on the surface independently of the flanges 26a', the point 27p-1' actually moves only to a position 27p-3' on the surface 18a', 21', 22', 23'. The difference X between the positions 27p-2' and 27p-3' again represents the distance which the hub portion 27a', 28a', 29a' must slide relative to the surface 18a', 21', 22', 23', but in this instance in a reverse direction as compared to that of the hub portion 27a, 28a, 29a in FIG. 6. As in FIG. 6, the degree of sliding movement of the hub portion 27a', 28a', 29a' is determined by the difference between the radii R'1 and R'2.

As is best shown in FIGS. 1 and 2, the arcuate contactor elements 27a, 28a and 29a (FIG. 2) are formed
in pairs for engagement with respective ones of the linear contactors 21, 22 and 23, and are integral with respective diametrical portions 27b, 28b and 29b (FIG. 1) and mounting portions 27c, 28c, and 29c of the contactors 27, 28 and 29. The mounting portions 27c, 28c and 29c of each of the contactors 27, 28 and 29 are disposed in opposed relationship through a respective slot 26c in the carrier member 26, and are held secured in the slot by the inherent resiliency of the contactors and a pair of suitable retaining dimples formed in the mounting portions. The arcuate contactor elements 27a, 28a and 29a also are independently resilient to assure good electrical contact with their respective linear contactors 21, 22 and 23 despite irregularities in the top surface 18a of the printed circuit board 18. In this regard, the arcuate contactor elements 27a, 28a and 29a are maintained in firm pressure engagement with the linear contactors 21, 22 and 23 by pressure rollers 32 mounted on projecting shaft portions of the carrier member 26 at each end thereof. The pressure rollers 32 are engaged with the adjacent side walls of the plastic housing 19 to preclude longitudinal movement of the carrier member 26, and the peripheral surfaces of the rollers ride on the inner surface of the top wall of the housing.

FIGS. 8-10 disclose an alternate embodiment of the invention in which an electrical switching device 16' includes a mounting board 18" of an insulating material, such as plastic, having a pair of make contactor elements 21', a pair of break contactor elements 22' and a set of transfer contactor elements 23-1', 23-2' and 23-3', on a top surface 18a' thereof. The make and break contactor elements 21' and 22' are fixed to a central portion of the mounting board 18" by having inner end portions thereof extended through the board and soldered to respective leads 24'. The transfer contactor elements 23-1' and 23-2' are fixed to the central portion of the mounting board 18" in the same manner, while the transfer contactor element 23-3' extends across the board and has an intermediate portion projected through and fixed to the board centrally thereof. The contactor elements 21, 22 and 23 are resilient and essentially linear in configuration, except that outer end portions thereof extend upward relative to the mounting board 18" as illustrated in FIG. 9, to facilitate the establishing of electrical contact therebetween despite irregularities in the top surface 18a' of the mounting board.

The electrical switching device 16' also includes a carrier member 26" of an insulating material, such as plastic, and having a semi-circular configuration. A make contactor 27', a break contactor 28' and a transfer contactor 29' are mounted on the carrier member 26" with intermediate portions of the contactor elements formed about an arcuate surface thereof on a radius R', to provide arcuate contactor elements 27a', 28a' and 29a', with diametrical portions 27b', 28b' and 29b' of the contactors folded into overlapped relationship and secured to the carrier member by suitable screws. The arcuate contactor elements 27a', 28a' and 29a' also may be made independently resilient in nature, as in the embodiment of FIGS. 1-6, if so desired.

Adjacent the opposite ends of the carrier member 26" laterally projecting flanges or legs 26a" thereof have inwardly directed mounting lugs 26b" disposed between opposed parallel surfaces 18c" (FIG. 9) of respective recesses in the mounting board 18", so that the carrier member is capable of pivotal movement on, and linear movement perpendicular to, the top surface 18a" of the board. As is best shown in FIG. 9, an elongated wire spring 37 is disposed in a longitudinally extending slot in the mounting board 18" between each mounting lug 26b" and an enlarged concave portion of the slot, to permit the carrier member to be rotated about the lugs on a radius R'. Thus, as the carrier member 26" is rotated between its operating positions as shown in solid and broken lines in FIG. 10, the wire springs 37 hold the carrier member, and thus the arcuate contactor elements 27a", 28a" and 29a" move relative to their respective linear contactor elements 21", 22" and 23". As a result, the arcuate contactor elements 27a", 28a" and 29a" move relative to their respective linear contactor elements 21", 22" and 23" on the mounting board 18" to perform their respective switching functions with a combined rotating and sliding action, thereby effecting self-cleaning of both sets of the contactor elements each time the switching device 16" is operated.

To facilitate rotation of the carrier member 26" between its two operating positions, an operating lever 39 is provided on one of the legs 26a" of the carrier member, as illustrated in FIG. 10.

FIG. 11 is an alternate embodiment of the invention of the same general construction as the embodiment shown in FIGS. 8, 9 and 10, except that the biasing arrangement comprising the wire springs 37 is replaced with clip-type spring 41. In this embodiment, each leg 26a" of the carrier member 26" is provided with an outwardly projecting lug 42 and a lost motion slot for receiving a laterally projecting pin 43 fixed to a mounting board 18". The spring clip 41 is engaged over the outwardly projecting lug 42 and the projecting pin 43 to retain arcuate contactor elements 27a", 28a" and 29a" on the carrier member 26" in engagement with the mounting board 18" and/or respective linear contactor elements 21", 22" and 23" on the mounting board. In other respects, the operation of the embodiment shown in FIG. 11 is substantially identical to the operation of the embodiment of FIGS. 8, 9 and 10.

Summarizing, in embodiments of the invention as illustrated in FIGS. 1-7, and referring to FIGS. 11-15 for the purpose of illustration, it is seen that an electrical switching device 16 has been disclosed in which the arcuate contactor elements 27a, 28a and 29a continuously slide relative to the linear contactor elements 21, 22 and 23 on the printed circuit board 18 with a wiping action at a controlled rate as the device is moved between its different operating positions, to effect a cleaning action on both sets of the contactor elements and thereby to insure good electrical contact therebetween. More specifically, the sliding movement of the arcuate contactor elements 27a, 28a and 29a is achieved by rotating the carrier member 26 as a linear translating motion is imparted thereto, to cause simultaneous rotation and sliding movement of the arcuate contactor elements, with the degree of sliding and cleaning action being dependent upon the difference between the radius of rotation R of the arcuate contactor elements and the radius of rotation R of the carrier member. As a result, a desired cleaning action can be effected without producing excessive wear of the contactor elements 21, 22 and 23 on the printed circuit board, which is particularly important where these con-
tactor elements are of relatively thin material. The independently resilient arcuate contactor elements 27a, 28a and 29a also help insure good electrical contact with their respective linear contactor elements 21, 22 and 23 on the printed circuit board 18, despite irregularities in the top surface 18a of the board. Similarly, in embodiments of the invention as shown in FIGS. 8-11, and referring specifically to FIGS. 8, 9 and 10, the desired controlled cleaning action is achieved by properly varying the differential between the radius R_e'' of the arcuate contactor elements 27a'', 28a'', 29a'' and the radius of rotation R_e'' of the carrier member 26''.

What is claimed is:

1. A contact making device, which comprises:
   a substantially linear contactor element mounted in a substantially fixed position;
   an arcuate movable contactor element mounted in coplanar relationship with respect to said linear contactor element, for engaging and making contact with said linear contactor element; and
   means for rotating said arcuate contactor element while imparting a translating motion to said arcuate contactor element, to rotate and slide said arcuate contactor element simultaneously and continuously on said linear contactor element, to effect contact between said contactor elements while cleaning said contactor elements.

2. A contact making device, which comprises:
   a substantially linear contactor element:
   a carrier member:
   an arcuate contactor element mounted on said carrier member and having a first preselected radius; and
   means for imparting a translating motion to said carrier member and said arcuate contactor element; and
   means for causing rotation of said carrier member about a second preselected radius which is different from the first preselected radius of said arcuate contactor element, during the translating movement of said carrier member and said arcuate contactor element, to cause simultaneous rotation and sliding movement of said arcuate contactor element on said linear contactor element.

3. A contact making device, as recited in claim 2, with further comprises:
   means for biasing said arcuate contactor element and said linear contactor element into engagement with one another during the translating and rotary movement of said carrier member.

4. A contact making device, as recited in claim 2, wherein the device is an electrical switching device and which further comprises:
   a plurality of linear contactor elements; and
   a plurality of arcuate contactor elements on said carrier member in opposed relationship to respective ones of said linear contactor elements for engagement therewith, said respective contactor elements forming sets in which at least one of said contactor elements of each set is resilient.

5. A contact making device as recited in claim 2, in which:
   the radius of said arcuate contactor element is less than the radius of rotation of said carrier member.

6. A contact making device as recited in claim 2, in which:
   the radius of said arcuate contactor element is greater than the radius of rotation of said carrier member.

7. A contact making device, as recited in claim 2, which further comprises:
   a support member having a planar surface portion on which said linear contactor element is mounted; reaction surface means offset with respect to the planar surface portion of said support member; a flange on said carrier member, said flange having an arcuate peripheral segment of the second preselected radius and drivingly engaged with said offset surface reaction means to cause the rotation of said carrier member and the simultaneous and continuous rotation and sliding of said arcuate contactor element on said linear contactor element when the translating motion is imparted to said carrier member by said motion imparting means.

8. A contact making device, as recited in claim 7, in which:
   said offset reaction surface means is constructed in the form of a gear rack; and
   the peripheral segment of said flange on said carrier member has teeth receivable in the gear rack formed by said reaction surface means.

9. A contact making device, as recited in claim 2, which further comprises:
   a support member having a planar surface portion on which said linear contactor element is mounted; means for mounting said carrier member on said support member for rotary movement about the second preselected radius and for linear movement perpendicular to the planar surface portion of said support member; means for rotating said carrier member about the second preselected radius to move said carrier member relative to the planar surface portion of said support member; and resilient means for causing linear movement of said carrier member perpendicular to the planar surface portion of said support member during the rotational movement of said carrier member, so that said arcuate contactor element simultaneously and continuously rotates and slides on said linear contactor element.

10. A contact making device, as recited in claim 9, in which:
   said linear contactor element is resilient and has at least one free end portion projecting from the planar surface portion of said support member for engagement by said arcuate contactor element.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Inventor(s) J. D. Brandlein

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 4, "therebeetween" should read --therebetween--.
Column 4, line 46, "flanged" should read --flanges--. Column 4, line 57, "X" should read --X'--. Column 6, line 31, before "clip-type", "a" should be inserted.

Signed and Sealed this twenty-second Day of July 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks