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P. G. EDWARDS ET AL

2,455,049

SHOCK-PROOF ELECTROMAGNETIC CIRCUIT CONTROLLER

Filed March 15, 1944

FIG. 1

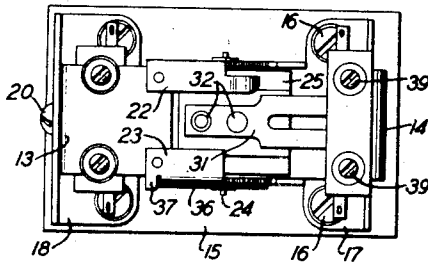


FIG. 2

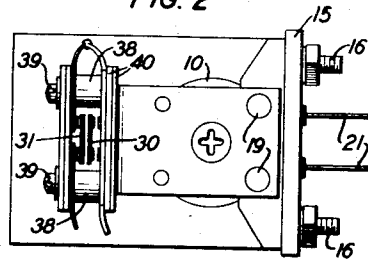


FIG. 3

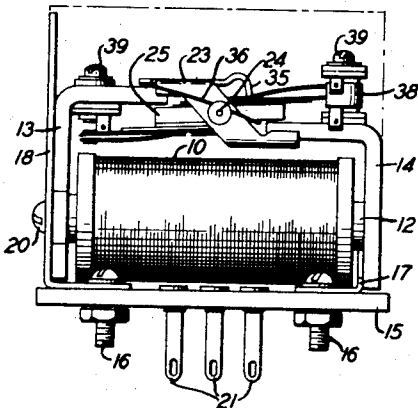


FIG. 4

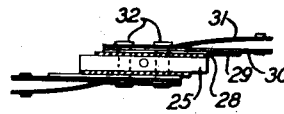


FIG. 5

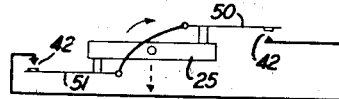


FIG. 7

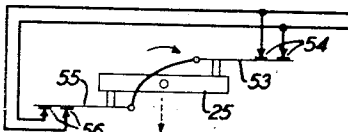


FIG. 8

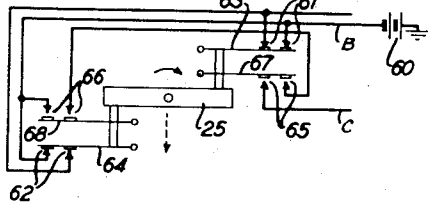


FIG. 10

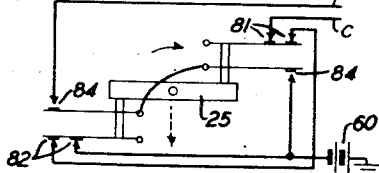


FIG. 6

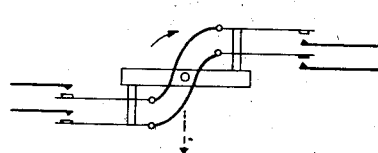
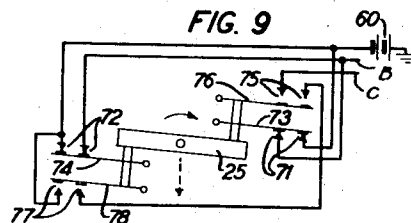


FIG. 9



INVENTORS: P. G. EDWARDS
H. W. HERRINGTON
BY A. F. Kane

ATTORNEY

UNITED STATES PATENT OFFICE

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SHOCKPROOF ELECTROMAGNETIC
CIRCUIT CONTROLLER

Paul G. Edwards and Harold W. Herrington,
Verona, N. J., assignors to Bell Telephone Lab-
oratories, Incorporated, New York, N. Y., a cor-
poration of New York

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This invention relates to electric circuit controllers and particularly to switching devices of the type that function to control electric circuits through the media of armature-operated contact springs.

In general, circuit controllers function to complete, or to interrupt a circuit by causing a contact bearing spring to be moved, under the action of an armature, into or out of engagement with an associated stationary contact included in the circuit to be controlled. Frequently, such devices are used under conditions which expose them to shock, which produces armature vibration and spring deflections and thereby causes the false and untimely operation of the controlled circuits.

It is the object of this invention to provide a circuit controller, or switching device which precludes the possibility of false and untimely circuit operation under conditions of shock.

This object is attained, in a switching device, by the use of duplicate circuit controlling contact springs mounted on diagonally disposed upper and lower faces of a dynamically balanced armature which is mounted for rotation about its center transverse axis. More particularly, the armature is balanced for rotation about its transverse center line so that any forces, produced by shock or impact, which act upon the armature at one side of its pivot support and tend to produce rotation of the armature in one direction are counterbalanced by similar forces which act upon the armature at the other side of its pivot support and tend to rotate the armature in the opposite direction. The armature accordingly, is rendered unresponsive to such forces and maintains its normal stable condition when subjected to shock. By virtue of the mounting of duplicate contact springs on upper and lower diagonally disposed faces of the armature, it is necessary for both springs to be jointly moved into, or out of engagement with their corresponding stationary contacts in order for a switching function to be performed. When such springs flex in response to shock or impact, to which the controller is subjected, they do so in such a manner that one flexes in a direction which tends to separate the spring from its stationary contact, while the other flexes in a direction which tends to emphasize its engagement with its corresponding stationary contact, thereby precluding the joint operation of the springs in such directions as would cause the completion of a switching operation.

The invention will be readily understood from

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the following detailed description when read in connection with the accompanying drawings, in which:

Figs. 1, 2 and 3 are top plan, end, and side elevations, respectively, of an electromagnetic switching device embodying the features of the invention in one of its aspects. It is to be understood that the particular form of magnetic circuit illustrated in these figures has been chosen for illustrative purposes only, and that any other suitable form of magnetic structure may be employed;

Fig. 4 is a detail assembly of the contact springs and armature incorporated in the switching device of Figs. 1, 2 and 3 and illustrates the manner in which the springs are mounted on the armature and in which they may be electrically interconnected if required;

Figs. 5, 6, 7, 8, 9 and 10 are schematic configurations which illustrate the invention in its application to various types of contact control, such as single and double pole series, or "make" contacts; single and multiple "break" contacts; and "transfer" contacts. Each of these figures will be described individually hereinafter.

The electromagnetic structure elected for illustrative purpose and shown in Figs. 1, 2 and 3 consists essentially of a horizontally disposed coil 10 mounted on a magnetic core 12, and two L-shaped pole-pieces 13 and 14, each of which has a vertically extending portion abutting a different end of the core 12 and a horizontal inwardly projecting portion. The vertical portions of the pole-pieces are of different lengths so that their respective horizontal portions project inwardly in different parallel planes, the horizontal portion of pole-piece 13 being at a higher level than that of the horizontal portion of pole-piece 14.

An insulating base 15 has secured thereto, by means of bolts 16, two brackets 17 and 18 of non-magnetic material. The bracket 17 may be riveted or otherwise fixed to the lower end of the vertical portion of pole-piece 12. Riveting of these two members is indicated at 19 in Fig. 2. The bracket 18 is provided with a relatively long vertical portion which serves as a guide and support for a cover whose location is indicated by the broken lines in Fig. 3. Near its lower end this portion of bracket 18 is centrally apertured to receive a screw 20 which passes through a corresponding hole in the vertical leg of pole-piece 13 and screws into a tapped, or threaded hole in the left end of core 12. The base 15 carries several terminals 21 by virtue of which various external circuit connections may be made to the

coil 21 and to the stationary contacts of the switching device.

A pair of brackets 22, 23 interconnect the inwardly projecting end of the horizontal portions of pole-pieces 13 and 14 and each consists of two short horizontal legs interconnected by a diagonal bridge piece. The upper horizontal legs of both brackets are spot welded, or otherwise fixed to the upper surface of the horizontal projection of pole-piece 13, while the lower horizontal legs of both brackets are similarly secured to the under surface of the horizontal projection of pole-piece 14. The diagonal pieces of the brackets 22, 23 are provided with centrally located aligned holes which receive a pin 24 which passes through the armature 25 at its center transverse axis and constitutes a support about which the armature is rotated.

As hereinbefore indicated, the armature 25 is mounted on its pivot pin 24 in such a manner that it is in a condition of stable equilibrium. As more clearly shown in Fig. 4, the armature 25 carries on its upper and lower faces identical spring pile-ups, each consisting of a flat insulator 28, a reinforcing flat metal sheet 29 and a pair of contact springs 30 and 31. The elements just identified are arranged in the order named in superposed relation, with the insulator 28 supported directly on the armature. A pair of rivets 32 serves to support both spring pile-ups on the armature and to electrically inter-connect the springs mounted on the upper face of the armature with those mounted on the lower face of the armature if the requirements of the circuit in which the controller is used necessitate such interconnection. It will be understood that the elements of one spring pile-up are identical to the corresponding elements of the other spring pile-up and that both spring pile-ups contain the same number of elements. Further, each spring pile-up is located on its respective armature surface in the same position relative to the center transverse axis of the armature so that the balanced condition of the armature is not disturbed. As clearly shown in Fig. 1, contact springs 30 and 31 are of the parallel contact type which provides double assurance against faulty contact.

The bracket 22 is provided with an integrally formed hook-line projection 35 which serves as an armature back stop. A spring 36 serves to restore the armature to normal position against back stop 35. This spring 36 is fixed at one end to a lateral projection 37 on the bracket 23 while its other end is hooked to fit under the armature as shown in Fig. 3 and does not disturb the balanced condition of the armature.

The stationary contacts which engage with the contacts carried by the springs are insulatively mounted on the horizontal portions of the pole-pieces 13 and 14. Those stationary contacts which function with the springs mounted on the upper surface of the armature 25 are supported on the upper surface of the horizontal portion of pole-piece 14, whereas those which function with the springs mounted on the lower surface of the armature are supported on the lower surface of the horizontal portion of pole-piece 13. As shown in the drawing, the upper and lower stationary contact elements are insulatively separated from each other by collars 38 through which screws 39 pass in securing the contact elements in position on the pole-piece.

When the coil 10 is energized the balanced armature 25 is rotated in a clockwise direction about its pivot 24 and carries with it the contact

springs supported on its upper and lower surfaces causing them to simultaneously engage with, or disengage from their corresponding stationary contacts.

Fig. 5 is a schematic illustration of a balanced armature 25 which, when operated, causes the simultaneous closure of the duplicate contacts 42. The small full arrow indicates the direction of armature rotation resulting from the energization of a coil such as the coil 10. The contacts illustrated are of the "make" type and, as is obvious, both contacts must be closed to effect a switching function.

If it is assumed that the switching device having the armature and contact arrangement schematically shown in Fig. 5 is dropped, or otherwise subjected to shock such as to cause the application of forces to the armature in a direction indicated by the broken line arrows, the armature will maintain its normal position. This is due to the fact that the moments of the forces acting upon the armature at each side of its pivot support will counterbalance each other, it being understood that the armature by design, is normally balanced. The contact spring 50 carried on the upper surface of the armature will, however, respond to the shock or impact and will flex in a direction such that it may engage the right-hand stationary contact 42. Contact spring 51, however, will flex in the same direction and tend to move further away from its associated left-hand stationary contact 42 with the over-all result that the normal open condition of the controlled circuit is maintained. Should the shock, or impact to which the switching device is subjected cause flexing of the springs in the opposite direction the contact spring 51 may flex so as to engage its corresponding contact 42 but the contact spring 50 will flex in a direction such as to emphasize the open condition at its corresponding contact 42. The normal open condition of the circuit will thus be maintained and the possibility of false circuit operation resulting from shock is precluded. While single contacts are indicated in Fig. 5 it will be understood that parallel contacts of the type shown in Fig. 1 may be employed.

Fig. 6 distinguishes from Fig. 5 only in that it shows a double pole arrangement suitable for use in cases requiring the control of more than one circuit.

In Fig. 7 duplicate sets of multiple contacts are shown normally bridging the controlled circuit through their respective contact springs. These contacts are "break" contacts and normally provide two parallel closures of the controlled circuit. As in the case of Figs. 5 and 6, it is necessary that both contact sets be opened to effect the completion of a switching function, that is, to effectively open the controlled circuit. As described in connection with Fig. 5, the balanced armature 25 of Fig. 7 is immune to shock. Also, any force to which the switching device is subjected and which causes the contact springs to flex will cause spring 53 to flex in a direction away from its corresponding stationary contacts 54 and cause one of the normal closures of the controlled circuit to be opened. The contact spring 55, however, will tend to flex in a direction towards its corresponding stationary contacts 56 and thereby will emphasize the circuit closure at these contacts. The normally closed condition of the controlled circuit accordingly, is not disturbed when the switching device is subjected to shock. Obviously, any forces of shock which tend to cause

spring 55 to move out of engagement with the stationary contacts 56 will tend to emphasize the engagement of spring 53 with its contacts 54 and thereby maintain the controlled circuit in its normal closed condition.

Fig. 8 illustrates a "transfer" arrangement in which the battery 60 is normally connected to the lead B by way of the duplicate sets of multiple contacts 61, 62 and their corresponding contact springs 63 and 64, respectively. The lead C to which the battery 60 is transferred when the controller is operated is normally open-circuited at contacts 65, which contacts are serially connected with contacts 66, when the controller is operated, by way of springs 67 and 68. When the armature 25 is rotated in the direction indicated by the arrow the springs 63 and 64 are moved out of engagement with their respective contacts 61 and 62 and thus disconnect the battery 60 from lead B. Springs 67 and 68 are moved into engagement with their respective contacts 65 and 66 thus connecting the battery 60 to the lead C.

Should the controller equipped with the contact arrangement shown in Fig. 8 be dropped or otherwise subjected to shock such as to cause the application of forces to the armature in a direction indicated by the broken arrow, the armature 25, due to its balanced condition will maintain its normal position. Springs 63, 64, 67 and 68 will all tend to flex in the same direction. Spring 63 may move out of engagement with its contacts 61 but spring 64 will tend to emphasize its engagement with springs 62 so that the normal connection of battery to lead B is maintained. Similarly spring 67 may flex so as to move into engagement with contacts 65 but spring 68 will separate further from contacts 66 so that no transfer operation occurs. Should the controller be subjected to shock or impact such as to cause the application of forces to the armature 25 in a direction opposite to that indicated by the broken arrow the normal connected condition of the battery to lead B will be maintained at contacts 61 and spring 63 and though spring 68 may engage contacts 66, the lead C will be held open at contacts 65.

In cases where it is desirable to effect a "transfer" operation only when the controller is released, it is essential that the device be shock-proof when in its operated position. Such a condition is met by the arrangement illustrated in Fig. 9 where the armature 25 is shown operated. Under this operate condition the connection from battery 60 to lead B is effected by the duplicate sets of contacts 71 and 72 and their associated contact springs 73 and 74, while the lead C is opened at contacts 75 which are serially connected to the battery 60 by way of spring 76, contacts 77 and spring 78 when the controller is released. It is apparent that when the controller is deenergized and the armature 25 rotates in a counter-clockwise direction, springs 73 and 74 move out of engagement with their associated stationary contacts 71 and 72 and thereby disconnect battery 60 from lead B, while springs 76 and 78 move into engagement with their respective stationary contacts 75 and 77 to connect battery 60 to the lead C to complete the "transfer" operation.

Should the controller schematically shown in Fig. 9, when in its operated position, be subjected to shock or impact such as to cause the application of forces thereto in a direction indicated by the broken arrow, spring 74 may flex so as to

move out of engagement with its contacts 72 but the spring 73 would tend to flex in the same direction and thereby maintain the connection of battery to the lead B by way of contacts 71. Similarly, though spring 78 might flex so as to engage contacts 77, the lead C would still be open at contacts 75 since spring 76 would flex in a direction such as to increase its separation from contacts 75. Thus the circuit conditions in effect when the controller is in its operated position are maintained under conditions of shock. Forces acting on the armature in the opposite direction and caused by shock similarly would be ineffective to disturb the circuit conditions illustrated.

Fig. 10 is shown merely to illustrate a possible "transfer" arrangement suitable for use in cases where the normal battery connection to a lead C is not so critically essential as to warrant safeguarding such connection under conditions of shock and where it is of prime importance that the "transfer" operation result only from the normal operation of the controller and not from causes produced by shock. When the controller of Fig. 10 operates, armature 25 rotates in a clockwise direction causing the battery connection to lead C to be opened at contacts 81 and 82 and completing the battery connection to lead B by way of contacts 83 and 84 and their associated springs.

Should the controller illustrated in Fig. 10 be subjected to shock or impact such as to cause the application of forces thereto in the direction indicated by the broken line arrow, the armature would remain in its normal position due to its balanced condition and though contact 83 would be closed due to the flexing of its associated spring, the contact 84 would maintain the open condition of the lead B due to the flexing of its associated spring away from the contact 84. Thus the transfer of battery from lead C to lead B is prevented even though the battery connection to lead B is interrupted.

While Figs. 5 to 10, inclusive, are intended to illustrate various switching functions capable of performance by a switching device embodying the features of the invention, it is to be understood that they do not constitute a showing of all the possible contact arrangements which are capable of being accommodated by such a switching device. The schematic illustrations are intended to convey the facts that the contacts may be of the "break," "make," or "transfer" types; that the switching functions may be performed on a single pole or multiple pole basis; and that the stationary and spring supported contacts may be of the single or parallel variety, the latter type serving as a precaution against contact failure caused by dirt, dust or other extraneous matter. Obviously, the invention is equally applicable to controllers in which the contacts are closed, or opened in a definite sequence such as in switching arrangement of the so-called "make-before-break" and "break-before-make" types.

What is claimed is:

1. In a shock-proof switching device, a dynamically balanced armature mounted for rotation about its transverse center axis, a contact spring fixed to the upper surface of said armature, a contact spring fixed to the lower surface of said armature, and a pair of circuit terminating stationary contacts for each of said contact springs having corresponding contacts electrically interconnected, said pairs of contacts being so disposed relative to their corresponding

contact springs that each pair of stationary contacts is bridged thereby when said armature is in its normal position to effect duplicate parallel closures of the circuit terminated by said stationary contacts, the arrangement of said springs on said armature relative to their corresponding stationary contacts being such that the accidental movement of said springs, caused by shock, relative to their stationary contacts precludes the simultaneous openings of the bridges effected by said springs.

2. In combination, an electric circuit having duplicate switching points and a switching device for controlling said circuit comprising a pair of stationary contacts identifying each of said duplicate switching points, wiring electrically interconnecting corresponding contacts of said pairs of stationary contacts, a dynamically balanced armature mounted for rotation about its center transverse axis, a pair of contact springs each bearing a pair of parallelly related contacts and mounted on opposite surfaces of said armature so as to extend radially from opposite ends thereof, each said pair of parallelly related contacts normally engaging a different pair of said stationary contacts whereby said circuit is rendered electrically continuous through two independent parallel paths, and means for rotating said armature to cause the simultaneous disengagement of each of said pairs of parallelly related spring contacts from its corresponding pair of stationary contacts to effect the simultaneous opening of said circuit at both said duplicate switching points.

3. In combination, an electric circuit having duplicate switching points whose joint opening is required to effect a change in the normal condition of said circuit, and a switching device controlling said circuit comprising a pair of stationary contacts identifying each of said duplicate switching points, a balanced armature mounted for rotation about its center transverse axis and normally assuming a position of stable equilibrium in which it is unresponsive to shock, a pair of bifurcated contact springs fixed to said armature each pair of tines thereof normally bridging the contacts of a different pair of said stationary contacts, and wiring electrically connecting corresponding contacts of each pair of stationary contacts whereby the said circuit is rendered electrically continuous through two parallel paths each including a pair of stationary contacts and the tines of the corresponding bifurcated spring, said contact springs being susceptible to movement relative to their stationary contacts and independently of said armature when said device is subjected to shock and being so fixedly located on said armature and disposed

relative to their stationary contacts that they move in opposite directions relative to their corresponding stationary contacts when said device is subjected to shock to thereby insure the electrical continuity of said circuit through one of said parallel paths, and in the same direction relative to their corresponding stationary contacts when said armature is rotated to thereby insure the opening of said circuit at both said duplicate switching points.

4. In combination, an electric circuit having duplicate switching points whose joint closure, or opening, is required to effect a change in the normal condition thereof, and a switching device for controlling said circuit comprising a pair of stationary contacts identifying each of said duplicate switching points, a dynamically balanced armature mounted for rotation about its center transverse axis, a bifurcated spring insulatively mounted on said armature having a pair of tines extending radially therefrom in one direction each in engaged, or engageable relation to a different contact of one of said pairs of stationary contacts whereby the contacts of said pair of stationary contacts are normally bridged, or bridgeable by said bifurcated spring, a second bifurcated spring insulatively mounted on said armature having a pair of tines extending radially therefrom in the opposite direction each in engaged, or engageable relation to a different contact of the other of said pairs of stationary contacts whereby the contacts of said other pair of stationary contacts are normally bridged, or bridgeable by said second bifurcated spring, wiring electrically interconnecting corresponding contacts of each of said pairs of stationary contacts, and means for causing the rotation of said armature whereby the tines of said contact springs are moved simultaneously into, or out of engagement with their corresponding stationary contacts to change the condition of said circuit which normally prevails at said duplicate switching points.

PAUL G. EDWARDS.
HAROLD W. HERRINGTON.

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