

Dec. 23, 1958

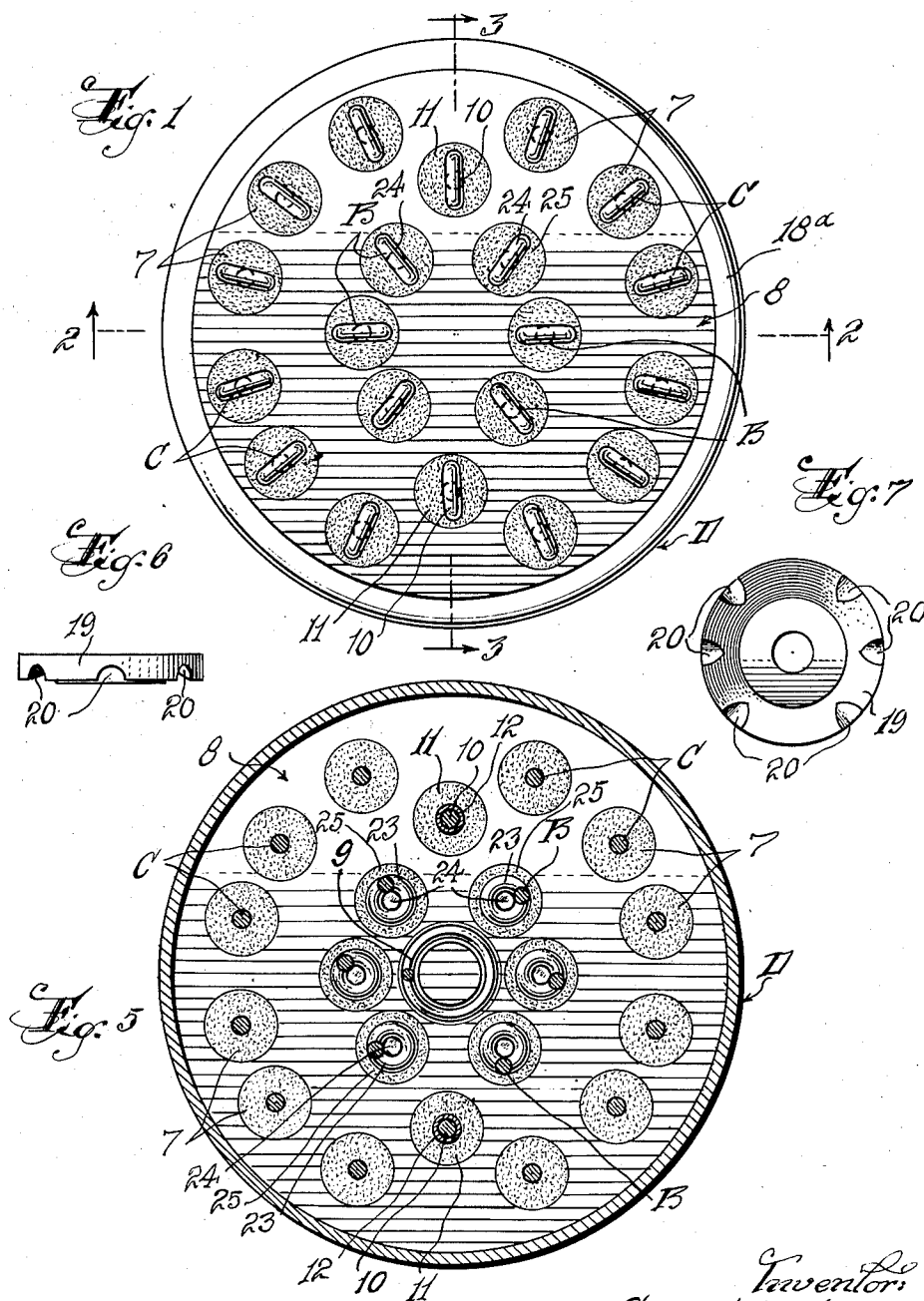
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2,866,046

RELAY WITH SELF-CLEANING CONTACT ELEMENTS

Filed March 23, 1956

3 Sheets-Sheet 1



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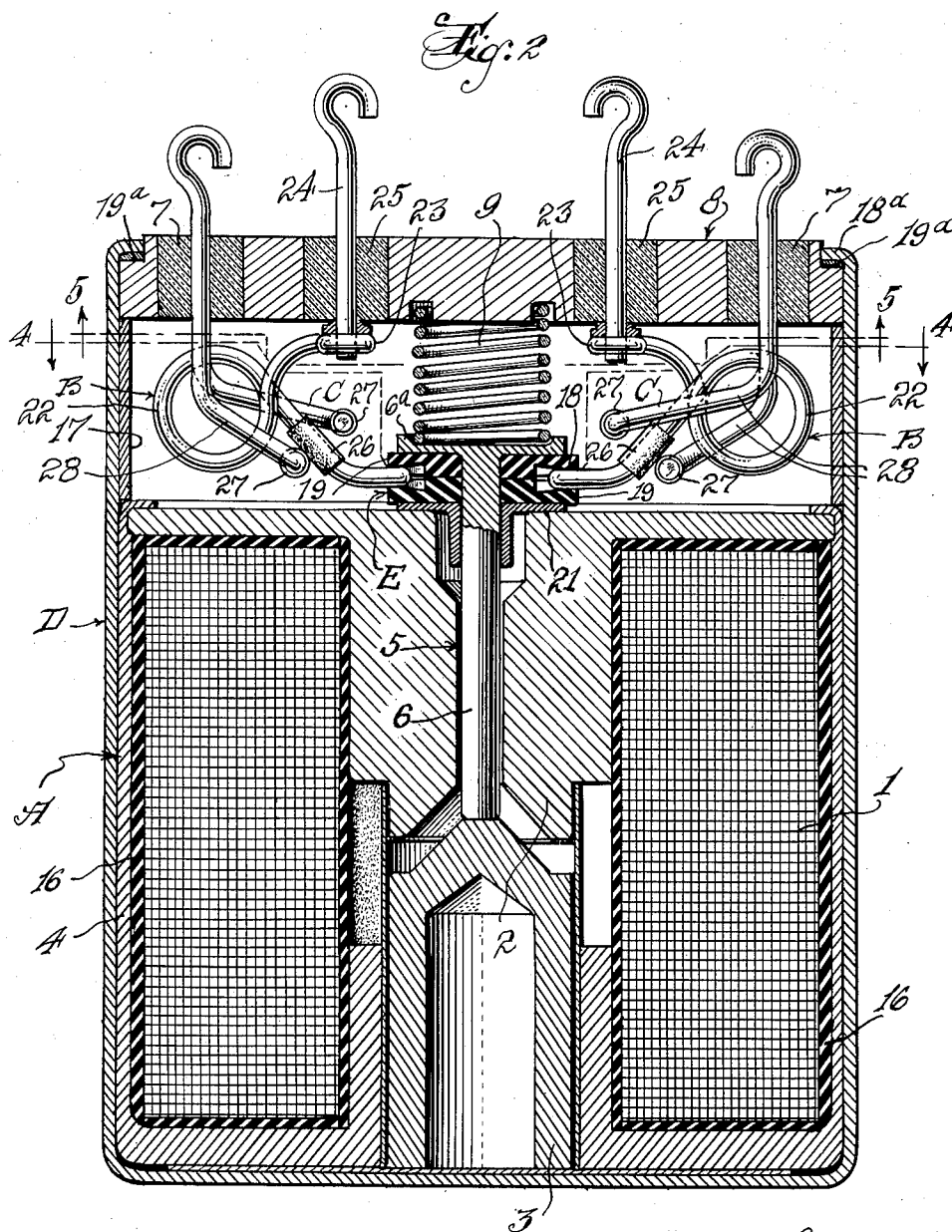
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3 Sheets-Sheet 2



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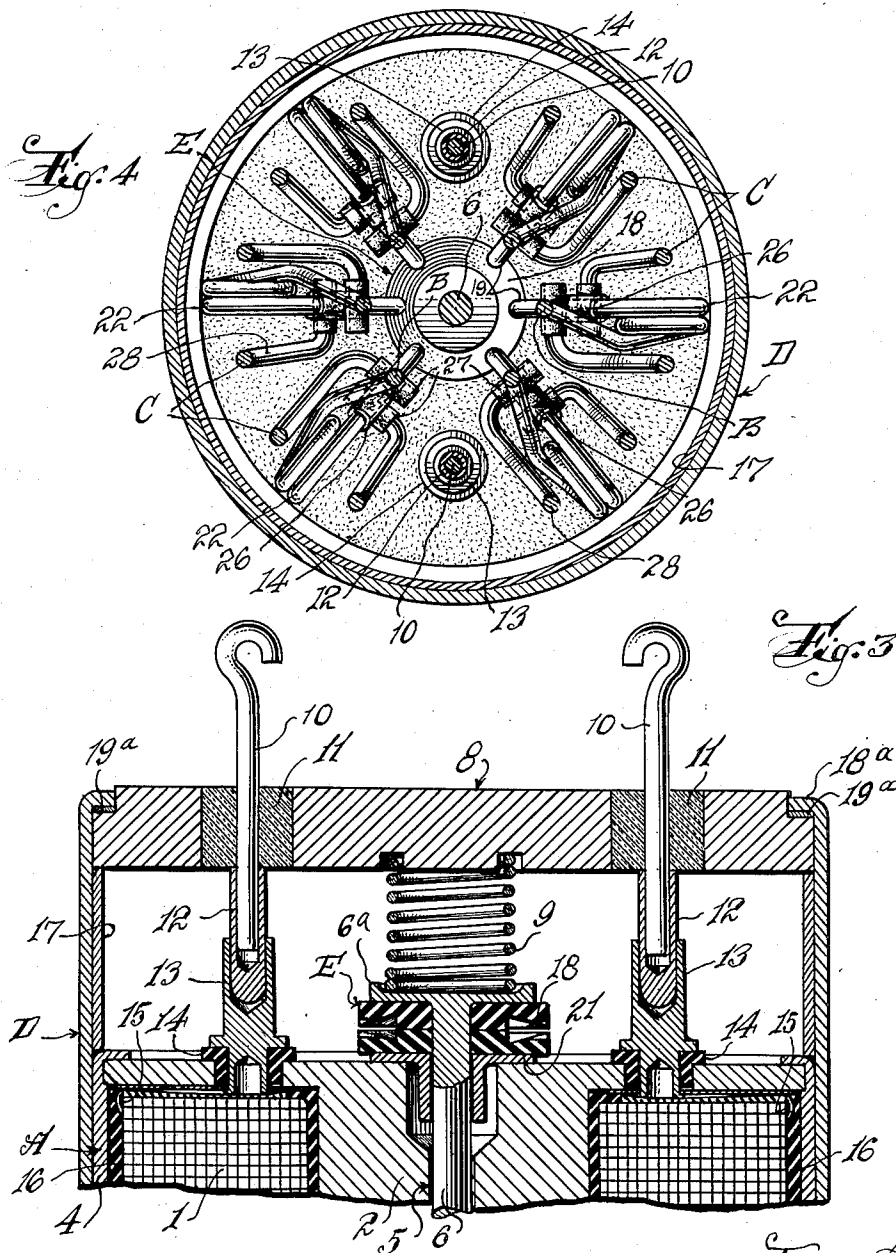
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2,866,046

RELAY WITH SELF-CLEANING CONTACT ELEMENTS

Filed March 23, 1956

3 Sheets-Sheet 3



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1

2,866,046

## RELAY WITH SELF-CLEANING CONTACT ELEMENTS

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Application March 23, 1956, Serial No. 573,379

14 Claims. (Cl. 200—164)

This invention relates in general to relays which include switch contact elements at least one of which is actuated by a prime actuating mechanism such as an electromagnetic device, so as to cause engagement and disengagement of said contact elements and thereby close and open a circuit, respectively, and the invention is especially useful in relays for low voltage, low current electrical circuits.

One object of the invention is to provide a relay of this character which shall embody switch contact elements constructed and combined so that said contact elements shall have a sliding engagement in a novel and improved manner as they are moved into and out of contact, whereby the contact surfaces shall be kept clean and free from foreign matter such as oxides, grease and dust.

Another object is to provide such a relay which shall be simple, small, compact, rugged and positive in operation.

Another object is to provide a relay which shall have uniform contact resistance, even when used in low current and low voltage circuits, and even when subjected to severe vibration shock and extreme high and low temperatures such as might occur in an aeroplane or missile.

A further object is to provide a relay of the general character described in which at least one of the contact elements shall embody a novel and improved construction including a spring portion to provide for relative movement of the contact elements together and apart into and out of mutual contact and for relative sliding movement of said contact elements while they are in mutual contact during the engaging and disengaging operations, all with a minimum of tendency to fatigue and with adequate rigidity to obviate malfunction of the contact elements such as vibration or relative bouncing of the contact elements or such as too light or too heavy engagement of the contact elements.

Another object is to provide a novel and improved switch comprising two contact elements having relatively movable portions each of which carries a contact surface, in combination with means for mounting said elements and means movable alternately in opposite directions for relatively moving said contact surfaces into and out of mutual contact, respectively, one of said elements having its contact surface elongated and disposed obliquely to said directions of movement of the actuating means so that said contact surfaces shall have a relative sliding mutual contact with a "wedging action" under constantly increasing yielding pressure whereby said contact surfaces shall be kept clean and a positive, efficient current-conducting contact of the two surfaces shall be insured.

Other objects, advantages and results of the invention will be brought out by the following description in conjunction with the accompanying drawings in which—

Figure 1 is a top plan view of a relay constructed in accordance with the invention;

Figure 2 is a greatly enlarged central vertical sectional view approximately on the plane of the line 2—2 of Figure 1;

2

Figure 3 is a fragmentary vertical sectional view approximately on the plane of the line 3—3 of Figure 1 with the contact elements omitted;

Figure 4 is a horizontal sectional view approximately on the plane of the line 4—4 of Figure 2;

Figure 5 is a similar view approximately on the plane of the line 5—5 of Figure 2;

Figure 6 is a detached side elevation of one of the plates forming a part of the motion transmitting device between the plunger of the electromagnet and the movable contact elements; and

Figure 7 is a bottom plan view of said plate.

For the purpose of illustrating the principles of the invention, I have shown the invention embodied in a relay for controlling a plurality of circuits in response to the energization of a single operating device such as an electromagnetic mechanism; but it should be understood that the invention may be utilized in other types of relays and with single or multiple circuits.

Specifically describing the invention, the relay is shown as comprising an actuating mechanism A of generally known construction including a coil 1, a fixed core 2 and a coaxial movable core 3 arranged in a case 4 so that the movable core 3 is drawn toward the fixed core 2 upon passage of the electric current through the coil 1. The fixed core 2 has a coaxial opening 5 in which a plunger 6 is reciprocable. One end of said plunger normally abuts the movable core 3 while the other end has connected thereto a motion-transmitting device E for transmitting motion from the core 3 to a plurality of movable electrical contact elements generally designated B each of which cooperates with a pair of fixed contact elements C which in turn are secured by insulating bushings 7 in a head plate 8 which closes one end of a main can or casing D in which the electromagnetic device and the contact elements are housed. The plunger 6 is normally influenced by a compression spring 9 in the direction to actuate the movable core 3 away from the fixed core 2 when the passage of current through the coil 1 is interrupted.

The coil 1 may be connected in circuit in any suitable manner but as shown, two terminal posts 10 are mounted by insulating bushings 11 in the head plate 8 and carry pins 12 which are frictionally fitted in socket elements 13 that are in turn mounted in insulating bushings 14 in the fixed core 2 of the electromagnetic device (see Figure 3). One terminal post is connected to each terminal of the coil by a tab 15 in the usual manner. The whole coil 1 is enclosed in the usual insulating wrapper 16. The head plate 8 with the fixed contact members C thereon may be handled as a unit and easily slipped into the can D for assembly of the parts, there being a spacer sleeve 17 between the head plate and the case 4 of the electromagnetic device, and the rim portion of the can D being spun inwardly over the edge of the head plate as indicated at 18a and sealed in any suitable manner; for example with a moisture proofing substance 19a.

Now referring more particularly to the contact elements, six movable contact elements B are shown in the drawings (Figure 4) and each cooperates with two fixed contact elements C. Each movable contact element includes a spring portion 22 and an elongate contact surface 26 related to elongate contact surfaces 27 of the fixed or stationary contact elements and to the motion-transmitting device E and as best shown in Figure 2, each movable contact surface 26 is disposed obliquely to the general directions or path of movement of the actuating or motion-transmitting device in a common plane therewith and also obliquely to the general directions of movement of the contact surfaces into and out of mutual contact so that upon movement of the motion-transmitting device in either of opposite directions in a predetermined path, the contact surface of the movable

3

contact element will move toward and into contact with one of the two corresponding fixed contact elements and away from the other, and upon continued movement or "overtravel" of the motion-transmitting device in the same direction will move both transversely and longitudinally in sliding contact with the contact surface of the first-mentioned fixed contact element and under constantly increasing pressure.

Each movable contact element is shown as comprising an elongate conductor, for example, a length of resilient wire having one end slidably fitted in a guide opening 18 formed between two complementary plates 19 of insulation which are mounted in superposed relation between a head 6a of the plunger 6 and flange 21 fixedly secured to the plunger as by soldering. The openings 18 are provided by undercut notches 20 in the plates 19. The flange 21 is normally pressed against the outer end of the fixed core 2 by the spring 9, as shown in Figure 2. The spring portion of the movable contact element is shown as comprising an helical coil in the wire intermediate the ends of the contact element, and the other end of the contact element opposite the end connected to the motion transmitting device E, is fixedly connected at 23 to a terminal post 24 which is secured by an insulating bushing 25 in the head plate 8. Between the spring coil 22 and the end of the movable contact element that is connected to the motion transmitting device, is the contact surface 26, preferably cylindrical, which cooperates with the contact surfaces 27, also preferably cylindrical, of the corresponding two fixed contact elements C.

Each fixed contact element C is shown as including a length of wire having a portion 28, projecting angularly inwardly from the head plate 8 and having its end portion carrying the contact surface 27 with its axis disposed approximately perpendicularly to the portion 28 and to the axis of the contact portion 26 of the corresponding movable contact element. The contact surfaces 27 of each pair of fixed contact elements are spaced apart so that the contact surface 26 of the corresponding movable contact element is normally in contact with one of the fixed contact surfaces 27 when the electromagnet is deenergized, as shown in Figure 2; and upon energization of the electromagnet, the core 3 will drive the motion transmitting device E to actuate the movable contact element and move the movable contact surface 26 into engagement with the contact surface 27 of the other fixed contact element.

A highly important feature of the invention is that due to the spring portion 22 of the movable contact element and due to the relative movement possible between the motion-transmitting device E and the movable contact element, the movable contact surface 26 is caused to move in a direction angularly related to the general directions of movement of the contact surfaces into and out of mutual contact and to slide with a wiping action along each fixed contact surface 27 as said surfaces are moved into and out of engagement with each other. In other words, and referring particularly to Figure 2 of the drawings, when the motion-transmitting member E moves upwardly, each movable contact surface 26 will be brought into contact with the corresponding stationary contact surface 27 and then upon continuance or "overtravel" of the motion-transmitting member in said direction, said movable contact surface will slide along the fixed contact surface. During this action and referring particularly to the right hand movable contact element B in Figure 2, the oblique relation of the movable contact surface 26 with respect to the direction of movement of the motion-transmitting member E in conjunction with the spring portion 22 of the movable contact element, causes the end of the movable contact element to move to the right, the openings 18 and notches 20 in the motion-transmitting device permitting

4

this movement and also allowing slight "pivoting" of the end of the contact element with respect to the motion-transmitting device. With the movable contact surface 26 in engagement with the upper stationary contact as described, when the motion-transmitting device E is moved downwardly, a similar but reverse action takes place with the movable contact surface in contact with the lower stationary contact surface. It will also be noted that the force applied at the point of contact is greater than the force exerted by the actuating member E.

This relatively sliding engagement will reduce bouncing of the movable contact and will remove from both the fixed and the movable contact surfaces all foreign matter, such as grease, dust and oxides, the point at which the contact surfaces engage each other during the current transmission being different from the points at which the contact surfaces engage and disengage each other, thereby ensuring clean surfaces for perfect conductivity and current transmission. The movable contact surface moves both transversely and longitudinally of the fixed contact surface while said surfaces are in engagement, so as to enhance said self-cleaning operation.

It will also be observed that the movable contact element has a low spring rate, that is, the resilient force is approximately constant throughout the movement of the contact element; but at the same time there is adequate resiliency to obviate fatigue and there is sufficient rigidity to prevent malfunction, particularly bouncing or vibration of the movable contact surface as well as too light or too heavy contact pressure. Furthermore, the holding of both ends of the movable contact element under control at the points 18 and 23, as well as the frictional resistance incident to the sliding contact of the movable and fixed contact surfaces, tend to improve operation under vibration.

As hereinbefore indicated, it is preferable to electroplate the contact surfaces 26 and 27 of the respective conductors, thereby to ensure a positive and permanent connection of the contact surfaces to the conductors, in contrast to soldering of contact points on contact elements, and at the same time ensure uniform contact resistance and substantially perfect electrical conductivity between the contacting surfaces.

It is desirable to electroplate one or more layers of a suitable metal or metals on the elongate conductors. One example is to first electroplate an initial layer of silver on the wire and then electroplate a finishing layer of gold of a thickness, for example, of .002 inches. The gold layer has been found to be excellent for use with low current because it has a minimum of tendency to tarnish and will not burn away. If the gold layer should burn away under exceptionally high current, then the silver layer would continue to carry the high current without difficulty.

While I have shown and described the invention as embodied in certain structural details, it will be understood that this is primarily for illustrating the principles of the invention and that many modifications and changes in the construction of the relay may be made within the spirit or scope of the invention. For example, while the helical coil spring in a length of wire appears to be preferable, other types of springs, contact configurations and conductors are contemplated and other means than the particular motion-transmitting device E and the plunger 6 might be utilized for actuating the movable contact elements.

What I claim is:

1. An electric switch including two contact elements having relatively movable portions each of which carries a contact surface, means mounting said elements and actuating means movable alternately in opposite directions and connected to at least one of said elements for

5

relatively moving said contact surfaces into and out of mutual contact, respectively, one of said elements having its contact surface elongated and disposed obliquely to said directions of movement of the actuating means, said mounting means and said actuating means providing for overtravel and relative sliding of said contact surfaces after movement thereof into mutual contact, and there being resilient means associated with at least one of said contact elements providing for mutual contact of said contact surfaces with a wedge action under constantly increasing yielding pressure during said relative sliding of the contact surfaces, said one contact element having one end movable relatively to its other end and toward and away from said portion of the other contact element, and said resilient means comprising a spring portion in said one element intermediate the ends thereof, said oblique contact surface being located between said spring portion and the first-mentioned end of said one element, and said actuating means being connected to said first-mentioned end of said one element.

2. An electrical switch as defined in claim 1 wherein the other contact element and the second-mentioned end of said one contact element are fixed.

3. An electric switch as defined in claim 2 wherein said one element comprises a wire and said spring portion constitutes a helically coiled portion of said wire.

4. An electric switch as defined in claim 3 wherein the other contact surface is elongated and is disposed transversely of said contact surface of said one element.

5. An electric switch including two contact elements having relatively movable portions each of which carries a contact surface, means mounting said elements and actuating means movable alternately in opposite directions and connected to at least one of said elements for relatively moving said contact surfaces into and out of mutual contact, respectively, one of said elements having its contact surface elongated and disposed obliquely to said directions of movement of the actuating means, said mounting means and said actuating means providing for overtravel and relative sliding of said contact surfaces after movement thereof into mutual contact, and there being resilient means associated with at least one of said contact elements providing for mutual contact of said contact surfaces with a wedge action under constantly increasing yielding pressure during said relative sliding of the contact surfaces, said one contact element having one end movable relatively to its other end and toward and away from said portion of the other contact element, and said resilient means comprising a spring portion in said one element intermediate the ends thereof, said oblique contact surface being located between said spring portion and the first-mentioned end of said one element, and said actuating means being connected to said first-mentioned end of said one element, with the addition of a support in which said actuating means is movably mounted and to which said stationary contact element and the second-mentioned end of said other contact element are connected, and wherein said connection between said actuating means and said first-mentioned end of said one element provides for positive movement of said first-mentioned end of said one element in said directions under control of said actuating means and for movement of said one element relatively to said actuating means in all other directions under influence of the wedge action of said oblique contact surface during said relative sliding of said contact surfaces.

6. An electric switch including two contact elements each of which has a contact surface which on at least one element is elongated, means mounting said elements and actuating means connected to at least said one of said elements and movable alternately in opposite directions, providing for relative movement of said contact surfaces into and out of mutual contact, respectively, and for overtravel after such mutual contact, there being con-

6

nections of said one element to said actuating means and to said mounting means at opposite sides of said elongated contact surface so that movement of said elongated contact surface is controlled between said connections, said connections and said one of said elements providing for movement of said elongated surface thereof in a direction angularly related to the general directions of movement of said contact surfaces into and out of mutual contact, said elongated contact surface being oblique to said general direction of movement thereof toward and from the other contact surface, whereby said elongated contact surface of said one element has continuous sliding contact with the other contact surface during said overtravel of said contact surfaces which is a function of said controlled movement of said elongated contact surface.

7. An electric switch including two contact elements each of which has a contact surface which on at least one element is elongated, means mounting said elements and actuating means connected to at least said one of said elements and movable alternately in opposite directions providing for relative movement of said contact surfaces into and out of mutual contact, respectively, and for overtravel after such mutual contact, and resilient means associated with said one of said elements, there being connections of said one element to said actuating means and to said mounting means at opposite sides of said elongated contact surface so that movement of said elongated contact surface is controlled between said connections, and said resilient means being connected to said one element between said elongated contact surface and one of said connections, thereby providing for resiliently yieldable movement of said elongated contact surface in a direction angularly related to the general direction of movement, said elongated contact surface being oblique to said general direction of movement thereof toward and from the other contact surface whereby said elongated contact surface of said one element has sliding contact with the other contact surface with a wedge action under constantly increasing yielding pressure which is a function of said controlled movement during said overtravel after movement of said contact surfaces into mutual contact.

8. An electric switch including two contact elements each of which has a contact surface which one element is elongated, means mounting said elements and actuating means having an actuating connection with at least said one of said elements at one side of said elongated contact surface and movable alternately in opposite directions providing for relative movement of said contact surfaces into and out of mutual contact, respectively, and for overtravel after such mutual contact, and resilient means associated with said one of said elements at the side of said elongated contact surface opposite said actuating connection, said one element being anchored against movement in said directions at a point on the side of said resilient means opposite said elongated surface so the movement of said elongated surface toward and from the other contact surface is controlled between said actuating connection and said anchor point, and said resilient means providing for resiliently yieldable movement of said elongated contact surface in a direction angularly related to the general directions of movement of said contact surfaces into and out of mutual contact, said elongated contact surface being oblique to said general direction of movement thereof toward and from the other contact surface whereby said elongated contact surface has sliding contact with the other contact surface with a wedge action under constantly increasing yielding pressure which is a function of said controlled movement during said overtravel after movement of said contact surfaces into mutual contact.

9. An electric switch as defined in claim 6 wherein said one element comprises a wire and said resilient means consists of an helically coiled portion of said wire.

10. An electric switch as defined in claim 6 wherein

7

said one element comprises a wire having an helically coiled portion between said elongated contact surface and the connection of said one element to said mounting means.

11. An electric switch including two contact elements having relatively movable portions each of which carries a contact surface, means mounting said elements and actuating means movable alternately in opposite directions in a predetermined path and connected to at least one of said elements for relatively moving said contact surfaces into and out of mutual contact, respectively, each of said elements having its contact surface elongated and one contact surface being disposed obliquely to said path of movement of the actuating means and in a common plane therewith, said mounting means and said actuating means providing for over-travel and relative sliding of said contact surfaces after movement thereof into mutual contact, and there being resilient means associated with at least one of said contact elements providing for mutual relative sliding contact of said contact surfaces transversely and longitudinally of said elongated surfaces, with a wedge action under constantly increasing yielding pressure during overtravel of said contact surfaces after mutual contact thereof.

12. An electric switch as defined in claim 6 wherein one of said connections provides for positive movement of said one element in said general directions into and out of contact with the other element under control of said actuating means, and the other of said connections provides for movement of said one element and said elongated contact surface in directions angularly related to said general directions of movement, under the influence of the wedge action of said oblique elongated contact surface during said relative sliding of said contact surfaces.

13. An electric switch including two contact elements each of which has a contact surface, means mounting said

8

elements and actuating means connected to at least one of said elements and movable alternately in opposite directions, providing for relative movement of said contact surfaces into and out of mutual contact, respectively, and for overtravel after such mutual contact, one element being connected to said actuating means and to said mounting means at opposite sides of the corresponding contact surface so that movement of said contact surface is controlled between said connections, one of said contact surfaces being elongated and oblique to the general directions of movement of said contact surfaces into and out of mutual contact, and one element and the connections of said elements to said mounting means and to said actuating means providing for resiliently yieldable movement of the corresponding contact surface relatively to said connections in a direction angularly related to said general directions of movement so that said contact surfaces during said overtravel thereof have continuous relatively slidable contact with a wedging action under constantly increasing pressure which is a function of said controlled movement of the contact surface of said contact element that is connected to said actuating means.

14. An electric switch as defined in claim 13 wherein one element comprises a wire having a helically coiled portion between the corresponding contact surface and the connection of said element to said mounting means.

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