June 10, 1958 A. HUFNAGEL 2,838,631

ELECTRICAL RELAYS

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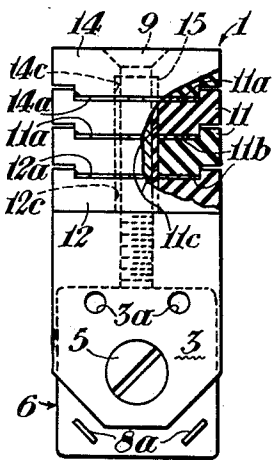


Fig. 1.

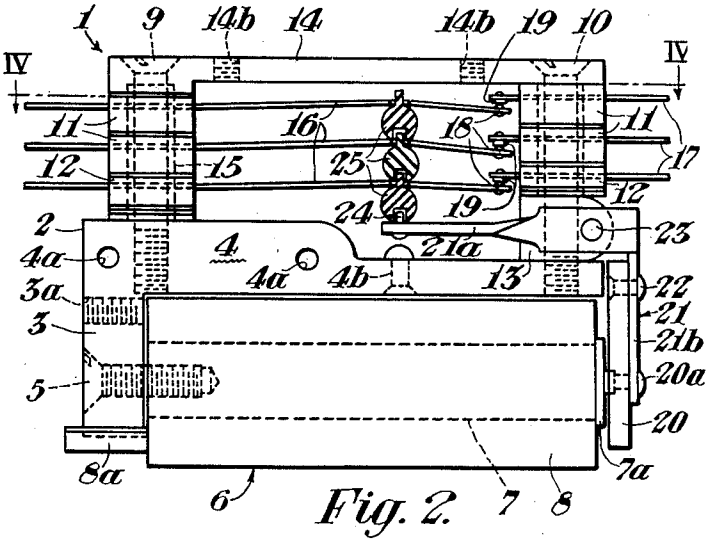


Fig. 2.

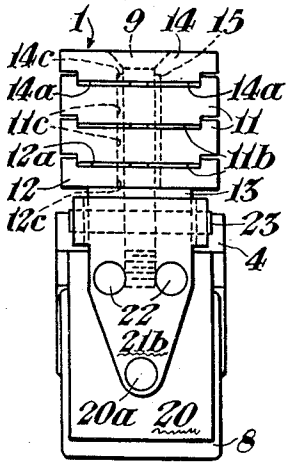


Fig. 3.

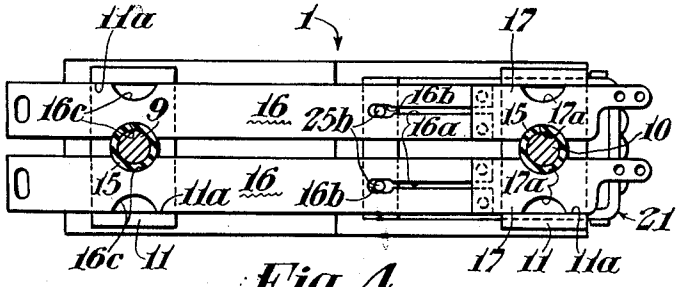


Fig. 4.

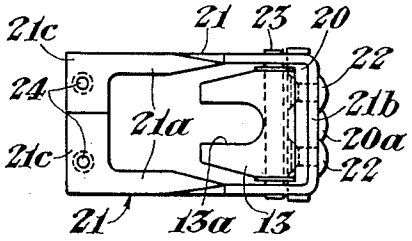


Fig. 5.

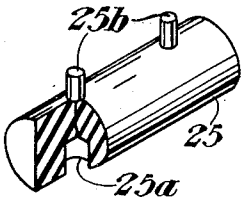


Fig. 6.

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ELECTRICAL RELAYS

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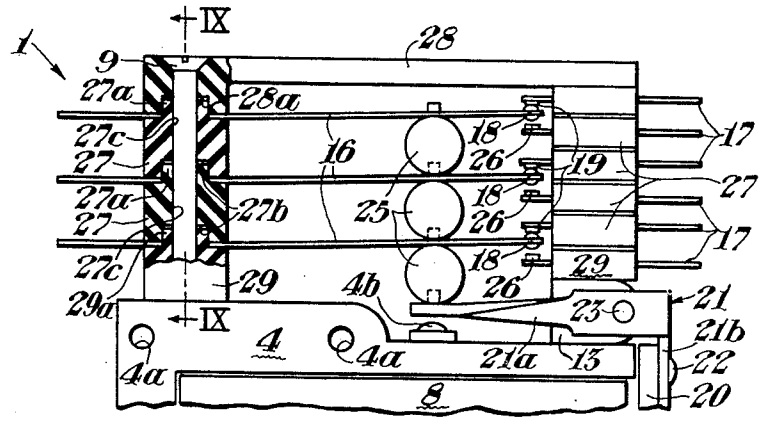


Fig. 7.

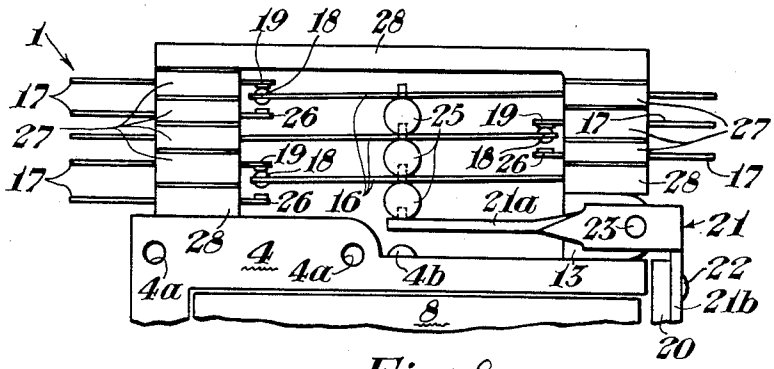


Fig. 8.

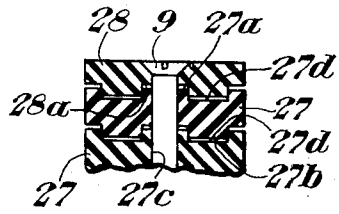


Fig. 9.

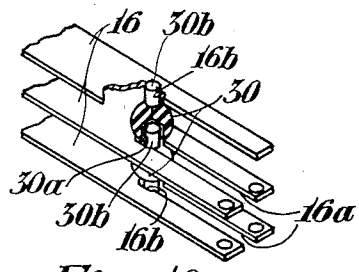


Fig. 10.

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ELECTRICAL RELAYS

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Application February 1, 1955, Serial No. 485,427

12 Claims. (Cl. 200—104)

My invention relates to electrical relays, and particularly to a contact structure for an electrical relay.

In certain forms of prior art relays, the contact structure comprises a stack of spring contact fingers and a contact actuator operated by or forming a part of the relay armature. The stacks of contact fingers normally comprise a plurality of contact fingers separated by contact spacers of insulating material, the contact stacks being secured by two or more screws to the relay frame. In such arrangements of the contact stacks, the contact fingers must be secured against misalignment and this requires the use of complex structures requiring several screws or bolts to provide the necessary clamping and securing action for the contact fingers. The structures of the contact stacks of prior art relays are such that any change in the type of contacts provided for the relay, or any change in the number of contact combinations, requires the substitution of entirely new contact stacks to provide the type or combination of contacts desired. To make the necessary changes in the contact stacks also requires a major change in the contact actuator provided for the relay contacts. In prior art relays, the contact actuators are for the most part designed for a particular stack of contacts, such contact actuators tending to create friction in their engagement with the contact fingers, thereby decreasing to a great extent the sensitivity and reliability of the calibration of the particular relay. The problem created by the contact actuator friction in prior art relays is further increased in the development and construction of accurate miniature relays.

It is therefore an object of my present invention to provide a relay contact structure of extremely compact design which may be readily assembled and disassembled and wherein any type or combination of contact fingers may be readily provided by the simple expedient of mounting such contact fingers in the stacks and adding to the contact actuator of the relay the necessary engaging elements for actuating the contact fingers.

Another object of my invention is to provide a contact actuator for relay contacts having rolling contact surfaces for the elimination of friction between the contact fingers of the relay and the actuator and the elimination of friction in the contact actuator linkage.

According to my invention, the contact structure provided for a relay includes nested contact spacers of insulating material, each of the spacers being provided with a suitable groove for receiving horizontally spaced contact fingers. Each of the spacers is formed with a dependent rib which is received within the groove of a lower spacer. A single bolt suitably insulated either by way of a sleeve of insulating material or by way of bosses and counterbores provided on the spacers, is used to hold the stacked contact fingers in alignment, the nested arrangement of the spacers locking the contact fingers in alignment. The contact actuator provided by me for the stacked contact fingers includes rollers of insulating material, each roller being formed with a pair of spaced openings and a pair of spaced pins extending diametrically

opposite the openings. The arrangement of the rollers is such that the pins of one roller pass freely through suitable openings in a bank of spaced contact fingers and are received with clearance in the spaced openings of the next roller. The contact fingers provided are preset or tensioned to engage and hold the rollers together, the cumulative force of the contact fingers being used to restore the actuating armature of the relay to its initial positon upon deenergization of the operating windings of the relay. The contact spring force for restoring the armature to its deenergized position permits operation of the relay in any position. In another form of my invention, a relay having a single tier of contacts is provided with an articulated contact actuator comprising a plurality of spherical members, each member being formed with an opening and a pin extending diametrically opposite the opening.

Other objects and characteristic features of my invention will become apparent as the description continues.

I shall describe several forms of a relay embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, wherein similar reference characters refer to similar parts in each of the several views,

Fig. 1 is an end elevational view of a relay embodying my invention.

Fig. 2 is a side elevational view of the relay embodying my invention, portions thereof being shown in cross section.

Fig. 3 is a front end view of the relay illustrated in Figs. 1 and 2.

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 2.

Fig. 5 is a top plan view of the armature assembly of the relay and the mounting of the armature on a hinge block.

Fig. 6 is an isometric view of a roller forming a part of the contact actuating mechanism of the relay, a portion of the roller being broken away for illustrating to better advantage the details of its construction.

Fig. 7 is a side elevational view of a relay contact structure embodying my invention, a portion thereof being shown in cross section.

Fig. 8 is a side elevational view of another relay contact structure embodying my invention.

Fig. 9 is a fragmentary sectional view taken along the line IX—IX of Fig. 7, while

Fig. 10 is an isometric view of a ball type contact structure for a relay, portions thereof being broken away to illustrate the construction thereof to better advantage.

Referring now in detail to Figs. 1 to 6 of the drawings, the reference numeral 1 designates a relay embodying one form of my invention. The relay 1 comprises a magnetizable, L-shaped frame member 2 formed with a vertical arm 3 and a horizontal arm 4. The vertical and horizontal arms 3 and 4 of the relay are provided with threaded openings 3*a* and 4*a*, respectively, for mounting the relay 1 to a panel or suitable support (not shown). Secured to the vertical arm 3 of the magnetizable frame member, as by a magnetizable bolt 5, is an operating coil structure 6 comprising a magnetizable core 7 and a winding 8, the core 7 terminating at its free end in a pole face 7*a*. The ends of the operating winding 8 are secured to terminal prongs 8*a* to which circuit connections are made in the usual manner.

Secured to the top surface of the horizontal arm 4 of the L-shaped frame member, as by bolts 9 and 10, are a plurality of nested contact spacers 11 and 12, a hinge block 13 and a U-shaped yoke member 14; the spacers, block and yoke member being made of suitable insulating material. The contact spacers 11 and 12 are formed with

longitudinal grooves or slots 11*a* and 12*a*, respectively, on their top surfaces while the bottom surfaces of the spacers 11 are formed with depending sections or ribs 11*b* which nest within the grooves 11*a* and 12*a* of the contact spacers when the spacers are stacked as illustrated. The bottom surfaces of the contact spacers 12 are flat. The yoke member 14 is also formed with a dependent section or rib 14*a* which nests in the grooves 11*a* (or 12*a*) of the spacers. The U-shaped yoke member is also provided with threaded openings 14*b* for securing the relay to a bracket or frame (not shown). The contact spacers 11 and 12, and the yoke member 14 are provided with bolt openings 11*c*, 12*c* and 14*c*, respectively, for the bolts 9 and 10, the bolts being insulated for purposes hereinafter appearing by sleeves 15 of suitable insulating material. The hinge block 13 is substantially U-shaped (Fig. 5) and is provided with a slot 13*a* to accommodate the bolt 10, the slot 13*a* permitting a slight adjustment of the contact actuating arm as will hereinafter appear.

Received within the grooves 11*a* and 12*a* of the contact spacers are spaced spring contact fingers 16 supported by the spacers secured by bolt 9, and spaced stationary contact fingers 17 supported by the spacers secured by bolt 10. The contact fingers 16 are provided with a longitudinal groove 16*a* (Fig. 4) terminating in an opening 16*b* for reasons hereinafter appearing, the bifurcated ends of the fingers having secured thereto suitable electrical contacts 18. The spring contact fingers 16 are further formed with arcuate notches 16*c* in opposite sides of the fingers, the notches being such to accommodate the sleeve 15 used for insulating the bolt 9 when the contact fingers are received within the grooves 11*a* and 12*a* of the contact spacers. The spring contact fingers 16 fit snugly within the grooves 11*a* and 12*a* of the spacers between the edges of the grooves and the sleeve 15 and are locked in place by the depending ribs 11*b* of the nesting spacer 11 or the rib 14*a* of the yoke member. The contact fingers 17 are also formed with arcuate notches 17*a* to engage the sleeve 15 insulating the bolt 10 when received within the grooves 11*a* and 12*a* of the contact spacers, the contact fingers fitting snugly in the grooves of the spacers and locked in place by the nesting spacer or yoke member. Electrical contacts 19 are provided for the ends of the fingers 17 for engagement by the contacts 18 on fingers 16. The relay 1 is illustrated in its energized condition to facilitate the drawings, the front contacts 18–19 being shown closed in Fig. 2.

It will be apparent from the description of the contact structure that an extremely simple and compact arrangement has been provided for mounting the relay contacts. The contact spacers which are used for holding the spring contact fingers and the stationary contact fingers are the same, the spacers 12 differing from the spacers 11 in the provision of a flat supporting surface instead of the depending nesting portion. The arrangement of the contact stacks is such that any combination of front and/or back contacts may be readily provided as illustrated for example in Figs. 7 and 8, the number of such combinations being readily changed by adding or subtracting the desired contact fingers and contact spacers. The nested arrangement of the contact spacers not only provides a very compact assembly but also locks the contacts in place and prevents turning or misalignment of the contact fingers despite the single bolt used to secure the stacked contacts to the frame member.

To actuate the stacked contact assembly described in response to energization and deenergization of the operating winding 8, there is provided a magnetizable armature 20 secured to a pivoted bell crank 21. The bell crank 21 (Fig. 5) is made of nonmagnetic material and comprises two spaced, horizontal arms 21*a* joined at the outer ends by a dependent tongue 21*b* and at their inner ends by horizontal surfaces 21*c*. The armature 20 is secured to the dependent tongue 21*b* by rivets 22 and by a core pin 20*a*. The arms 21*a* of the bell crank will hereinafter be referred to as contact actuating arms 21*a*. The bell crank 21 is pivoted on a pin 23 which is pressed through the hinge block 13 secured to the horizontal frame arm 4 by the bolt 10. Secured to the inner ends of the contact actuating arms 21*a* of the pivoted bell crank are upright pins 24.

Supported on the pins 24 of the contact actuating arms is a roller 25 (Fig. 6) of insulating material. The roller 25 is formed with two spaced openings 25*a* for receiving the upright pins 24 with some clearance. The roller 25 is further provided with spaced projections or pins 25*b* diametrically opposite the openings 25*a*. The pins 25*b* of the roller are adapted to pass freely through the openings 16*b* provided in the spring contact finger 16, the contact finger abutting the roller 25. Additional rollers 25 are interposed between the contact fingers 16 of the contact assembly, the pins 25*b* of the lower roller after passing through the opening 16*b* of the contact fingers being received with some clearance by the openings 25*a* of the upper roller to form an articulated contact actuator for actuating the double tier of spring contact fingers in response to the energization and deenergization of the relay operating winding 8. It will be readily apparent that a plurality of tiers of contact fingers may be actuated by my novel articulated contact actuated by increasing the number of pins and openings provided on the rollers 25.

The operation of the relay 1 illustrated in Figs. 1 to 6 of the drawings is obvious, the energization of the operating winding 8 causing the armature and contact actuating arms 21*a* to pivot clockwise about the pivot pin 23 to the position illustrated in Fig. 2 to lift the articulated contact actuator formed by the rollers 25 to close the front contacts 18—19. Deenergization of the relay operating winding 8 will permit the front contacts 18—19 to open, the spring force of the contact fingers 16 serving as the restoring force to return the armature 20 to its deenergized position, this spring force being such that the relay 1 may be mounted and properly operated in any position. It will be appreciated that each of the spring contact fingers must be adjusted to exert a downward force against the roller below it. These forces keep the actuator elements in engagement and the sum of these forces is the total force which causes the armature to release when the operating coil is deenergized. The armature opening or total stroke is determined by the height of a back stop pin 4*b* secured in frame arm 4, the height of the back stop pin being determined by the contact arrangement provided for the relay.

It will be apparent that the slotted opening 13*a* provided in the hinge block 13 will permit a slight adjustment of the armature assembly pivoted thereto. Since the hinge block is securely clamped between the horizontal arm of the frame member and the contact spacer 12 by the bolt 10, the hinge block will not turn or be displaced. Any tendency for the hinge block to turn or move would be checked by the connection to the locked-in contact fingers through the pins 24 provided on the contact actuating arms 21*c* of the armature assembly.

In Figs. 7 and 8 I have illustrated relays embodying my invention wherein different contact arrangements are provided. In Fig. 7 I have illustrated a relay contact structure wherein front contacts 19 and back contacts 26 are provided for the relay 1, the front contacts 18—19 being closed. Fig. 8 illustrates a contact assembly for the relay 1 in which spring contact fingers and stationary contact fingers are secured and locked in the same stacks, the articulated contact actuator provided by the rollers 25 engaging and actuating the spring contact fingers of both stacks in the manner heretofore described.

In Figs. 7 and 9 of the drawings I have illustrated by way of sectional views another form for the interlocking spacers 27 provided for the contact fingers 16 and 17 of the relay illustrated in Figs. 7 and 8. In this alternate form, the spacers are provided with interlocking bosses 27*a* on the top surfaces and counterbores 27*b* on the bot-

tom surfaces about the bolt opening 27c provided for the securing bolt 9 (or 10). This particular construction insulates the screw from the contact fingers received within the grooves 27d of the spacers and eliminates the need for the insulating sleeve 15 illustrated in Figs. 1 to 4. A U-shaped yoke member 28 secured to the tops of the two stacks is provided with nesting counterbores 28a for receiving the bosses 27a of the top contact spacer 27. The bottom spacer 29 is provided with a boss 29a for nesting in the counterbore 27b of the first spacer 27.

In Fig. 10 I have illustrated an articulated contact actuator for a single tier of spring contact fingers 16, the actuator comprising spherical insulating members 30 formed with an opening 30a and provided with a projecting pin 30b diametrically opposite the opening 30a. As in the case of the rollers 25, the opening 30a of the lowermost member receives with some clearance a pin 24 secured to the contact actuating arm of the armature assembly, the pin 30b of the lowermost spherical member passing freely through the opening 16b provided in the spring contact finger to register in the opening 30a of the next spherical member 30 with some clearance.

It will be readily appreciated that the rollers 25 and/or the spherical members 30 forming the novel articulated contact actuators are free to rotate within the limits set by the clearances provided for the registering pins. Due to the rolling contact surfaces of the rollers and spherical members there is practically no friction in the linkage thus provided, there bing only a line contact or point contact between the rollers and spherical members, respectively, with the spring contact fingers. The linkage friction in prior art relays is extremely objectionable since it accumulates with the number of contacts in the stacks and tends to destroy the sensitivity and reliability of the relay calibration. The interlocking pins and openings of the rollers besides keeping the rollers in place also provide an additional safeguard against horizotnal misalignment of the contact spring fingers.

The articulated contact actuator and the nested contact spacers provided by me for the relay 1 are extremely advantageous in the manufacture of miniature relays. The dimensions of the relay illustrated in the accompanying drawings are approximately 1¼ inches high, ½ inch wide, and 1 1/16 inches long. The nested contact spacers permit, within limits, close spacing of the contact fingers insulated from each other and locked against misalignment by the provision of the nesting surfaces of the spacers. The contact spacers herein provided may be readily assembled and disassembled by the manipulation of a single bolt, the number of contact fingers being readily increased or decreased according to the predetermined need. The contact actuator comprising the rollers or the spherical members also lends itself to the compact and simple design of the described relay. As the number of contact fingers of the stack is increased or decreased, rollers or spherical members may be added or removed from the articulated contact actuator. While the relay herein illustrated is primarily of the miniature type wherein the problem of actuator friction is of prime importance in the accuracy and calibration of the relay, it will be appreciated that the novel details herein described may be used to advantage in relays of other types.

Athough I have herein shown and described several forms of a relay embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form banked tiers of electrical contacts, a yoke member interconnecting the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, and a plurality of members of insulating material interposed between said spring contact fingers, each of said members having rolling surfaces engaging said contact fingers, said members being provided with extending pins and openings for interconnecting said members in an articulated actuating linkage, said armature moving said articulated linkage to actuate said contacts.

2. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form banked tiers of electrical contacts, a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, and a plurality of rollers of insulating material interposed between said spring contact fingers, each of said rollers having a line engagement with said contact fingers, said rollers being provided with extending pins and openings for interconnecting said rollers in an articulated actuating linkage, said armature moving said articulated linkage to actuate said contacts.

3. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form banked tiers of electrical contacts, a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, and means movable by said armature for actuating said electrical contacts.

4. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, each of said spacers being formed with a groove and boss on one surface thereof and a rib and a counterbore on the opposite surface to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves between the bosses and the edges of the grooves to form banked tiers of electrical contacts, a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack passing through an opening in the counterbores and bosses to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, and means movable by said armature for actuating said electrical contacts.

5. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of contact spacers of insulating material arranged

in spaced stacks on said frame, one of said stacks including a hinge block, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers to form banked tiers of electrical contacts, said spring contact fingers being formed with an opening; a yoke member interconnecting the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, said armature including contact actuating arms, a pin in said contact actuating arms for each tier of contacts, a plurality of rollers of insulating material interposed between said contact fingers, each of said rollers being provided with an extending pin for each tier of contacts and formed with an opening diametrically opposite each of the pins, said openings being adapted to receive the contact actuating arm pins and the pins of the other rollers with some clearance, the contact actuating arm pins registering in the openings of one of said rollers, the extending pins of said one roller and the pins of the other rollers extending through the spring contact finger openings with some clearance, the pins of said rollers being received by the openings of the next succeeding roller to form an articulated contact actuator for opening and closing said contact fingers in response to armature movement upon energization and deenergization of the operating winding of the relay.

6. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form a tier of electrical contacts, each of said spring contact fingers being formed with an opening; a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame; a magnetizable armature pivoted to said hinge block, said armature including a contact actuating arm, a pin in said contact actuating arm, and a plurality of spherical members of insulating material interposed between said contact fingers, each of said spherical members being provided with an extending pin and formed with an opening diametrically opposite the pin, said openings being adapted to receive the contact actuating arm pin and pins of the other spherical members with some clearance, the contact actuating arm pin registering in the opening of one of said spherical members, the extending pin of said one spherical member and the pins of the other spherical members extending through the spring contact finger openings with some clearance, the pins of said spherical members being received by the openings of the next succeeding spherical members to form an articulated contact actuator for opening and closing said contact fingers in response to armature movement upon energization and deenergization of the operating winding of the relay.

7. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form banked tiers of electrical contacts, each of said spring contact fingers being formed with an opening; a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame; a magnetizable armature pivoted to said hinge block, said armature including contact actuating arms, a pin in said contact actuating arms for each tier of contacts, and a plurality of rollers of insulating material interposed between said spring contact fingers, each of said rollers being provided with an extending pin for each tier of contacts and formed with an opening diametrically opposite each of the pins, said openings being adapted to receive the contact actuating arm pins and the pins of the other rollers with some clearance, the contact actuating arm pins registering in the openings of one of said rollers, the extending pins of said one roller and the pins of the other rollers extending through the spring contact finger openings with some clearance, the pins of said rollers being received by the openings of the next succeeding roller to form an articulated contact actuator for opening and closing said contact fingers in response to armature movement upon energization and deenergization of the operating winding of the relay.

8. A relay comprising a frame, a magnetizable core and an operating winding secured to said frame, a plurality of nested contact spacers of insulating material arranged in spaced stacks on said frame, one of said stacks including a hinge block, said spacers including a groove and a rib on opposite surfaces to provide interlocking elements for said spacers, a plurality of spaced spring contact fingers and stationary contact fingers interposed between said spacers and disposed within said grooves to form banked tiers of electrical contacts, each of said spring contact fingers being formed with an opening; a yoke member interconnecting and interlocked with the spaced stacks, a bolt for each stack to secure and clamp said yoke member, contact spacers, contact fingers and hinge block to said frame, a magnetizable armature pivoted to said hinge block, said armature including contact actuating arms, a pin in said contact actuating arms for each tier of contacts, and a plurality of rollers of insulating material interposed between said spring contact fingers, each of said rollers being provided with an extending pin for each tier of contacts and formed with an opening diametrically opposite each of the pins, said openings being adapted to receive the contact actuating arm pins and the pins of the other rollers with some clearance, the contact actuating arm pins registering in the openings of one of said rollers, the extending pins of said one roller and the pins of the other rollers extending through the spring contact finger openings with some clearance, the pins of said rollers being received by the openings of the next succeeding roller, said spring contact fingers being preset to provide a force for holding said rollers together to form an articulated contact actuator for actuating said spring contact fingers in response to armature movement upon energization of the operating winding of the relay, the cumulative force of said spring contact fingers restoring said armature and contact actuating arms upon deenergization of the operating winding.

9. In combination with banked tiers of spring contact fingers each of said fingers having an opening therein, a plurality of rollers of insulating material interposed between said fingers, each of said rollers being formed with a pin for each tier of fingers and provided with an opening diametrically opposite each pin, the pins of said rollers extending freely through the openings in the contact fingers and into the openings of the succeeding roller with some clearance, and means for moving the articulated element formed by the rollers.

10. In combination with banked tiers of spring contact fingers each of said fingers having an opening therein, a plurality of rollers of insulating material interposed between said fingers, each of said rollers being formed with a pin for each tier of fingers and provided with an opening diametrically opposite each pin, the pins of said rollers extending freely through the openings in the contact fingers and into the openings of the succeed-

ing roller with some clearance, said contact fingers being preset to bear against said rollers to hold the rollers together as an articulated element, and means for moving the articulated element formed by the rollers from an initial position to an operated position, the cumulative force of the preset spring contact fingers serving as a restoring force to restore the articulated element to its initial position.

11. In combination with a tier of spring contact fingers, each of said fingers having an opening therein; a plurality of spherical members of insulating material interposed between said fingers, each of said members being formed with a pin and provided with an opening diametrically opposite the pin, the pins of said members extending freely through the openings in the contact fingers and into the opening of the succeeding spherical member with some clearance, and means for moving the articulated element formed by the rollers.

12. In combination with a tier of spring contact fingers, each of said fingers having an opening therein; a plurality of spherical members of insulating material interposed between said fingers, each of said members being formed with a pin and provided with an opening diametrically opposite the pin, the pins of said members extending freely through the openings in the contact fingers and into the opening of the succeeding spherical member with some clearance, said contact fingers being preset

to bear against said spherical members to hold the members together as an articulated element, and means for moving the articulated element formed by the rollers from an initial position to an operated position, the cumulative force of the present spring contact fingers serving as a restoring force to restore the articulated element to its initial position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,521,591	Beck	Jan. 6, 1925
2,066,491	Sheatsley	Jan. 5, 1937
2,069,169	Leake	Jan. 26, 1937
2,069,171	Merkel	Jan. 26, 1937
2,259,183	Snavely	Oct. 14, 1941
2,268,161	Miller	Dec. 30, 1941
2,272,496	Wood	Feb. 10, 1942
2,385,858	Horman	Oct. 2, 1945
2,480,132	Hammond et al.	Aug. 30, 1949
2,496,917	Poitras	Feb. 7, 1950
2,500,413	Horlacher	Mar. 14, 1950
2,565,508	Lomholt	Aug. 28, 1951

FOREIGN PATENTS

591,384	Great Britain	Aug. 15, 1947
729,979	Germany	Jan. 5, 1943