

Aug. 25, 1959

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2,901,572

ELECTRICAL RELAYS

Filed Jan. 22, 1954

4 Sheets-Sheet 2

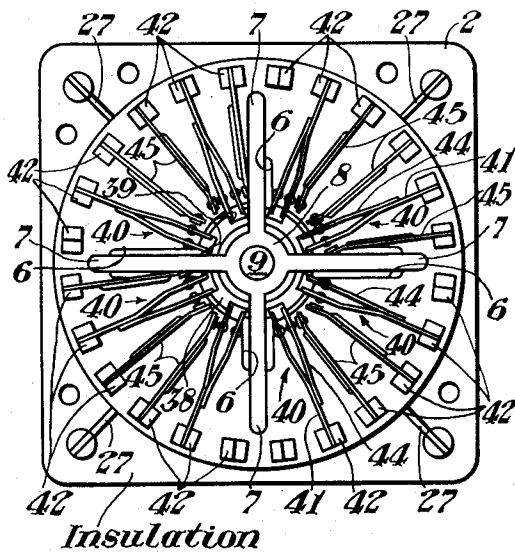


Fig. 2.

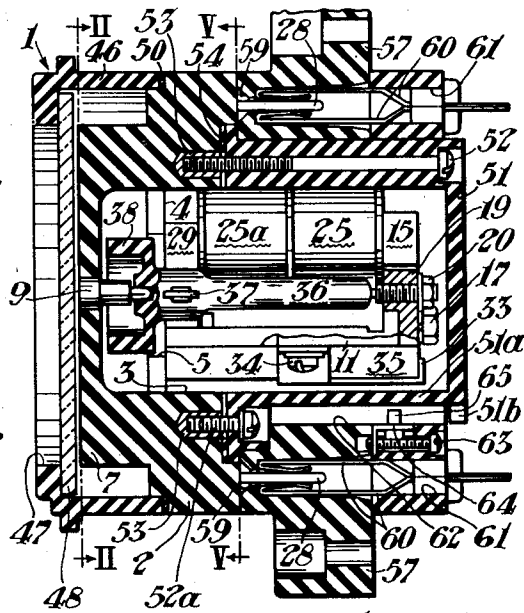


Fig. 3.

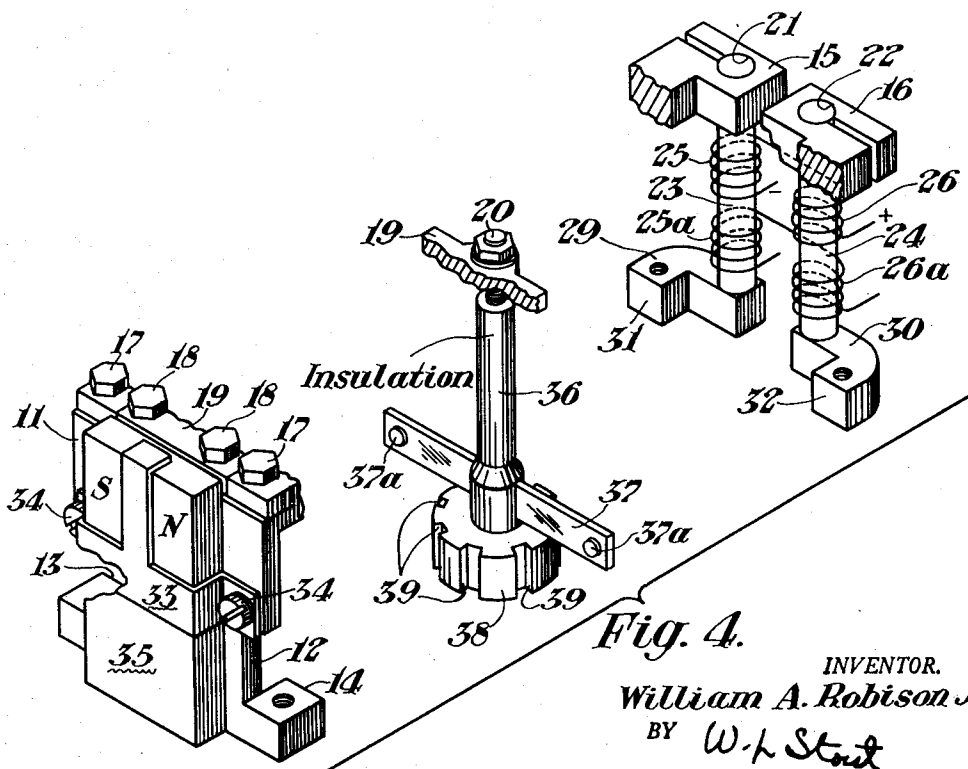


Fig. 4.

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4 Sheets-Sheet 3

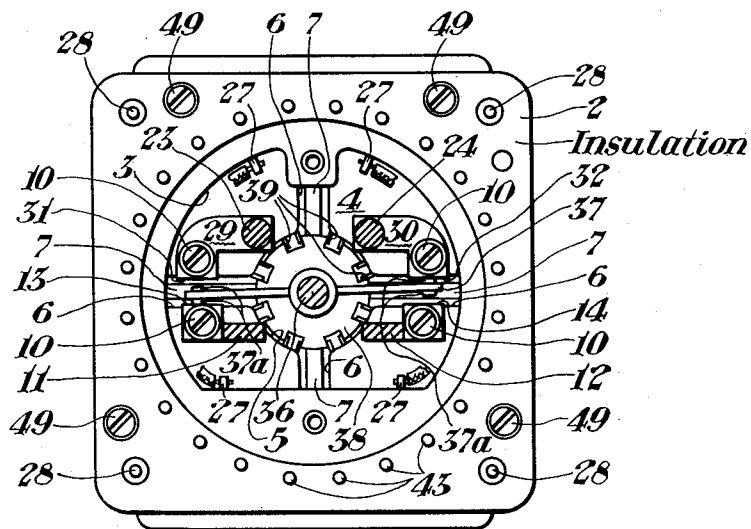


Fig. 5.

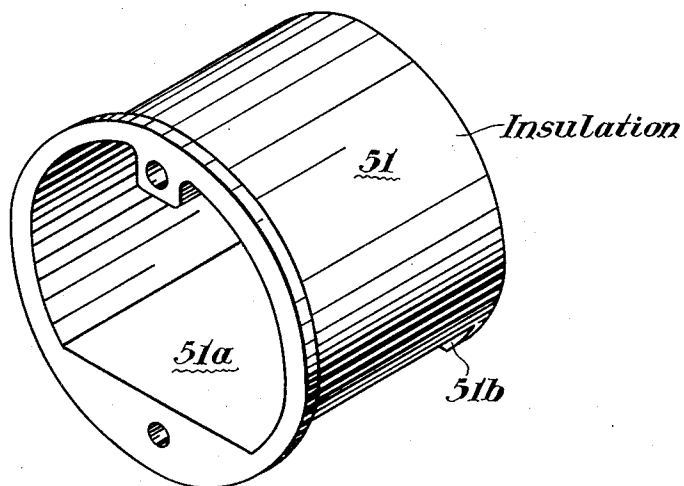


Fig. 6.

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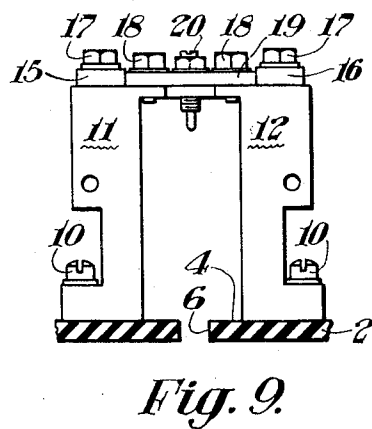
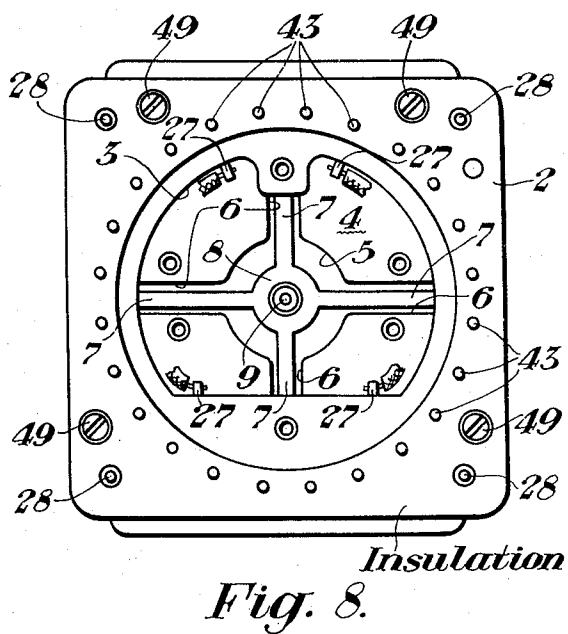
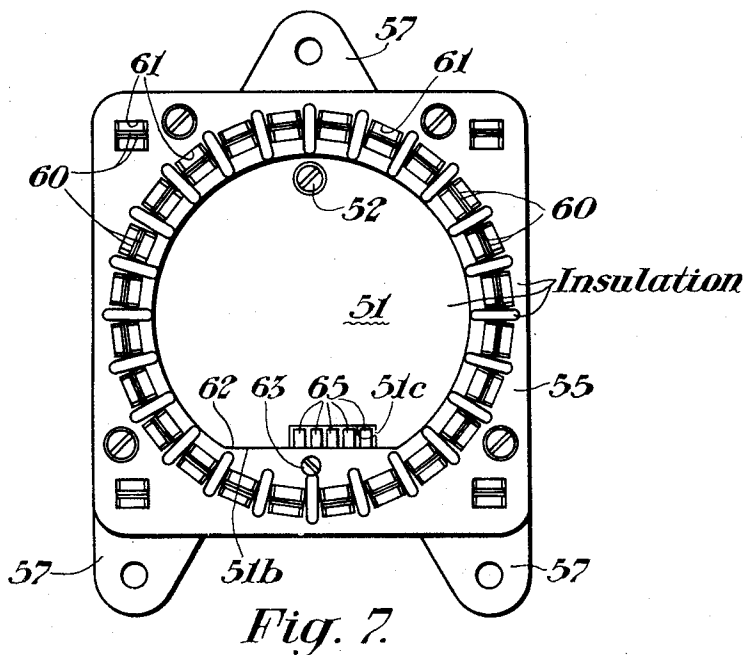
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4 Sheets-Sheet 4



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2,901,572

ELECTRICAL RELAYS

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Application January 22, 1954, Serial No. 405,566

23 Claims. (Cl. 200—93)

My invention relates to electrical relays, and particularly to polar relays for use in high speed code systems.

In high speed code systems of the type widely used for governing the movements of railway traffic, the relays employed in such systems must be designed to provide a number of characteristic features which have heretofore been incompatible. The relays employed in high speed code systems must include the operational features of sensitivity, high speed operation, and because of circuit requirements have a relatively large number of contacts so arranged and operated that contact rebound or bounce is reduced to a minimum or entirely eliminated. In relays heretofore provided, one or possibly two of these features were provided, but all of these operational features are not found in one relay.

Due to physical and electromagnetic limitations, the number of contacts a relay may operate in a dependable manner is limited. Attempts to provide additional contacts on relays have been made, but for the most part such relays require more shelf or rack space for mounting, and such relays do not operate as quickly or as efficiently as relays having a normal contact complement.

It is therefore an object of my invention to provide a novel quick-acting polar relay having a greater number of contacts than heretofore provided for relays of this type, the mounting and arrangement of the relay structure and contacts being such that the relay is of a small and compact size, the relay operating efficiently in a dependable and positive manner in use.

Another object of my invention is to provide a quick-acting polar relay in which the armature forming a part of an oscillatory armature assembly operates in a highly efficient magnetic circuit, the armature assembly being of light weight to reduce the inertia of the assembly to a minimum.

A further object of my invention is to provide a quick-acting polar relay in which voltage surges in the operating windings of the relay due to lightning or other causes will have little or no effect upon the magnetization and/or polarization of a permanent magnet provided for the relay.

Still another object of my invention is to provide a quick-acting polar relay in which contact bounce or chatter is eliminated.

In carrying out my invention, I provide a magnetic structure of low reluctance in which the leakage flux from the operating windings is minimized. In the embodiment hereinafter more fully described, two pairs of operating windings are provided for the magnetic structure so that the relay may be operated from two different remotely positioned control points if desired. The magnetic structure is such that a low reluctance path is provided for the flux due to the energized operating windings, the necessary air gaps in the magnetic path in which the armature of the relay oscillates being

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of minimum width to reduce the losses. I also provide a permanent magnet for my novel relay, the permanent magnet supplying the necessary polarizing flux. The oscillatory armature of my relay forms an integral part of a dynamically balanced armature and contact operating assembly, the assembly comprising a pivoted spindle for supporting the armature, the spindle terminating at one end in an annular contact driving member.

As will hereinafter more fully appear, the magnetic structure provided for my relay comprises two low reluctance loops substantially closed except for the small air gap provided between two opposing pole faces in each loop. The two loops of magnetizable material are mounted side-by-side, each loop supporting a similarly wound operating winding. The windings of the two loops are series-connected to the same energy source. The two magnetizable loops are magnetically interconnected by the oscillatory armature operating between the pole faces of the two loops, and by the permanent magnet which is so secured that a leg of each loop is oppositely polarized. The novel construction of the magnetic circuit provides a quick and efficiently operating armature.

A base plate of suitable insulating material is provided for the relay, the base plate having a recess in one surface in which the magnetic structure of the relay is mounted. The base plate is provided with a centrally disposed opening through which the contact actuating member of the supporting spindle extends. The contact driving member cooperates with a plurality of radially disposed movable spring finger contacts secured to the other or front surface of the base plate. The movable contacts and the stationary contacts with which the movable contacts engage in response to the oscillations of the armature are secure to terminal posts molded in the base plate, the terminal posts terminating in rearwardly extending connecting prongs.

Each of the movable contacts provided for the relay comprises an elongated spring finger to which is secured a shorter spring finger. The two fingers are initially stressed apart. The contact actuating member is formed with a plurality of slots into which the two fingers comprising a movable contact are inserted. The spring fingers forming the movable contacts are thus under tension. In the operation of the relay, the trapped pressure of the spring fingers is instantaneously transferred to the fixed contacts, thereby eliminating the tendency of the contacts to bounce.

An apertured cover member is provided for the front surface of the base plate, the aperture of the cover member being provided with a transparent member through which the operation of the contacts may be viewed. A second cover member is provided for the rear surface of the base plate, the rear cover member enclosing the magnetic elements of the relay. The fully enclosed relay unit is mounted on an apertured supporting base secured to a rack, the supporting base being provided with suitable connectors for receiving the prongs provided on the base plate. The rear cover member of the enclosed relay unit is receivable within the aperture of the supporting base, the two parts being nested to form a small compact unit requiring very little space and extending only a short distance from the front of the rack on which the relay is mounted. The mounting and support for my novel relay is characterized by two keying or indexing means provided for the assembled relay unit and the apertured supporting base. The one keying means provided insures the proper mounting of a relay unit relative to the supporting base, while the second keying means insures the mounting of a relay unit having particular operational characteristics on the supporting base.

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These and other objects and characteristic features of my invention will become apparent as the description proceeds.

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

In the accompanying drawings in which similar reference characters designate similar parts in each of the several views,

Fig. 1 is an exploded isometric view of a relay embodying my invention, portions thereof being cut away and shown in section for better illustrating the various cooperating elements.

Fig. 2 is an elevational end view of the relay taken approximately along the line II—II of Fig. 3.

Fig. 3 is a longitudinal sectional view of the relay illustrated in Fig. 1.

Fig. 4 is an isometric exploded view of the novel magnetic structure provided for the relay.

Fig. 5 is a sectional view taken approximately along the line V—V of Fig. 3.

Fig. 6 is an isometric view of the cover member for enclosing the magnetic elements of the relay.

Fig. 7 is a rear elevational view of my novel relay.

Fig. 8 is a rear view of the base for supporting the magnetic and contact structures of the relay, while

Fig. 9 is an elevational view of a portion of the magnetic structure of the relay illustrating the spacing and method of securing the magnetic members.

Referring now in detail to the drawings, the reference numeral 1 designates a relay embodying my invention. The relay 1 comprises a square base 2 made of a suitable insulating material which forms the support for the relay elements hereinafter described. The base 2 is formed with a recess 3 in the rear surface thereof, the recess having a bottom wall 4 (Figs. 5 and 8). The bottom wall is provided with a centrally disposed aperture or opening 5 and four slots 6 in a cruciform arrangement, the slots terminating in the opening 5. Integral with the front face of the base are four ribs 7 in a cruciform arrangement (Fig. 2), the ribs being spaced from but parallel to the front face of the base. The ribs 7 and slots 6 in the base are in alignment. The inner ends of the ribs 7 terminate in a bearing support 8 having a pivot bearing 9 of a nonmagnetic material molded or otherwise secured therein, the pivot bearing being in axial alignment with the opening 5 in the bottom wall 4.

Secured to the bottom wall 4 in the supporting base 2 as by nonmagnetic screws 10 are two upstanding pole members 11 and 12 of magnetizable material, the secured ends of the members being formed with pole faces 13 and 14, respectively (Figs. 1, 4, 5 and 9). The pole faces 13 and 14 are parallel with the edges of two diametrically extending slots 6 provided in the bottom wall 4, the edges of the pole faces extending slightly beyond the edges of the slots as shown in Fig. 5. Secured to the free ends of the pole members 11 and 12 are two L-shaped backstraps 15 and 16, respectively; the backstraps being of magnetizable material and secured to the pole members by nonmagnetic screws 17. For purposes hereinafter appearing, there is secured to the upper ends of the pole members 11 and 12, by nonmagnetic screws 18, a bridging member 19 of nonmagnetic material (Figs. 4 and 9), the bridging member supporting a pivot bearing 20 of nonmagnetic material which is in axial alignment with the opening 5 in the base 2 and the pivot bearing 9 on bearing support 8.

The L-shaped backstraps 15 and 16 are provided with slotted openings 21 and 22, respectively, for receiving and securing the upper ends of two magnetizable cores 23 and 24, respectively. Disposed about the cores 23 and 24 are operating windings or coils 25 and 25a and coils 26 and 26a, respectively, an end of the coils 25 and 26 and an end of the coils 25a and 26a being interconnected. The free ends of the coils are connected to circuit con-

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nectors 27 molded in the base and having exposed ends within the recess 3 (Figs. 5 and 8), the connectors terminating in rearwardly extending prongs 28 located at the corners of the base. The pair of coils on each core is similarly wound. The two pairs of operating windings supported on the cores 23 and 24 provide two independent sources of magnetizing flux for operating the relay in the manner hereinafter described. The flux due to each of the paired operating windings operates the relay in the same manner, the two pairs of connecting windings making it possible to operate the relay from two distant control points.

The magnetic cores 23 and 24 have secured to their lower ends L-shaped pole pieces 29 and 30, the pole pieces being secured to the bottom wall 4 of the base by nonmagnetic screws 10. The pole pieces 29 and 30 are provided with pole faces 31 and 32 which extend slightly over the edges of the slots 6. The pole faces 31 and 32 are parallel with the pole faces 13 and 14 provided on the pole members 11 and 12 (Fig. 5), the two pairs of opposing pole faces having small air gaps therebetween. For purposes hereinafter appearing, there is secured to the rear faces of the pole members 11 and 12, by a nonmagnetic T-shaped bracket 33 and screws 34, a permanent magnet 35 (Fig. 4). The permanent magnet is magnetized across its width, the poles of the magnet having been arbitrarily indicated in the drawings by the legends "N" and "S."

Rotatably mounted on the pivot bearings 9 and 20 is an armature driven member or spindle 36 made of a suitable insulating material, a magnetizable armature 37 being molded or otherwise secured in the lower portion of the member. The ends of the armature 37 are adapted to oscillate in the air gaps between the pole faces 13 and 31 and between the pole faces 14 and 32 upon energization of the windings 25—28 in the manner to be described. The ends of the armature are provided with the usual nonmagnetic core pins 37a to prevent sticking of the armature ends to the pole faces. The lower end of the driven member 36 is enlarged to form a contact driving member 38. The contact driving member is cylindrical in form and provided with a plurality of longitudinal slots 39 in its outer periphery. The contact driving member extends through the opening 5 provided in the bottom wall 4 of the base to drive the movable contacts designated generally by the reference character 40 which are secured to the front face of the base.

From the description of the magnetic structure provided for my novel relay, it will be noted that such structure is essentially two independent, spaced, magnetic loops, each provided with its own operating winding (or windings). Thus the pole piece 29, the core 23, the backstrap member 15, and the pole member 11 form one closed loop with the exception of the small air gap between the pole faces 13 and 31. The pole piece 30, the core 24, the backstrap 16, and the pole member 12 form the other closed loop with the exception of the small air gap between the pole faces 14 and 32. Each of the loops supports an operating winding (or windings) on its core portion, the first described loop supporting the winding 25 (and 25a) and the second described loop supporting the winding 26 (and 26a). An extremely efficient magnetic circuit is thus provided for the operating windings of the relay.

The two magnetizable loops provided for the relay are held in proper spaced relation by the nonmagnetic bridging member 19 secured to the upper ends of the pole members 11 and 12 and by the screws 10 securing the pole members and pole pieces 29 and 30 to the bottom wall 4 of the base plate. The permanent magnet is so secured that poles of the magnet engage the pole members of each magnetic loop. Thus the pole members of the loops are oppositely polarized so that the polarizing flux due to the permanent magnet will thread the armature in the same direction regardless of the extreme posi-

tion the armature takes in the air gap between the pole faces.

As previously set forth, the right-hand side of the permanent magnet 35, as viewed in Fig. 4, is assumed to be the north pole and the left-hand side to be the south pole of the magnet. Considering the core pins 37a of the armature 37 of the relay to be in engagement with the pole faces 13 and 32 as illustrated in Fig. 5 of the drawings, the polarizing flux due to the permanent magnet may be traced from the north pole of the magnet 35 through the pole member 12, the backstrap 16, through the core 24 and pole piece 30 to the pole face 32. The polarizing flux leaves the pole face 32 and passes through the armature 37 from right to left to the pole face 13, through the pole member 11 to the south pole of the magnet 35. With the armature 37 in its opposite extreme position against the pole faces 14 and 31, the polarizing flux due to the permanent magnet 35 may be traced from the north pole of the magnet through the core 12 and pole face 14, through the armature 37 to the pole face 31. The polarizing flux then threads through the pole piece 29, core 23, through the backstrap 15, the pole member 11 to the south pole of the magnet. It will be noted that, in both extreme positions of the armature 37, the polarizing flux due to the permanent magnet threads the armature from right to left under the polarity conditions assumed.

Assuming now that the armature 37 is in its first extreme position with the core pins 37a abutting the pole faces 13 and 32 and an energizing current of a polarity as indicated in Fig. 4 is applied to the ends of the paired operating windings 25 and 26, the upper ends of the cores 23 and 24 will be north poles. The magnetizing flux due to the operating winding 26 will pass upwardly through the core 24, through the backstrap 16 to the pole member 12, through the permanent magnet 35 to the pole member 11 to the pole face 13. The magnetizing flux then threads the armature 37 from left to right in opposition to the polarizing flux to the pole face 32, then through the pole piece 30 to the lower end of the core 24. The magnetizing flux due to the energized operating winding 25 will pass upwardly through the core 23, through the backstrap 15 and pole member 11 to the pole face 13, thence through the armature 37 in opposition to the polarizing flux due to the permanent magnet. A portion of the magnetizing flux due to winding 25 passes across the small air gap between the abutting end of the armature 37 to the pole face 31 of the pole piece 29, through the pole piece 29 to the lower end of the core 23. The pole faces 13 and 32 having the same polarity, due to the magnetizing flux, as the polarity of their respective abutting ends of the armature 37, due to the polarizing flux, will tend to repel the abutting ends of the armature 37. As the armature 37 is moved toward its second extreme position against the pole faces 14 and 31, the magnetizing flux due to the energized winding 26 passes from the pole face 14 through the armature 37 to the pole face 31 instead of through the permanent magnet 35 as previously described. The path of the magnetizing flux due to the energized winding 25 is also altered as the armature moves from its first extreme position against the pole faces 13 and 32; the path being from the pole member 11 through the permanent magnet 35 to the pole member 12, through the pole face 14 and thence through the armature 37 to the pole face 31. The magnetizing flux through the armature is now in the same direction as the polarizing flux. The armature 37 is thus moved to its second extreme position with a snap action when voltage of proper polarity is applied to the paired operating windings 25 and 26 (or 25a and 26a).

To move the armature 37 from its second extreme position against the pole faces 14 and 31 back to its first extreme position against the pole faces 13 and 32, a voltage of opposite polarity is applied to either of the paired operating windings. The operation of the relay when an

impulse of opposite polarity is applied to the operating windings is similar to that hereinabove described and any further detailed explanation of the operation appears unnecessary. It will be readily apparent from the foregoing description that the armature 37 will be oscillated between its two extreme positions by impulse voltages applied to the operating windings. Since the armature 37 is dynamically balanced and of extreme light weight and since the polarizing and magnetizing fluxes due to the permanent magnet and operating windings respectively are provided with magnetic paths of low reluctance with very small losses due to leakage, the armature 37 of the relay described may be efficiently oscillated at an extremely rapid rate.

The rapid oscillation of the armature 37 in the manner described will oscillate the contact driving member 38 forming an integral part of the armature assembly, to operate the movable contacts 40 secured to the front face of the base 2. Each of the movable contacts 40 (Figs. 1 and 2) comprises an elongated spring finger 41 which is secured to a terminal post 42 molded in the base 2, the terminal posts terminating in prongs 43 which extend from the back of the supporting base 2. Secured in a suitable manner to the spring finger 41 is a second spring finger 44, the ends of the two spring fingers being biased apart. In assembling the relay, the biased spring fingers 41 and 44 are pressed together and inserted into one of the longitudinal slots 39 provided in the contact driving member 38. As will hereinafter appear, the spring fingers 41 and 44 are under tension, the resulting trapped pressure of the fingers preventing contact rebound or bounce upon engagement thereof with their respective fixed contacts 45. The contacts 45 are rigid and individually secured to terminal posts 42 which terminate in extending prongs 43 heretofore described.

The pretension under which the spring fingers 41 and 44 are placed when inserted into the slots 39 provided in the contact driving member 38 eliminates contact rebound or bounce when the fingers engage the fixed contacts 45. The parts are so proportioned that the energy developed by the fast moving mass of the spring fingers is kept to a minimum so that the tendency of the spring fingers to bounce upon engagement with the fixed contacts is reduced. This tendency of the spring fingers to bounce is entirely eliminated by the trapped spring pressure of the spring fingers. The trapped spring pressure upon engagement of the spring fingers is instantaneously transferred to the fixed contacts. The spring fingers thus engage and remain in engagement with the fixed contacts so that arcing between and pitting of the contacts are eliminated. With the relay contacts closing under positive pressure without bounce, the circuits controlled by such a relay are operated in a positive and dependable manner.

In providing the radially disposed movable contacts 40 and the fixed contacts 45 I am able to incorporate in a relay of a given size many more contacts than heretofore provided in relays of the prior art. In railway signaling circuits wherein my novel relay finds many uses, the number of circuits and functions which may be controlled by the relay have been materially increased. As previously pointed out in connection with the operating windings provided for the relay, the relay described may be controlled from two distant control points. With the added number of contacts controlled by the described relay, the function of two or more relays previously required may be incorporated in a single relay of the type described.

To protect the contacts from dirt, moisture and other deleterious matter, I provide a cover member 46 having an aperture 47 therein which is sealed by a transparent window 48 through which the operation of the contacts may be observed. The cover member 46 is secured to the base 2 by means of screws 49 which are threaded from the back of the base into the cover member, a seal-

ing gasket 50 (Fig. 3) being interposed between the cover and base. I also provide a cover member 51 to protect the relay elements secured on the rear of the base 2, the cover member 51 being substantially cylindrical in form and fitting over the core structure and windings. The cover member 51 is secured to the base 2 by screws 52, 52a which are threaded into suitable inserts 53 molded into the base, a sealing gasket 54 being interposed between the cover member and the base. For purposes hereinafter appearing, the cover member 51 (Figs. 3 and 6) is formed with a flat side 51a, the cover fitting over the magnetic structure of the relay only when the side 51a is adjacent to the permanent magnet 35. The flat side 51a of the cover is provided with a dependent flanged end 51b on the rear edge which forms a part of an indexing means hereinafter described.

The fully enclosed relay structure thus described is adapted to be mounted to a supporting base 55. The supporting base 55 is made of suitable insulating material and is formed with a centrally located aperture 56 for receiving the relay elements protected by the cover member 51. The supporting base 55 is further formed with three integral mounting flanges 57 whereby the base may be mounted to a support or rack. Spaced about the perimeter of the aperture 56 of the supporting base are a plurality of countersunk openings 58 for receiving the terminal prongs 43 on the supporting base 2. Similar openings 59 are also provided in the corners of the supporting base for receiving the terminal prongs 23 for connecting the relay windings. Circuit connections to the prongs are made from the rear of the supporting base (Figs. 3 and 7) by means of clamping spring fingers 60 inserted and secured within recesses 61 provided in the back surface of the supporting base.

It will be noted that the rearwardly extending prongs 28 and 43 of the base 2 and the countersunk openings 58 and 59 of the supporting base 55 are symmetrically disposed about the longitudinal axis of the relay. In mounting an assembled and enclosed relay unit on the supporting base 55, it is possible to mount the relay unit in any one of four positions. To insure the proper positioning of a relay unit relative to the supporting base, a flat surfaced ledge 62 (Figs. 1 and 3) is provided within the aperture 56 of the supporting base. The ledge 62 in conjunction with the flanged end 51b of the cover member 51 for the relay unit forms an indexing or keying means to prevent the improper insertion of a relay unit. The cover member 51 of such a unit will be received within the aperture only if the flanged end of the cover member and the flat surfaced ledge are in juxtaposition.

In high speed code systems wherein the relay described may be advantageously employed, the relays are operated to perform various control functions in response to particular signal voltages. In such a system many of the relays may have the same operational characteristics, but many of the relays will have different operational characteristics. In order to insure the insertion and mounting of a certain type of relay unit on a particular supporting base, a second indexing or keying means is provided for my novel relay. To this end there is secured to the ledge 62, as by screws 63, an indexing member 64 having secured thereto a plurality of upright pins 65. The pins 65 are evenly spaced in line on the member 64, one or more of the pins being omitted from the line of pins in accordance with the operational characteristics of the desired relay. The pins 65 are adapted to cooperate with the flanged end 51b of the cover member 51 (Figs. 1, 3 and 7), the flanged end being provided with a notch or notches 51c to correspond to the pins 65 of the supporting base. Upon proper insertion of the relay unit cover member 51, the flanged end 51b will pass over the flat surfaced ledge 62; the pins 65 being received in the notch or notches 51c. The indexing means thus provided insures the insertion and

mounting of a relay unit having the proper operational characteristics on a particular mounting base as more fully described in Letters Patent of the United States No. 2,281,958 issued to Clarence S. Snively on May 5, 1942, for Mounting Means for Relays.

The provisions of the recessed base 2 for mounting the magnetic structure and contacts of the relay together with the front cover member 46 and the rear cover member 51 form a small compact unit wherein the operating parts of the relay are fully protected from extraneous dirt or other deleterious material. Such units may be readily assembled and stored for future use without the need for any further protection, proper installation of the relay unit being assured by the indexing means formed by notched flange end 51b of the rear cover member. The further provision of an apertured supporting base 55 for mounting the assembled unit also lends itself to compactness and reduction in size. The supporting base and relay unit form a nested assembly which protrudes but a very short distance from the support, bracket or rack to which the supporting base is secured.

The relay herein described, in addition to the features and advantages enumerated, has the additional advantages of being light in weight, compact in structure, and capable of high speed operation. Another advantage of a relay constructed in the manner described is that it is possible to inspect and observe the contacts in operation without removing the relay from service. Should a relay embodying my invention fail to function properly, the relay may be readily removed from the supporting base and another relay having the same operational characteristics substituted in its place.

Although I have herein shown and described only one form 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. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, said loops being positioned in parallel planes substantially equidistant at all points from one another, each of said loops being formed with an air gap; means for each of said magnetizable loops for at times magnetizing said loops, a pivoted armature of magnetizable material extending into the air gaps provided in each of said magnetizable loops and rotatable between two extreme positions, and a source of polarizing flux magnetically interconnecting both of said loops, said polarizing flux and the flux due to said magnetizing means having in part a common path, the polarizing flux in each of said loops being of opposite polarities.

2. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, each of said loops being formed with an air gap; an operating winding supported by each of said loops for magnetizing said loops when energized, a magnetizable armature pivoted between said loops and rotatable between two extreme positions, the ends of said armature extending into the air gaps provided in each of said magnetizable loops, and a source of polarizing flux magnetically interconnecting both of said magnetizable loops, said polarizing flux and the flux due to said magnetizing means having in part a common path, the polarizing flux in each of said loops being of opposite polarities.

3. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, said loops being positioned in parallel planes substantially equidistant at all points from one another, each of said loops being formed with an air gap; two similarly wound series-connected operating windings, an operating winding being supported on each of said loops for magnetizing said loops when said windings are energized, the magnetic flux due to the energized windings threading said loops in the same direction, a magnetizable armature

pivoted between said loops and rotatable between two extreme positions, the ends of said armature extending into the air gaps provided in each of said magnetizable loops, and a source of polarizing flux magnetically interconnecting both of said magnetizable loops, said polarizing flux and the flux due to said magnetizing means having in part a common path, the polarizing flux in each of said loops being of opposite polarities.

4. The combination as set forth in claim 3 wherein the source of polarizing flux is a permanent magnet, each pole of said magnet being in juxtaposition with one of said magnetizable loops.

5. In an electrical relay, the combination comprising a base of insulating material, two similar substantially closed loops of magnetizable material secured to the rear face of said base, each of said loops including a core and a pole member parallel to each other, and formed with an air gap between pole faces provided on adjacent ends of said core and said pole member; a similarly wound operating winding on each core, said operating windings being series-connected for connection to an energizing source of potential; a permanent magnet magnetically interconnecting the two magnetizable loops, each pole of said magnet being juxtaposed to the pole member of a loop, a nonmagnetic member interconnecting said loops, a pivot on said nonmagnetic member and on said base, a spindle of nonmagnetic material mounted for oscillation on said pivots, and a magnetizable armature supported intermediate its ends by said spindle, the ends of said armature extending into the air gaps between the pole faces of said loops.

6. An electrical relay comprising, a base of insulating material having an aperture therein, two similar substantially closed loops of magnetizable material secured to the rear face of said base, each of said loops including a core and a pole member parallel to each other, and formed with an air gap between pole faces provided on adjacent ends of said core and said pole member; a similarly wound operating winding on each core, said operating windings being series-connected for connection to an energizing source of potential; a permanent magnet magnetically interconnecting the two magnetizable loops, each pole of said magnet being juxtaposed to the pole member of a loop, a nonmagnetic member interconnecting said loops, a nonmagnetic member on said base and spaced from the front face of said base, a pivot on each of said nonmagnetic members in axial alignment with the aperture in said base, a spindle of nonmagnetic material mounted for oscillation on said pivots, a magnetizable armature supported intermediate its ends by said spindle, the ends of said armature extending into the air gaps between the pole faces of said loops, an annular contact driving member on said spindle and extending through the aperture in said base, a plurality of contact fingers radially disposed about the aperture in said base and secured at their outer ends to the front face of said base, stationary contacts disposed about the base aperture, and a plurality of slots in the periphery of said contact driving member for retaining the inner ends of the contact fingers and moving said fingers into engagement with the stationary contacts upon oscillation of said armature.

7. An electrical relay comprising, a base of insulating material having an aperture therein, two similar substantially closed loops of magnetizable material secured to the front face of said base, each of said loops including a core and a pole member parallel to each other, and formed with an air gap between pole faces provided on adjacent ends of said core and said pole member; a similarly wound operating winding on each core, said operating windings being series-connected for connection to an energizing source of potential; a permanent magnet magnetically interconnecting the two magnetizable loops, each pole of said magnet being juxtaposed to the pole member of a loop, a nonmagnetic member interconnect-

ing said loops, a nonmagnetic member on said base and spaced from the front face of said base, a pivot on each of said nonmagnetic members in axial alignment with the aperture in said base, a spindle of nonmagnetic material mounted for oscillation on said pivots, a magnetizable armature supported intermediate its ends by said spindle, the ends of said armature extending into the air gaps between the pole faces of said loops, an annular contact driving member on said spindle and extending through the aperture in said base, a plurality of contact fingers radially disposed about the aperture in said base and secured at their outer ends to the front face of said base, stationary contacts disposed about the base aperture, a plurality of slots in the periphery of said contact driving member for retaining the inner ends of the contact fingers and moving said fingers into engagement with the stationary contacts upon oscillation of said armature, said spring fingers and stationary contacts being connected to connector prongs extending from the rear face of said base, a cover member secured to the front face of the base to enclose said contacts and contact fingers secured to said base, a cover secured to said base for enclosing the magnetic structure secured to the rear face of the base, and an apertured mounting base provided with connector receptacles for receiving said connector prongs, said cover being received within the aperture of the base to form a nested assembly therewith.

8. An electrical relay comprising, a base of insulating material having an aperture therein, two similar substantially closed loops of magnetizable material secured to the rear face of said base, each of said loops including a core and a pole member parallel to each other, and formed with an air gap between pole faces provided on adjacent ends of said core and said pole members; a similarly wound operating winding on each core, said operating windings being series-connected for connection to an energizing source of potential; a permanent magnet magnetically interconnecting the two magnetizable loops, each pole of said magnet being juxtaposed to the pole member of a loop, a nonmagnetic member interconnecting said loops, a nonmagnetic member on said base and spaced from the front face of said base, a pivot on each of said nonmagnetic members in axial alignment with the aperture in said base, a spindle of nonmagnetic material mounted for oscillation on said pivots, a magnetizable armature supported intermediate its ends by said spindle, the ends of said armature extending into the air gaps between the pole faces of said loops, an annular contact driving member on said spindle and extending through the aperture in said base, a plurality of contact fingers radially disposed about the aperture in said base and secured at their outer ends to the front face of said base, the inner ends of each of said contact fingers comprising two divergently stressed spring fingers, relatively rigid contact fingers radially disposed about the base aperture for engagement by said spring fingers, a plurality of slots in the periphery of said contact driving members for retaining the stressed contact fingers under compression and moving said fingers into engagement with the rigid contact fingers upon oscillation of said armature, connector prongs extending from the rear face of said base, said connector prongs being connected to said spring and rigid contact fingers, a cover member secured to the front face of said base to enclose said contact fingers, a cover secured to the rear face of said base for enclosing the magnetic structure secured to the rear face of the base, and an apertured mounting base provided with connector receptacles for receiving said connector prongs, said cover being received within the aperture of the base to form a nested assembly therewith.

9. In an electrical relay, the combination comprising a base of insulating material having an aperture therein, supporting members spaced from the front and rear faces of said base, a pivot secured to each of said mem-

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bers in axial alignment with the base aperture, a spindle of nonmagnetic material mounted for oscillation on said pivots, a magnetizable armature supported by said spindle, means supported on the rear face of said base for oscillating said armature, an annular contact driving member on said spindle and extending through the aperture in said base, a plurality of contact fingers radially disposed about the aperture in said base and secured at their outer ends to the front face of said base, the inner ends of each of said contact fingers comprising two divergently stressed spring fingers, relatively rigid contact fingers radially disposed about the base aperture, a plurality of slots in the periphery of said contact driving member for retaining the stressed contact fingers under compression and moving said fingers into engagement with the rigid contact fingers upon oscillation of said armature, said spring and rigid contact fingers being connected to connector prongs extending from the rear face of said base, a cover member secured to the front face of the base to enclose said contact fingers secured to said base, a cover secured to the rear surface of said base for enclosing the supporting member and oscillating means on the rear face of the base, and an apertured mounting base provided with connector receptacles for receiving said connector prongs, said cover being received within the aperture of the base to form a nested assembly therewith.

10. In an electrical relay, the combination comprising, a base plate of insulating material having an aperture therein, a plurality of radially extending movable contacts disposed adjacent the front face of the base and about the base aperture, the outer ends of said contacts being secured to said base, the inner ends of said contacts comprising two divergently stressed spring fingers, fixed contacts disposed about the base aperture and adjacent the front face, a contact driving member normal to said base and extending through the base aperture, means on said driving member for engaging the spring fingers of said movable contacts with compression, means secured to the rear face of said base for oscillating said driving member to engage said movable contacts with said fixed contacts, cover members for the front and rear faces of said base to enclose the elements secured thereto, and an apertured mounting base for securing said base, the rear cover member being received within the aperture of the mounting base to form a nested assembly.

11. In an electrical relay, the combination comprising, a base plate of insulating material having an aperture therein, a plurality of radially extending movable contacts disposed adjacent the front face of the base and about the base aperture, the outer ends of said contacts being secured to said base, fixed contacts disposed about the base aperture and adjacent the front face, a contact driving member normal to said base and extending through the base aperture, means on said driving member for engaging the movable contacts, means secured to the rear face of said base for oscillating said driving member to engage said movable contacts with said fixed contacts, cover members for the front and rear faces of said base to enclose the elements secured thereto, and an apertured mounting base for securing said base, the rear cover member being received within the aperture of the mounting base to form a nested assembly.

12. In an electrical relay the combination comprising an apertured supporting base, a plurality of electrical connectors disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay unit adapted to engage the connectors of said base when said relay portion is within the base aperture, and cooperating means in said base aperture and on said projecting portion to permit insertion of said relay portion into said base aperture in only one position of the relay unit relative to said supporting base.

13. In an electrical relay the combination comprising

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an apertured supporting base, a plurality of electrical connectors symmetrically disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay unit adapted to engage the connectors of said base when said relay portion is within the base aperture, and cooperating means in said base aperture and on said projecting portion to permit insertion of said relay portion into said base aperture in only one position of the relay unit relative to said supporting base.

14. In an electrical relay, the combination comprising an apertured supporting base, a plurality of electrical connectors disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay adapted to engage the connectors of said base when said relay portion is within the base aperture, and indexing means for said supporting base and relay unit preselected in accordance with the operational characteristics of the relay unit, including cooperating abutment elements on said relay portion and in said base aperture, said elements being susceptible to different arrangements in accordance with the operational characteristics the relay unit should have for mounting in the supporting base so that only a relay unit having the desired operational characteristics may be mounted on said supporting base.

15. In an electrical relay, the combination comprising an apertured supporting base, a plurality of electrical connectors disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay adapted to engage the connectors of said base when said relay portion is within the base aperture, cooperating means in said base aperture and on said relay portion to permit insertion of said relay portion into said base aperture in only one position of the relay unit relative to said supporting base, and indexing means for said supporting base and relay unit preselected in accordance with the operational characteristics of the relay unit, including cooperating abutment elements on said relay portion and in said base aperture, said elements being susceptible to different arrangements in accordance with the operational characteristics the relay unit should have for mounting in the supporting base so that only a relay unit having the desired operational characteristics may be mounted on said supporting base.

16. In an electrical relay, the combination comprising an apertured supporting base, a plurality of electrical connectors disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay adapted to engage the connectors of said base when said relay portion is within the base aperture, cooperating surfaces in said base aperture and on said relay portion to permit partial insertion of the relay portion into said base aperture in only one position of the relay unit relative to said supporting base, the cooperating surface on said relay portion including removable portions preselected in accordance with the operational characteristics of the relay unit to form notches in said surface, and an indexing member within said base aperture including abutment elements for registering in the notches of the relay portion, said elements being selectively arranged to permit the complete insertion of the relay portion into the base aperture only when the relay unit has the particular operational characteristics denoted by the arrangement of the abutment elements.

17. In an electrical relay, the combination comprising an apertured supporting base, a plurality of electrical connectors symmetrically disposed about the base aperture, a relay unit for mounting on said supporting base

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including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay adapted to engage the connectors of said base when said relay portion is within the base aperture, and indexing means for said supporting base and relay unit preselected in accordance with the operational characteristics of the relay unit, including cooperating abutment elements on said relay portion and in said base aperture, said elements being susceptible to different arrangements in accordance with the operational characteristics the relay unit should have for mounting in the supporting base so that only a relay unit having the desired operational characteristics may be mounted on said supporting base.

18. In an electrical relay, the combination comprising an apertured supporting base, a plurality of electrical connectors symmetrically disposed about the base aperture, a relay unit for mounting on said supporting base including a projecting portion for insertion into said base aperture, a plurality of mating electrical connectors on said relay adapted to engage the connectors of said base when said relay portion is within the base aperture, cooperating surfaces in said base aperture and on said relay portion to permit partial insertion of the relay portion into said base aperture in only one position of the relay unit relative to said supporting base, the cooperating surface on said relay portion including removable portions preselected in accordance with the operational characteristics of the relay unit to form notches in said surface, and an indexing member within said base aperture including abutment elements for registering in the notches of the relay portion, said elements being selectively arranged to permit the complete insertion of the relay portion into the base aperture only when the relay unit has the particular operational characteristics denoted by the arrangement of the abutment elements.

19. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, each of said loops including an air gap, energizing means for each of said magnetizable loops for at times impressing a magnetizing flux on said loops, a pivoted armature of magnetizable material having portions thereof extending into the air gaps provided in each of said loops, said armature being movable between two extreme positions, a source of polarizing flux magnetically interconnecting said loops, the polarizing flux in each of said loops being of opposite polarities, said polarizing flux threading said armature in the same direction in each position of said armature, each of said loops being energizable to provide a magnetizing flux having a path which threads said armature in a direction opposing said polarizing flux when said armature is at one of its extreme positions and thereby to actuate said armature away from said one of its extreme positions, movement of said armature away from said one of its extreme positions causing the magnetizing flux threading said armature in a direction opposing said polarizing flux to diminish, and causing the magnetizing flux path to be altered to thread said armature in the same direction as said polarizing flux whereby said armature is moved to its other extreme position with a snap action.

20. In an electrical relay, the combination comprising independent substantially closed magnetizable loops, each of said loops including an air gap, energizing means for each of said magnetizable loops for at times impressing a magnetizing flux on said loops, a pivoted armature of magnetizable material having portions thereof extending into the air gaps provided in each of said loops, said armature being movable between extreme positions, a source of polarizing flux magnetically interconnecting said loops, said polarizing flux threading said armature in the same direction in each position of said armature, each of said loops being energizable to provide a magnetizing flux having a path which threads said armature in a direction opposing said polarizing flux when said arma-

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ture is at one of its extreme positions, movement of said armature away from said one of its extreme positions causing the magnetizing flux path to be altered to thread said armature in the same direction as said polarizing flux whereby said armature is moved to the other of its extreme positions with a snap action.

21. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, each of said loops including an air gap, an operating winding for each of said loops for at times impressing a magnetizing flux on said loops, the magnetizing flux due to the operating windings threading said loops in the same direction, a pivoted armature of magnetizable material having portions thereof extending into the air gaps provided in each of said loops, said armature being movable between two extreme positions, a source of polarizing flux magnetically interconnecting said loops, the polarizing flux in each of said loops being of opposite polarities, said polarizing flux threading said armature in the same direction in each position of said armature, each of said operating windings being energizable to provide a magnetizing flux having a path which threads said armature in a direction opposing said polarizing flux when said armature is at one of its extreme positions and thereby to actuate said armature away from said one extreme position, movement of said armature from said one extreme position causing the magnetizing flux path to be altered to thread said armature in the same direction as said polarizing flux whereby said armature is moved to the other extreme position with a snap action.

22. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, each loop including two spaced magnetizable members having pole faces on the ends thereof, in each said loop said pole face on one magnetizable member being adjacent the pole face of said other magnetizable member and forming an air gap therebetween, said pole faces disposed in rectangular configuration, an operating winding supported by each of said loops for magnetizing said loops when energized, a magnetizable armature pivoted in the center of said rectangular configuration, portions of said armature extending into the air gaps provided in each of said magnetizable loops, said armature being movable to extreme positions determined by the pole faces of said magnetizable members, said armature being adapted to bear against diagonally opposed pole faces, a source of polarizing flux magnetically interconnecting both of said loops, the polarizing flux in each of said loops being of opposite polarities, the polarizing flux threading said armature in the same direction regardless of the position of said armature, each of said operating windings being energizable to provide a magnetizing flux to thread said armature in a direction opposite to said polarizing flux when said armature is at one of its extreme positions, said magnetizing flux reversing direction through said armature when said armature moves away from an extreme position against said diagonally opposed pole faces, and said polarizing flux and said magnetic flux being in the same direction as the armature moves toward its second extreme position against the opposite pole faces.

23. In an electrical relay, the combination comprising two independent substantially closed magnetizable loops, each loop including two spaced magnetizable members having pole faces on the ends thereof, in each said loop said pole face on one magnetizable member being adjacent the pole face of said other magnetizable member and forming an air gap therebetween, said pole faces disposed in rectangular configuration, an operating winding supported by each of said loops for impressing a magnetizing flux on said loops when energized, a magnetizable armature pivoted between said loops and in the center of said rectangular configuration, the ends of said armature extending into the air gaps provided in each of said magnetizable loops, said armature having

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one end thereof bearing against one of said pole faces and the other end thereof bearing against a pole face diagonally opposite to said one pole face, a permanent magnet providing a polarizing flux for magnetically interconnecting both of said magnetizable loops, the polarizing flux in each of said loops being of opposite polarities, the polarizing flux threading said armature in the same direction regardless of the position of said armature for magnetizing said armature in a predetermined manner, each of said windings being energizable to provide a magnetizing flux having a path which threads said armature in a direction opposite to said polarizing flux when said armature bears against said diagonally opposite pole faces and thereby to actuate said armature away from said pole faces, movement of said armature away from said pole faces causing the magnetizing flux threading said armature in a direction opposing said polarizing flux to diminish and causing the magnetizing flux path to be altered to thread said armature in the same direction as said polarizing flux as the armature moves toward the oppositely disposed pole faces whereby said armature is moved with a snap action.

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