Nov. 17, 1953 A. HUFNAGEL 2,659,786

CODE FOLLOWING RELAY

Filed June 27, 1950 2 Sheets-Sheet 1

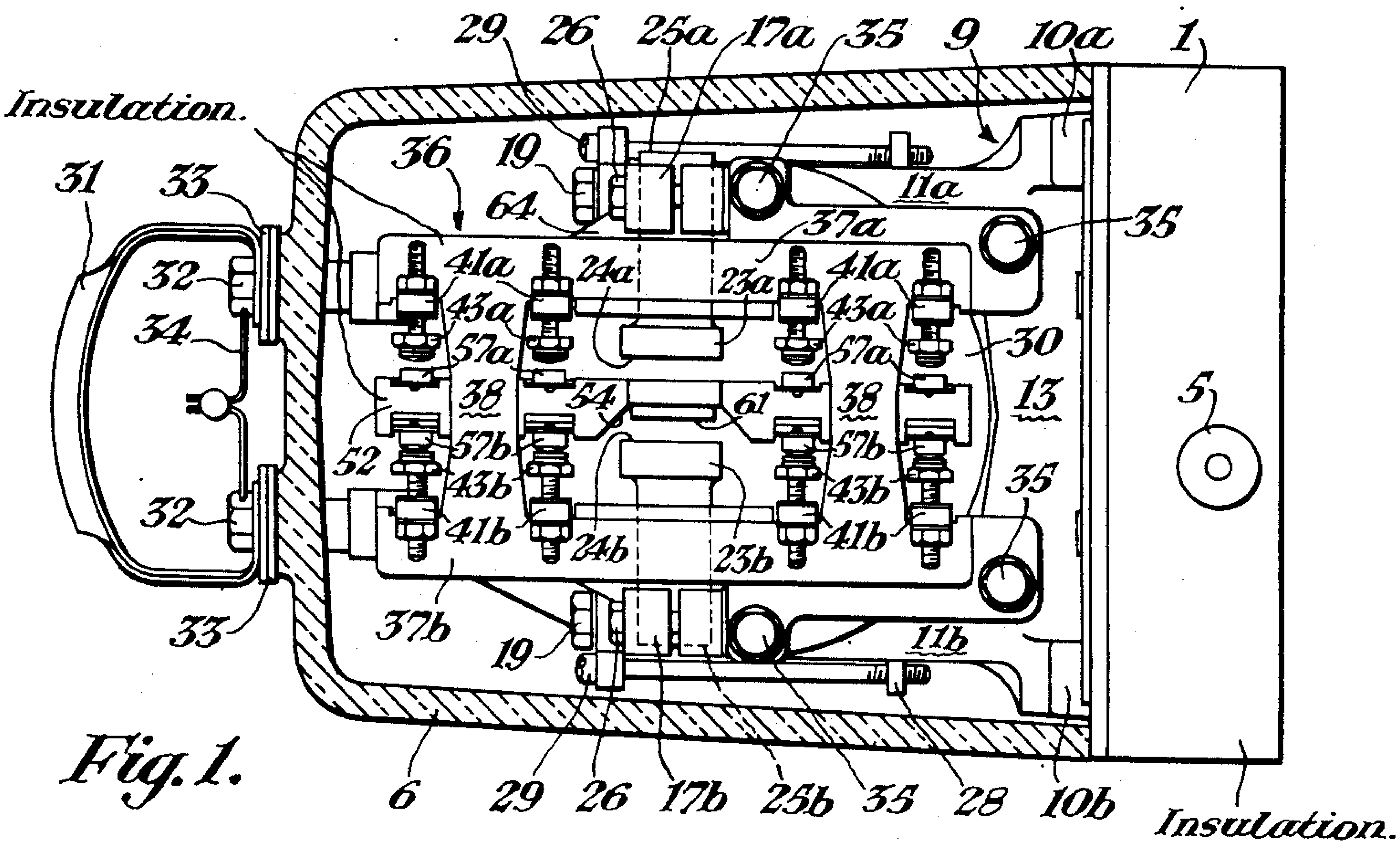

Fig. 1.

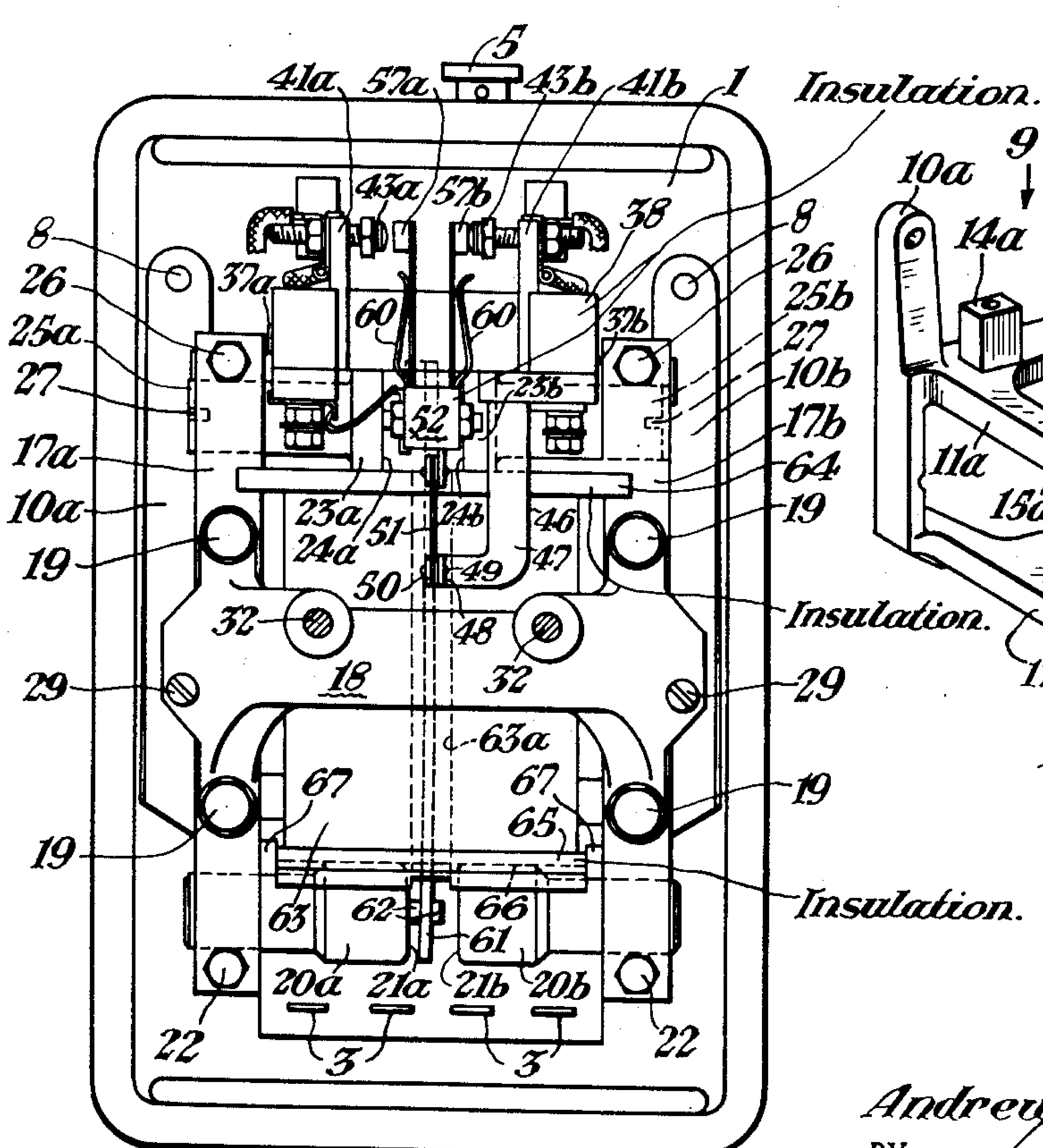

Fig. 3.

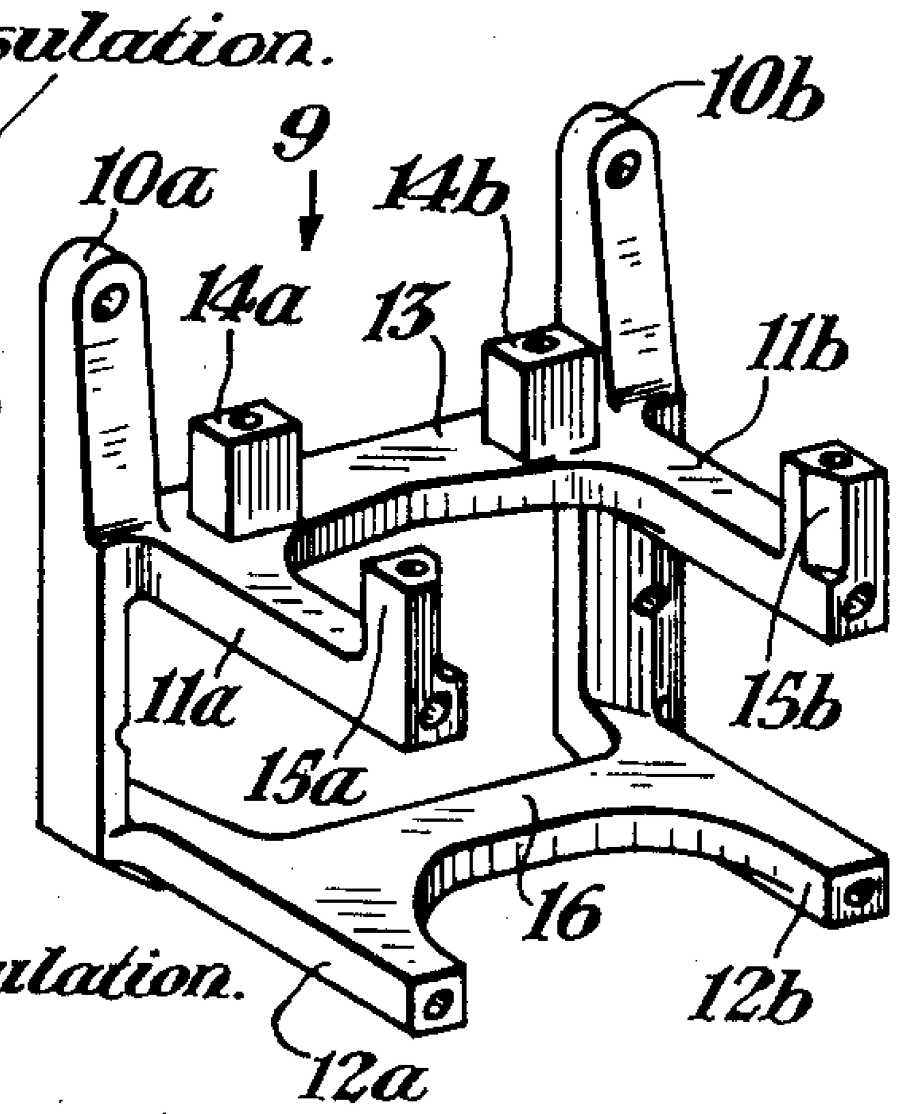

Fig. 5.

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BY

[signature]

HIS ATTORNEY

Nov. 17, 1953 A. HUFNAGEL 2,659,786

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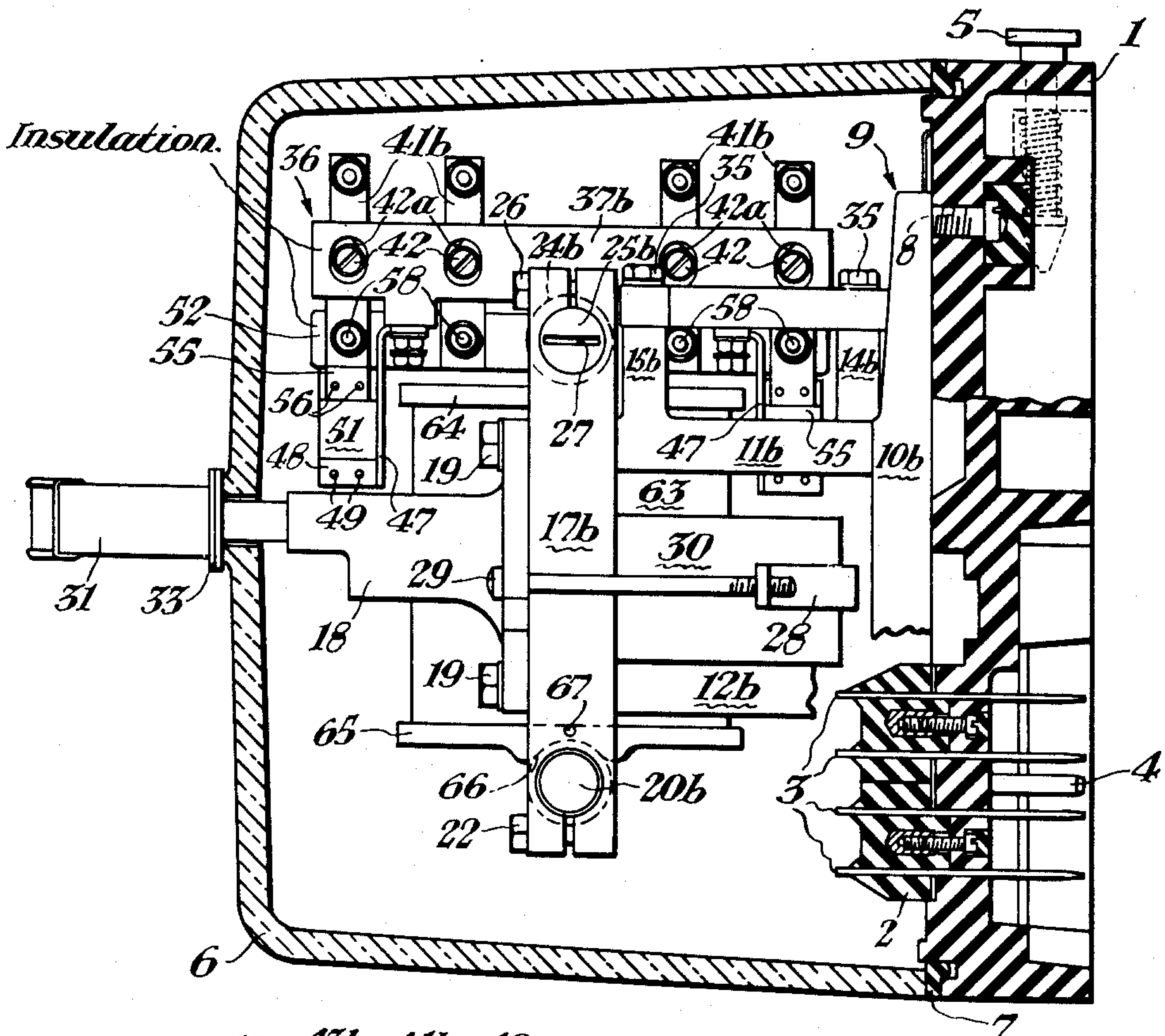

Fig. 2.

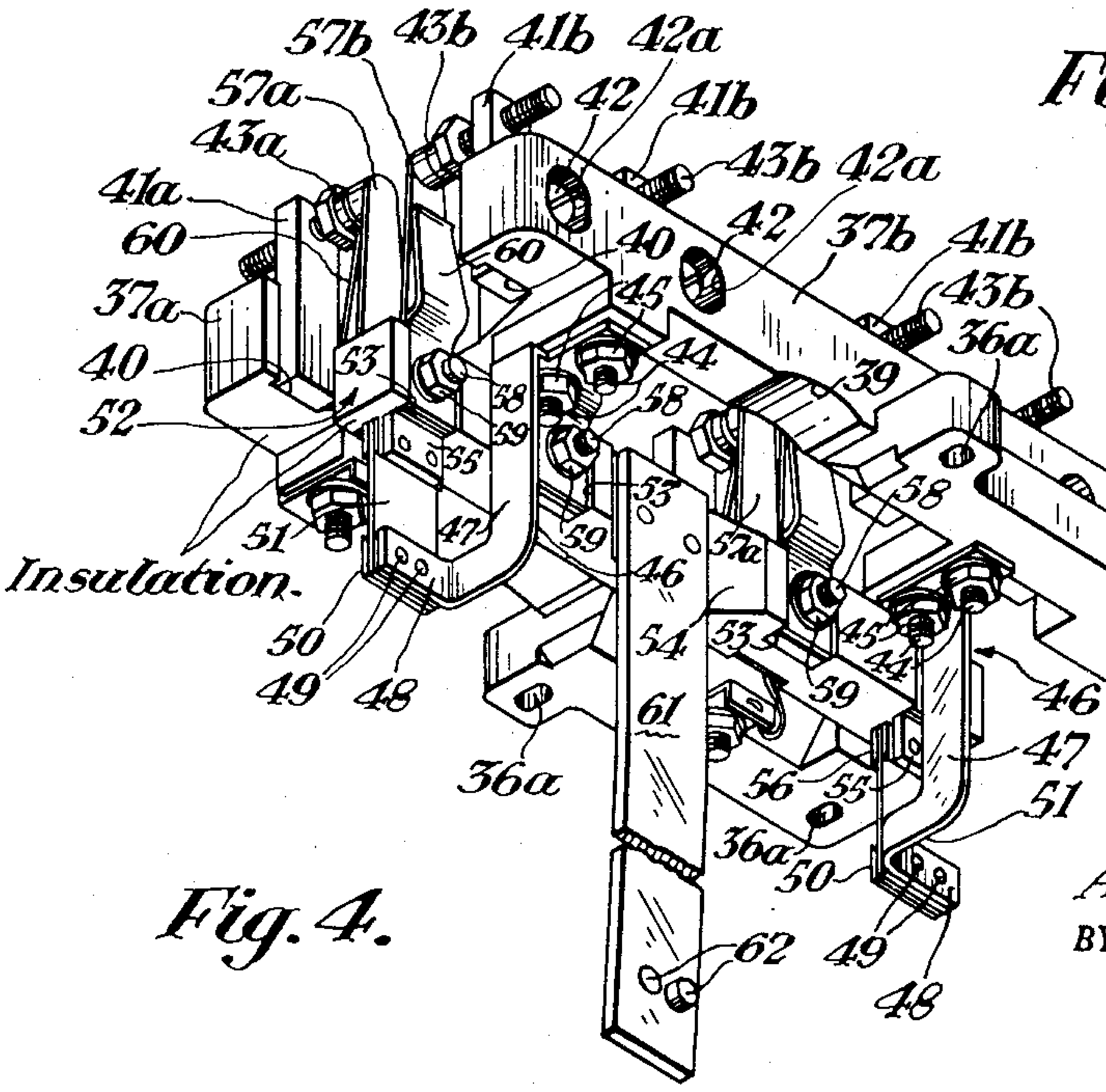

Fig. 4.

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UNITED STATES PATENT OFFICE

2,659,786

CODE FOLLOWING RELAY

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Application June 27, 1950, Serial No. 170,595

13 Claims. (Cl. 200—93)

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My invention relates to electrical relays and more particularly to electrical relays which are suitable for use as track or line relays in railway signaling systems in which periodically interrupted or coded current is used to control signaling devices in accordance with different traffic conditions.

Previous code following relays used in such railway signaling systems comprised an armature surrounded by an operating winding, a core structure including pole pieces, a permanent magnet magnetically coupled to the core structure and a set of contacts operated by the movement of the armature in response to the energizing current through the operating winding. The operating winding of such relays was locked in place on the core structure by special springs to prevent shifting or movement of the winding. The armature was usually pivoted at its lower end by a hinge spring fixed to the bottom of the relay casing, while the upper end of the armature was connected to the movable contact fingers by a mechanical coupling. While such relays have performed satisfactorily for many years, the inertia of the moving elements of the relays affected the response thereof to the on and off periods of code energization.

It is therefore an object of my invention to provide a code following relay in which the mechanical inertia of the moving element is reduced to a minimum so that the relay will follow on and off periods of code energization with maximum fidelity.

A further object of my invention is to provide a relay in which the conventional armature hinge and the mechanical coupling between the relay armature and the contact spring support are eliminated.

Another object of my invention is to provide a relay in which the pole pieces of the core structure serve to hold the operating winding of the relay in place on the core structure.

Other objects of my invention will appear as the description proceeds.

The several objects of my invention are accomplished by providing a bracket of non-magnetic material for supporting the stationary contact assembly, the core structure and the operating winding of the relay. The core structure of the relay comprises two vertical magnetizable members fixed to the bracket, the upper and lower ends of the members being provided with opposing pole pieces. Both sets of pole pieces are adjustable so that the air gap between the opposing pole faces may be accurately formed, the upper

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pole pieces in addition to being adjustable are also eccentric with respect to their supporting shanks. The bracket and core structure are such that the operating winding of the relay is seated on the lower set of pole pieces, while the upper set of pole pieces due to their eccentricity are used to clamp the operating winding in place.

The operating winding of the relay surrounds the armature which is fastened to the movable contact supporting member. The movable contact supporting member is pivotally mounted on two upstanding hinge springs supported by dependent brackets fastened to the ends of the stationary contact support. The armature is thus mounted on the two hinge springs supported by the stationary contact support and pivots about an axis which coincides with a line connecting the pivot points of the two hinge springs. The lengths of the elements and the masses of the armature and the movable contact assembly forming the moving element of the relay have been so chosen that the pivotal axis of the armature coincides with the center of inertia of the moving element.

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

In the accompanying drawings, Fig. 1 is a top plan view of a plug-in type of code following relay embodying my invention. Fig. 2 is a side elevational view of the relay, portions being in cross-section. Fig. 3 is a front elevational view of the relay with the glass cover removed. Fig. 4 is an isometric view of the contact structure of the relay, while Fig. 5 is an isometric view of the supporting bracket for the relay structure.

Referring to Figs. 1 and 2 of the drawings, the relay comprises a case consisting of a vertical mounting plate 1 of suitable insulating material provided at its lower end with an electrical connector 2 having a plurality of rearwardly extending contact prongs 3 and an indexing pin 4. The contact prongs 3 serve as a connecting element for the relay contacts and coil winding hereinafter described, the indexing pin aligning the mounting plate and prongs with a fixed plug-in receptacle (not shown); a locking pin 5 provided on the upper edge of the mounting plate locking the mounting plate to the plug-in receptacle. A cover 6 of transparent material, preferably glass, is fixed to the mounting plate in a manner to be described, a gasket 7 of cork or other suitable material being interposed between the cover and the mounting plate to seal the case against the entry of dust and other foreign objects.

Fixed to the mounting plate 1 as by screws 8, is a bracket 9 having two spaced vertical arms 10a and 10b (Fig. 5), two horizontal forwardly extending arms 11a and 11b intermediate the ends of the vertical arms, and two spaced forwardly extending arms 12a and 12b at the lower ends of the vertical arms. The vertical arms and the horizontal arms 11a and 11b are interconnected by a web 13. The web 13 is provided with two upstanding lugs 14a and 14b and the ends of the arms 11a and 11b are provided with similar upstanding lugs 15a and 15b. The two lower arms 12a and 12b of the bracket are interconnected by a web 16.

The operating mechanism of the relay is mounted on the bracket 9, and comprises a core structure consisting of two vertically disposed magnetizable bars 17a and 17b secured respectively to the forwardly extending arms 11a, 12a and 11b, 12b of the bracket 9 by a front bracket 18 and screw 19. The upper and lower ends of the bars 17a and 17b are split, the lower ends of the bars being provided with concentric pole pieces 20a and 20b having confronting pole faces 21a and 21b. The pole pieces are adjustably secured to the bars by clamping bolts 22 threaded into the split ends of the bars. The upper ends of the bars 17a and 17b are provided with pole pieces 23a and 23b having confronting pole faces 24a and 24b. The pole pieces 23a and 23b are eccentrically disposed with respect to their respective shanks 25a and 25b clamped in the bars 17a and 17b by the action of the clamping bolts 26 threaded through the split ends of the bars. The ends of the shanks are slotted as at 27 so that the eccentric pole pieces may be turned by means of a suitable instrument such as a screw driver, for the purposes hereinafter appearing.

Fixed intermediate the ends of the bars 17a and 17b by a clamping strap 28 and studs 29 passing through the front bracket 18, is a permanent magnet 30. The permanent magnet is U-shaped, the ends of the two legs of the magnet engaging the rear faces of the vertical bars 17a and 17b.

The front bracket 18 in addition to forming a means for supporting the permanent magnet 30 and fixing the vertical bars 17a and 17b to the bracket 9, also serves to hold the cover 6 in place (Fig. 1). The relay is provided with a handle 31 to facilitate plugging the relay into and removing it from a suitable mounting rack, the handle and cover being fixed to the front bracket by bolts 32 and the washers 33 and a sealing wire 34 being passed through the heads of the bolts to provide a tell-tale should the relay casing be opened by unauthorized persons.

Fixed to the top of the upstanding lugs 14a, 14b and 15a, 15b of the bracket 9 as by bolts 35, is a contact mounting block 36 made of a suitable insulating material. The contact mounting block comprises two spaced arms 37a and 37b joined together by web members 38 (Figs. 1 and 3) which bridge the space between the two arms. The arms 37a and 37b are provided with slotted mounting holes 36a (Fig. 4) for the mounting bolts 35. As will hereinafter appear, the contact mounting block and its contact assemblies may be shifted slightly to properly center the armature, hereinafter described, in the coil spool hereinafter described. The lower edges of the arms 37a and 37b are each provided with a shallow arcuate recess 39 adapted to fit over the shanks 25a and 25b of the upper pole pieces 23a and 23b, respectively. The two arms of the mounting block are further formed with a plurality of shallow recesses 40 (Fig. 4). Upright contact bearing members 41a and 41b are secured within the recesses 40 by screws 42, each member carrying at its upper end adjustable screw contact 43a or 43b, respectively. The contact members 41a and 41b are vertically adjustable by the provision of slotted openings 42a provided in the arms 37a and 37b for the screws 42. By loosening the screws the members 41a and 41b may be raised or lowered slightly to compensate for any misalignment of these contacts with their cooperating movable contacts, as will hereinafter appear.

Fixed to the underside of the arm 37b of the contact mounting block 36 by screws 44 and nuts 45 are two hinge brackets 46 (Fig. 4), each formed with a dependent arm 47 terminating in a longitudinally disposed, horizontal arm 48. Fastened to the arms 48 as by rivets 49 and clamping plates 50, are upstanding hinge springs 51. The upper ends of the hinge springs are fastened to a movable contact supporting member 52, the springs supporting the member 52 in an intermediate position between and slightly below the side arms 37a and 37b of the contact mounting block 36. The movable contact supporting member 52 is formed with a plurality of recesses 53 in horizontal alignment with the recesses 40 of the contact mounting block 36, and with a larger recess 54 intermediate the ends of said member. Fixed in two end recesses 53 of member 52 are two dependent brackets 55, the lower ends of said brackets being riveted to the upper ends of the hinge springs 51 together with clamping plates 56. It will be noted that the inner upper edges of the arms 48 and clamping plates 50, and the inner lower edges of the brackets 55 and the clamping plates 56 are rounded to prevent sharp bends in the hinge springs 51.

A plurality of back and front spring contacts 57a and 57b are fastened within the recesses 53 of the contact supporting member as by bolts 58 and nuts 59, together with suitable stops 60. The contacts 57a and 57b are of sufficient length to engage the stationary contacts 43a and 43b, respectively, upon oscillation of the movable contact supporting member 52.

Means are also provided to oscillate the movable contact supporting member 52 to selectively close the front and back contacts 43a—57a and 43b—57b.

To this end an armature 61 of magnetic material is fastened at its upper end to the contact supporting member 52 within the recess 54. The armature extends downwardly between the upper pole pieces 23a and 23b and the lower pole pieces 20a and 20b, the lower end of the armature being provided with core pins 62 of bronze or other non-magnetic material. The core pins are adapted to engage the lower pole faces 21a and 21b and serve as stops for the armature, limiting the armature to a given stroke, and also prevent the armature from engaging the pole pieces and possibly sticking thereto.

The relay embodying my invention is of the code following type in which the armature is oscillated at a rapid rate in following the code frequency of the current through its operating winding. To follow the on and off periods of code energization with maximum fidelity the mechanical inertia of the armature and the movable contact supporting member must be kept at a minimum. To this end, I have considered the masses and lengths of the armature and its attendant movable contact assembly as the mass and length of a single movable element and found a center of inertia of the element intermediate the ends of the armature which satisfies the required condition that the inertia of the mass on one side of the center point equals the inertia of the mass on the other side of the center point. The armature is so mounted that its pivotal axis coincides with a line drawn through the hinge points of the two springs 51 and which passes through the center of inertia of the armature and its attendant movable contact assembly. Thus the effects of the mechanical inertia of the movable elements are minimized to provide a fast acting relay which will follow the code frequency of the current through the operating windings with maximum fidelity.

Surrounding the armature 61 between the upper pole pieces 23*a* and 23*b* and the lower pole pieces 20*a* and 20*b* is an operating winding 63 wound on a hollow spool 63*a* having the spool ends 64 and 65. The top surface of the upper spool end 64 is flat, while the bottom surface of the lower spool end 65 is formed with an arcuate recess 66 (Fig. 2) which seats on the pole pieces 20*a* and 20*b*. Centering pins 67 are provided in the vertical bars 17*a* and 17*b*, which abut the periphery of the lower spool end 65 to center the operating winding with respect to the core structure and armature. The operating winding is held in place on the core structure by the eccentric pole pieces 23*a* and 23*b*. As previously described the pole pieces are eccentric with respect to their respective shanks 25*a* and 25*b*. By turning the shanks with a screw driver, the peripheral surfaces of the upper pole pieces are brought to bear against the top surface of the upper spool end 64, thereby clamping the operating winding between the lower pole pieces 20*a* and 20*b* upon which the spool seats, and the upper pole pieces 23*a* and 23*b*.

With the above described construction, the polarizing flux due to the permanent magnet 30 traverses several different paths. As viewed in Fig. 3, one of these paths passes downwardly from the right-hand end of the permanent magnet through the lower end of the vertical bar 17*b*, through the pole piece 20*b* and across the air gap between the pole face 21*b* and the lower end of the armature 61, the lower end of said armature, across the air gap between the lower end of the armature and the pole face 21*a*, through the pole piece 20*a* and then upwardly through the lower end of the vertical bar 17*a* to the left-hand end of the permanent magnet 30. Another path for the permanent magnet flux may be traced from the right-hand end of the permanent magnet upwardly through the upper end of the vertical bar 17*b*, the shank 25*b* and pole piece 23*b*, across the air gap between the pole face 24*b* and the upper end of the armature 61, the upper end of said armature, the air gap between the upper end of the armature and the pole face 24*a*, through the pole piece 23*a* and shank 25*a*, and then downwardly through the upper end of the vertical bar 17*a* to the left-hand end of the permanent magnet 30. With the armature in the position shown in Fig. 3, another path for the polarizing flux may be traced from the right-hand end of the permanent magnet 30 upwardly through the upper end of bar 17*b*, the shank 25*b* and pole pieces 23*b*, the air gap between the pole face 24*b* and the armature 61, downwardly through the length of the armature, across the air gap between the lower end of the armature and the pole face 21*a*, through the pole piece 20*a* and then upwardly through the lower end of the bar 17*a* to the left-hand end of the permanent magnet. When the armature 61 occupies the opposite extreme position from that shown in Fig. 3, a polarizing flux path may be traced from the right-hand end of the permanent magnet downwardly through the lower end of the bar 17*b*, through the pole piece 20*b* and across the air gap between the pole face 21*b* and the lower end of the armature 61, then upwardly through the armature and across the air gap between the upper end of the armature and the pole face 24*a*, through the pole piece 23*a* and shank 25*a* and downwardly through the upper end of the bar 17*a* to the left-hand end of the permanent magnet.

The amount and direction of the polarizing flux which threads the armature 61 is dependent upon the position of the armature with respect to the pole faces 24*a*, 24*b* and 20*a*, 20*b*. When the armature is midway between the two sets of pole faces, no polarizing flux will thread the length of the armature because both ends of the armature are then at the same magnetic potential. As the upper end of the armature moves toward one or the other of the pole faces 24*a* and 24*b* and the lower end of the armature moves toward one or the other of the pole faces 21*b* and 21*a*, the polarizing flux will thread the length of the armature in one direction or the other depending upon the position of the armature with respect to the pole faces.

With an energizing current flowing through the operating winding 63, the path of the flux due to the energizing current may be traced from the upper end of the armature 61 where it divides and crosses over the air gaps between the armature and the pole faces 24*a* and 24*b*, through the pole pieces 23*a* and 23*b* and their resepctive shanks 25*a* and 25*b*, downwardly through the vertical bars 17*a* and 17*b*, through the pole pieces 20*a* and 20*b* and across the air gaps between the pole faces 21*a* and 21*b* and the lower end of the armature. The direction of the flux in these paths will depend upon the polarity of the current supplied to the winding 63. With the current through the winding 63 of one polarity, the upper and lower ends of the armature may be repelled by the pole pieces 23*b* and 20*a* and attracted by the pole pieces 23*a* and 20*b*. With the current reversed the upper and lower ends of the armature will be repelled by the pole pieces 23*a* and 20*b* and attracted by the pole pieces 23*b* and 20*a*. A third path for the operating flux may also be traced through the permanent magnet 30. Due to the fact that the magnetomotive force of the electromagnetic flux approximates that of the permanent magnet at the junction point of the permanent magnet ends and the vertical bars 17*a* and 17*b*, and also due to the high reluctance of the permanent magnet as compared to that of the vertical bars forming the core structure, practically no part of the electromagnetic flux returns by this path.

The armature 61 is constantly biased to the position illustrated in Fig. 3 wherein the core pin 62 engages the pole face 21*a* of the core piece 20*a* and the back contacts 43*b*—57*b* are closed. I provide both mechanical bias and magnetic bias for the armature to maintain the armature in the position shown. While the mechanical bias for the armature may be provided by an initial stressing or setting of the hinge springs **51**, it will be appreciated that some difficulty may be encountered in providing an equal set to both of the hinge springs. I prefer to provide the mechanical bias for the armature **61** by an asymmetrical arrangement of the contacts operated by the armature. As previously described, lateral adjustment of the contact mounting block **36** is possible by the slotted mounting holes **36***a* provided in the block. By laterally shifting the block **36** on the bracket **9** and adjusting the back contacts **43***b* on their supports **41***b* so that the back contacts **43***b*—**57***b* are closed when the hinge springs **51** are unflexed and vertical, the required mechanical bias is provided for the armature. It will be noted in Fig. 3 that the back contacts **43***b* extend further inwardly from their supporting members **41***b* than do the front contacts **43***a* from their supporting members **41***a*.

Magnetic bias for the armature **61** is provided by adjusting the upper pole pieces **23***a* and **23***b* so that the air gaps between the respective pole faces **24***a* and **24***b* and the upper end of the armature are unequal (Fig. 1). The armature **61** will be in a magnetically unbalanced position so that the end of the armature will be attracted by the proximate pole face **24***b* due to the polarizing flux threading the length of the armature, as previously described. The back contacts **43***b*—**57***b* will be held closed and under full compression of the spring contact **57***b*.

The lower pole pieces **20***a* and **20***b* are adjusted to limit the throw of the armature **61**, the pole pieces being adjusted symmetrically with respect to the axis of the operating winding **63**. It will be noted that the opening in the hollow spool **63***a* (Fig. 3) is of limited width. The lower end of the armature is slightly bowed or bent to the left so that it can make its full stroke without striking the opposite side of the opening in the spool. The armature will remain in the position illustrated until the flux threading the armature is reversed by the flux due to the energized operating winding.

In operating the relay described, when no energizing current flows through the operating winding **63**, the armature will be held in the position illustrated in Fig. 3 by the magnetic bias due to the polarizing flux of the permanent magnet. The back contacts **43***b*—**57***b* will be held closed and under full compression while the front contacts **43***a*—**57***a* will be held open. When the operating winding **63** is energized, if the electromagnetic flux threading the armature is in the same direction as the flux due to the permanent magnet, i. e., passes downwardly through the armature, the armature will remain in the position illustrated, the attraction of the ends of the armature to the diagonally opposite pole pieces **20***a* and **23***b* being increased by the electromagnetic flux. Should the electromagnetic flux threading the armature be reversed, i. e., pass upwardly through the armature due to a reversal in the polarity of the energizing current, then the ends of the armature will have the same polarity as the pole pieces **20***a* and **23***b*. The pole pieces **20***a* and **23***b* will tend to repel the ends of the armature to rotate the armature in a counterclockwise direction on the hinge springs **51** to its opposite position in which the pole pieces **20***b* and **23***a* attract the ends of the armature. With the armature in its opposite position the front contacts **43***a*—**57***a* will be closed and under full compression, while the back contacts **43***b*—**57***b* are held open. The armature will remain in its opposite position as long as the winding **63** carries the energizing current of the reverse polarity. When the winding becomes deenergized, the flexed hinge springs **51** will return the armature to its off-center position between the pole pieces. The polarizing flux due to the permanent magnet **30** will again thread the length of the armature in the manner described to magnetically bias the armature to the position illustrated in Fig. 3 with the back contacts **43***b*—**57***b* closed and the front contacts **43***a*—**57***a* open.

It will be apparent from the foregoing description, that the polar bias relay described is ideally suited for use as a code following relay in a railway signaling system. By the non-symmetrical adjustment of the pole pieces and the contacts, the back contacts will always be closed to such an extent that mechanical vibration cannot cause false coding of the front contacts when the relay is deenergized. Should the permanent magnet become demagnetized for any reason, the back contacts will again remain closed due to the non-symmetrical arrangement described.

While the foregoing description has been limited to a relay of the polar bias type, it will be readily appreciated that with a few modifications in the arrangement of the parts, a relay of the polar stick type may be provided. To provide a polar stick relay, the pole pieces and contacts are arranged symmetrically with respect to the operating winding and armature, the armature being straight and in vertical alignment with the unflexed hinge springs. The ends of the armature when midway between the pole faces of the upper and lower set of pole pieces will be in a magnetically balanced position. An energizing current through the operating winding will polarize the ends of the armature to move the armature toward one or the other pairs of diagonally opposite pole faces. With no current flowing in the operating winding, the polarizing flux due to the permanent magnet will always hold the armature in its last attracted position.

One advantage of a relay embodying my invention is the unitary structure formed by the armature and the movable contact spring support. The conventional mechanical coupling between the armature and contact support is eliminated as well as the separate hinge spring and supporting structure for the armature. The unitary structure may be treated as a single moving element in determining the center of inertia of the vibrating element. The mechanical inertia of the structure vibrating about an axis coincident with the center of inertia is thus reduced to a minimum so that the relay will follow the frequency of code energization with maximum speed and fidelity.

Another advantage of a relay embodying my invention is the provision of the contact and armature assembly. Whereas several subassemblies were required in former relays, the contact and armature assembly now provided permits adjustment and inspection of the contacts and armature as an operating unit before assembly rather than after assembly. The slotted mounting holes in the contact mounting block permit the contact and armature assembly to be mounted as a unit with respect to the operating winding and core structure instead of adjusting each of the elements as formerly required.

A further advantage of my relay is the elimination of the conventional hinge spring fixed to the lower end of the armature in previous relays, thereby reducing the overall height of the relay so that the relay is more compact, and occupies less space. The provision of the two hinge springs exteriorly of the operating winding for supporting the armature and contact assembly permits larger and more rugged springs to be used. The exteriorly placed hinge springs and the clamping of the operating winding between the pole pieces by the turning of the eccentrically mounted pole pieces provide a simpler and more rugged relay assembly than heretofore which is readily assembled and operates with a minimum of maintenance.

Although I have herein shown and described only one form of 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 stationary contact assembly, a movable contact assembly, spaced support means for supporting said movable contact assembly for oscillation, an armature fixed adjacent one end to and supported by said movable contact assembly and forming a unitary structure therewith, a core structure, and an operating winding between said spaced support means and on said core structure and surrounding said armature to oscillate said armature about an axis intermediate its ends whereby said movable contact assembly is oscillated to engage and disengage said stationary contact assembly.

2. A relay comprising a stationary contact assembly, a movable contact assembly, spaced support means on said stationary contact assembly for supporting said movable contact assembly for oscillation, an armature fixed adjacent one end to and supported by said movable contact assembly and forming a unitary structure therewith, a core structure, and an operating winding between said spaced support means and on said core structure and surrounding said armature to oscillate said armature about an axis intermediate its ends whereby said movable contact assembly is oscillated to engage and disengage said stationary contact assembly.

3. A relay comprising two magnetizable bars in spaced parallel relation, two sets of axially aligned pole pieces having opposing pole faces adjustably secured adjacent the ends of said bars, a pair of spaced hinge springs, a movable support fixed to said hinge springs, a magnetizable armature secured to said movable support and disposed between the opposing faces of said pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the axis determined by the flexing points of the two hinge springs, an operating winding between said hinge springs and surrounding said armature, and a permanent magnet connected with said magnetizable bars to polarize said relay.

4. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, two sets of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent to the ends of said bars, a pair of spaced hinge springs supported on said bracket, a movable support fixed to said hinge springs, a magnetizable armature secured only at one end to said movable support and disposed between the opposing faces of said pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the axis determined by the flexing points of the two hinge springs, an operating winding surrounding said armature between said two sets of pole pieces and said hinge springs, and a permanent magnet connected with said magnetizable bars to polarize said relay.

5. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, two sets of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the upper and lower ends of said bars, one of said sets of pole pieces being eccentrically mounted, a pair of spaced hinge springs supported on said bracket, a movable support fixed to said hinge springs, a magnetizable armature secured to said movable support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the axis determined by the flexing points of the two hinge springs, an operating winding between said hinge springs and surrounding said armature, said armature being seated on the lower pole pieces and clamped between both sets of pole pieces by the eccentrically mounted pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to polarize said relay.

6. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, a first pair of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the lower ends of said bars, a second pair of axially aligned pole pieces having opposing pole faces and adjustably and eccentrically secured adjacent the upper ends of said bars, a block secured to said bracket above said upper pole pieces, a bracket secured to each end of said mounting block, a hinge spring fixed at one end to each of said brackets, a movable support fixed to the other ends of said hinge springs, a magnetizable armature secured to said movable support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the axis determined by the flexing points of the two hinge springs, an operating winding between said hinge springs and surrounding said armature, said winding being seated on the lower pole pieces and clamped between both sets of pole pieces by the eccentrically mounted upper pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to polarize said relay.

7. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, a first pair of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the lower ends of said bars, a second pair of axially aligned pole pieces having opposing pole faces and adjustably and eccentrically secured adjacent the upper ends of said bars, a block secured to said bracket above said upper pole pieces, a dependent bracket secured to each end of said mounting block, an upstanding hinge spring fixed at one end to each

of said dependent brackets, a movable support fixed to the other ends of said hinge springs, a magnetizable armature secured to said movable support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the axis determined by the flexing points of the two hinge springs, said armature being in an off-center position between the opposing faces of said upper and lower pole pieces; an operating winding between said hinge springs and surrounding said armature, said winding being seated on the lower pole pieces and clamped between both sets of pole pieces by the eccentrically mounted upper pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to magnetically bias said armature to its off-center position whereby said relay will respond to energizing current of only one polarity in said operating winding.

8. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, a first pair of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the lower ends of said bars, a second pair of axially aligned pole pieces having opposing pole pieces and adjustably and eccentrically secured adjacent the upper ends of said bars, a contact mounting block secured to said bracket, a plurality of contacts secured to said mounting block, a bracket secured to each end of said mounting block, a hinge spring fixed at one end to each of said brackets, a movable contact support fixed to the other ends of said hinge springs, a plurality of contacts on said movable contact support adapted to engage the contacts on said mounting block, a magnetizable armature secured to said movable contact support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the center of inertia of the armature, the movable contact support and its contacts, and coincident with the axis determined by the flexing points of the two hinge springs, said armature being in an off-center position between the opposing faces of said upper and lower pole pieces; an operating winding surrounding said armature seated on the lower pole pieces and clamped between both sets of pole pieces by the eccentrically mounted upper pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to magnetically bias said armature to its off-center position whereby said relay will respond to energizing current of only one polarity in said operating winding.

9. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, two sets of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the upper and lower ends of said bars, a contact mounting block secured to said bracket above said upper pole pieces, a plurality of upstanding contacts secured to said mounting block, a dependent bracket secured to each end of said mounting block, an upstanding hinge spring fixed at one end to each of said dependent brackets, a movable contact support fixed to the other ends of said hinge springs, a plurality of upstanding contacts on said movable contact support adapted to engage the upstanding contacts on said mounting block, a magnetizable armature secured to said movable contact support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the center of inertia of the armature, the movable contact support and its contacts, and coincident with the axis determined by the flexing points of the two hinge springs, said armature being in an off-center position between the opposing faces of said upper and lower pole pieces; an operating winding surrounding said armature between said two sets of pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to magnetically bias said armature to its off-center position in which the upper and lower ends of the armature are adjacent diagonally opposite pole faces of the upper and lower pole pieces whereby said relay will respond to energizing current of only one polarity in said operating winding.

10. A relay comprising a bracket of non-magnetizable material, two vertically disposed magnetizable bars secured to said bracket in spaced parallel relation, a first pair of axially aligned pole pieces having opposing pole faces and adjustably secured adjacent the lower ends of said bars, a second pair of axially aligned pole pieces having opposing pole faces and adjustably and eccentrically secured adjacent the upper ends of said bars, a contact mounting block secured to said bracket above said upper pole pieces, a plurality of upstanding contacts secured to said mounting block, a dependent bracket secured to each end of said mounting block, an upstanding hinge spring fixed at one end to each of said dependent brackets, a movable contact support fixed to the other ends of said hinge springs, a plurality of upstanding contacts on said movable contact support adapted to engage the upstanding contacts on said mounting block, a magnetizable armature secured to said movable contact support and disposed between the opposing faces of said upper and lower pole pieces so that said armature is free to oscillate between said pole pieces about an axis intermediate its ends which is coincident with the center of inertia of the armature, the movable contact support and its contacts, and coincident with the axis determined by the flexing points of the two hinge springs, said armature being in an off-center position between the opposing faces of said pole pieces; an operating winding surrounding said armature seated on the lower-pole pieces and clamped between both sets of pole pieces by the eccentrically mounted upper pole pieces, and a permanent magnet connected with said magnetizable bars between said upper and lower pole pieces to magnetically bias said armature to its off-center position whereby said relay will respond to energizing current of only one polarity in said operating winding.

11. A relay comprising a core structure having confronting pole pieces, an operating winding for said core structure, a pivotally supported member, an armature disposed within said operating winding and between said pole pieces, said armature being fixed adjacent one end to said pivotally supported member to form a unitary element, means exteriorly of said operating winding for supporting the unitary element in a manner to

permit free oscillation thereof about an axis coincident with its center of inertia, and a permanent magnet connected with said core structure for polarizing said relay.

12. A relay comprising a core structure having confronting pole pieces, an operating winding for said core structure, a pivotally supported member, an armature disposed within said operating winding and between said pole pieces, said armature being fixed adjacent one end to said pivotally supported member to form a unitary element, and means exteriorly of said operating winding for supporting the unitary element in a manner to permit free oscillation thereof about an axis intermediate its ends.

13. A relay comprising a core structure having confronting pole pieces, an operating winding for said core structure, a pivotally supported member, an armature disposed within said operating winding and between said pole pieces, said armature being fixed adjacent one end to said pivotally supported member to form a unitary element, and means exteriorly of said operating winding and between the planes of the ends of the operating winding for supporting the unitary element in a

manner to permit free oscillation thereof about an axis intermediate its ends.

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