

May 4, 1943.

W. J. LEVERIDGE

2,318,405

RELAY

Filed June 18, 1941

2 Sheets-Sheet 1

FIG. 1

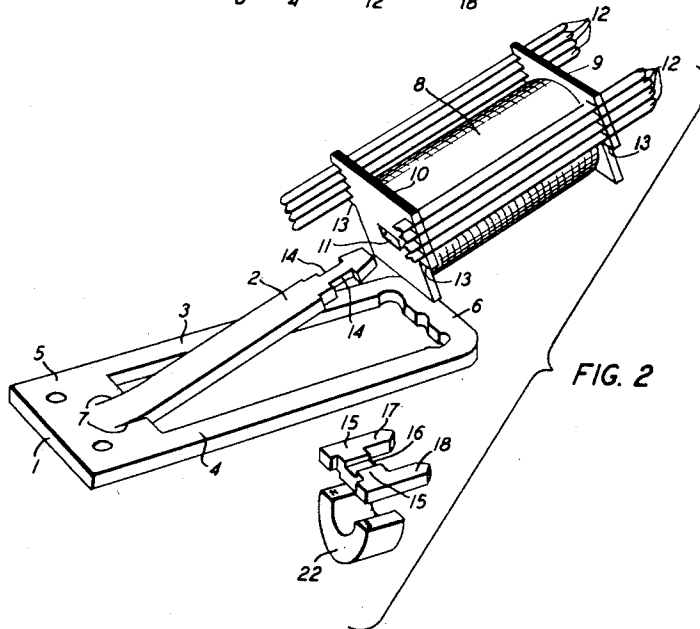
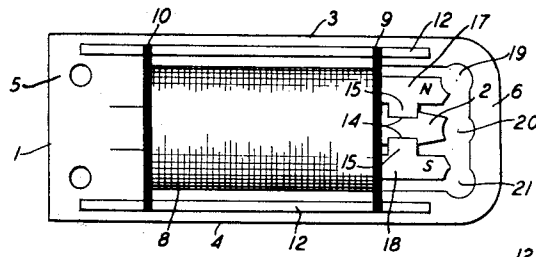
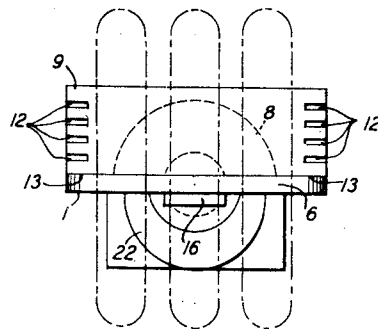


FIG. 2

FIG. 3



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FIG. 4

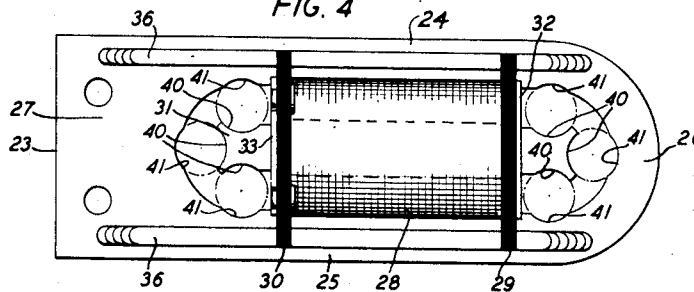


FIG. 5

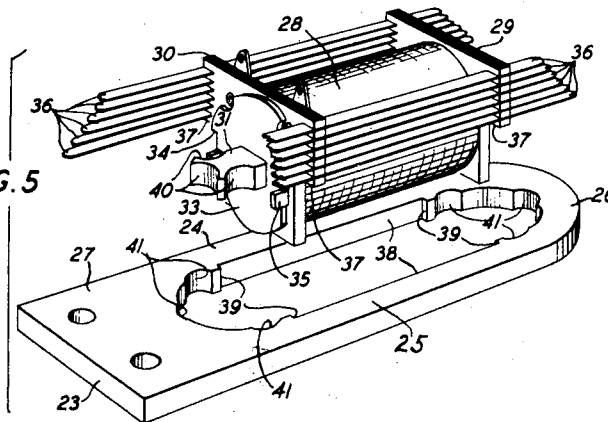


FIG. 6

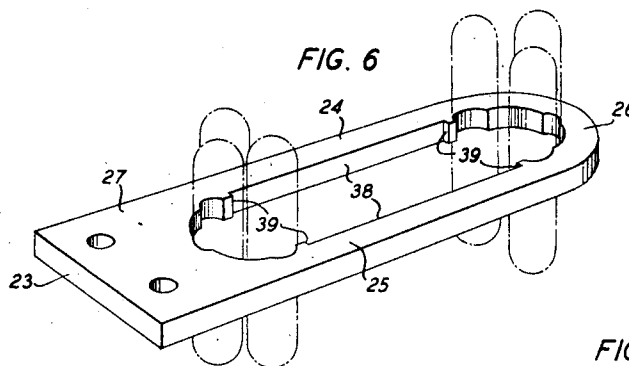


FIG. 8

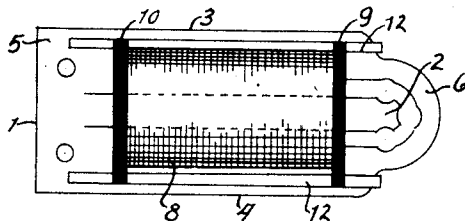
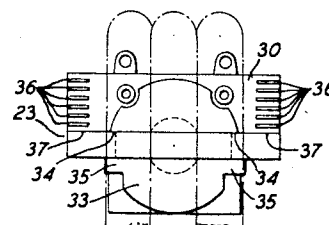


FIG. 7



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2,318,405

RELAY

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Application June 18, 1941, Serial No. 398,538

9 Claims. (Cl. 200—87)

This invention relates to electromagnetic devices and more particularly to relays.

Relay structures have heretofore been proposed in which a plurality of individual switch units could be mounted for operation by a single magnet coil. A structure of this character is disclosed, for example, in the application Serial No. 340,653 of H. C. Harrison, filed June 15, 1940, and comprises a comb of magnetic material with the teeth spaced in groups of three, each group of three teeth forming the magnetic circuit for two switches. More specifically, magnet coils surround the outer two teeth of the group which serve as core pole-pieces, and the central tooth serves as a common return pole-piece. The adjacent edges of these teeth are arcuately notched to form two openings for receiving and holding a pair of switch units, such switch units being disclosed as of the mercury contact type each comprising a metal capsule having contact electrodes insulatedly sealed through its upper end, a pool of mercury in the bottom of the capsule and a ball of magnetic material floating in the surface of the mercury pool with its entire surface wetted by the mercury and attractable when subjected to the magnetic field to bridge the inner ends of the contact terminals.

The objects of the present invention are to attain a greater degree of simplicity in relay structures of this type; to enable a greater number of switch units to be efficiently operated by the same magnet coil; to enable a relay of this character to be operated as a polarized relay and in other respects to improve relays and switches for circuit controlling purposes.

To attain these objects, one feature of the invention resides in a relay structure in which the entire magnetic circuit is stamped from a sheet of magnetic material into a substantially rectangular shape with three parallel arms all joined at one end and with the outer two joined at the other end. The middle arm serves as a core upon which the operating coil is mounted and is bent upwardly at an angle to the other arms to permit the coil to be slipped thereon and is then bent back into the plane of the other arms. The two outer arms together with the interconnecting yoke at one end of the structure serve as return paths for the magnetic flux. The end of the core arm which protrudes from the forward end of the coil may be arcuately notched in its end and on its two sides and the side arms and yoke may be correspondingly notched to form air-gap openings for the reception of switch units. These

switch units may, for example, be of the type disclosed in the Harrison application hereinbefore referred to, of the type disclosed in my copending application Serial No. 393,163, filed May 13, 1941, which became Patent No. 2,288,811 on July 7, 1942, or of any other suitable type.

A further feature of the invention resides in a relay of the type just described with a cross-piece connected to the forward end of the relay core having two forwardly extending pole-pieces which with the end of the core arm form three pole-pieces, each having an arcuate notch in its end, said notches being disposed opposite to similar arcuate notches in the inner edge of the yoke joining the forward ends of the side arms. The pole-pieces of the cross-member are oppositely polarized by a permanent magnet whereby, with switch units placed in the air-gap openings between the ends of these pole-pieces and the yoke, when the coil is energized by current of one polarity, the center unit and one of the outer units will be operated and when the coil is energized by current of the opposite polarity, the center unit and the other of the outer units will be operated. This structure therefore effects an efficient polarized operation in a very simple manner.

A further feature of the invention resides in a relay of the type described in which a greater number of switch units may be controlled by a single coil. In this structure the return magnetic circuit member of the relay is stamped from magnetic material into a substantially oval frame shape between the parallel longitudinal arms of which the energizing coil is supported by its spoolheads. The core of the relay extends axially through the coil in the plane of the return magnetic circuit member but with its protruding ends spaced from the end yokes of such member. The ends and sides of both ends of the core are arcuately notched and corresponding notches are formed in the inner edges of the end yokes to form openings in which a plurality of switch units may be supported at each end of the coil.

Other features of the invention will be apparent from a consideration of the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a top plan view of a polarized relay constructed in accordance with the present invention;

Fig. 2 is an exploded perspective view of the relay of Fig. 1 prior to its complete assembly;

Fig. 3 is a front end view of the relay of Fig. 1;

Fig. 4 is a top plan view of a modified form of relay constructed in accordance with the invention;

Fig. 5 is an exploded perspective view of the relay of Fig. 4 showing the coil and core assembly prior to its assembly with the return circuit member;

Fig. 6 is a perspective view of the return circuit member illustrating how a plurality of switch units may be assembled therewith;

Fig. 7 is a rear end view of the relay of Fig. 4; and

Fig. 8 is a top plan view of a non-polarized relay similar in structure to the relay of Fig. 1.

Referring first to Figs. 1 to 3, inclusive, which disclose a polarized relay constructed in accordance with the present invention, the magnetic circuit member 1 is stamped from a sheet of magnetic material into the shape best disclosed in Fig. 2, but with the center or core arm 2 thereof normally positioned in the plane of the two side arms 3 and 4. The side arms 3 and 4 are united at their rear ends to form a support 5 by which the relay may be secured to any desired mounting plate or apparatus rack and are united at their forward ends by a yoke portion 6. The side arms 3 and 4, together with the support portion 5 and forward yoke 6 constitute the return flux paths for the relay.

The support portion 5 is slotted as shown at 7 to permit the central or core arm 2 to be bent as shown to enable the coil assembly to be positioned thereon. The coil assembly comprises a coil 8 having front and rear spoolheads 9 and 10 of insulating material such as phenol linen or hard rubber cemented or otherwise secured to its ends. The coil and spoolheads are provided with aligned rectangular holes such as 11 throughout of sufficient cross-sectional area to receive the core arm 2, and the vertical edges of the spoolheads are provided with slots in which are seated a plurality of flat terminal strips 12 to the forward ends of which the terminals of switch units may be connected. In assembling the relay, the coil assembly is slipped over the bent-up core arm 2 until its rear spoolhead 10 engages against the forward edge of the support portion 5 and the core arm 2 is then bent downwardly until it lies in the plane of the side arms 3 and 4 in which position the shoulders 13 of the spoolheads 9 and 10 will engage the upper surfaces of the side arms 3 and 4 as best disclosed in Fig. 3.

The forward end of the core arm 2 is provided with notches 14 in the edges thereof in which are seated the portions 15 of an H-shaped cross-piece 16 of magnetic material. The parallel arms 17 and 18 of the cross-piece are positioned parallel to the core arm 2 and in the plane thereof when the portions 15 are seated in the notches 14, with their rear ends abutted against the front spoolhead 9 and with their forward ends spaced from the yoke 6. The cross-piece has a push fit upon the notched end of the core arm but if required could be further secured by staking or in any suitable manner.

The forward or pole-piece ends of the core arm 2 and of the cross-piece arms 17 and 18 are arcuately notched as best disclosed in Fig. 1 and the yoke 6 is correspondingly notched to form three circular openings 19, 20 and 21 in which switch units of any magnetically operated type may be inserted, as indicated by the dotted lines in Fig. 3, with their terminals connected to the forward ends of the terminal strips 12. The

switch units as previously stated could be of one of the types disclosed in the application of H. C. Harrison or in my copending application hereinbefore referred to.

Positioned beneath the cross-piece 16 with its polar ends in engagement with the arms 17 and 18 thereof, is a U-shaped permanent magnet 22 of suitable magnet material such as vicalloy. The cross-piece acts as a keeper for the magnet and the magnet so magnetizes the pole-piece arms 17 and 18 that the arm 17, for example, becomes a north pole and the arm 18 becomes a south pole.

In the operation of this relay, when the coil 8 is energized, a coil flux will be generated which will flow through the core arm 2 dividing at its junction with the rear portion 5 and flowing through the side arms 3 and 4 across the air-gaps through the switch units inserted in the openings 19, 20 and 21 to the pole-piece of the core arm and to the pole-pieces of the arms 17 and 18. The direction of the flow of flux in the divided flux path will, of course, depend upon the direction of the energizing current flowing through the coil 8. If the direction of flux due to the current in the coil is visualized as leaving the core and entering the cross-piece 16, the coil flux opposes the permanent magnet flux in the direction of the air-gap between the pole-piece arm 17 and the yoke 6 and the flux density in the pole-piece arm 17 is therefore decreased and flux readily flows across the air-gap between the arm 17 and the yoke 6 whereby the switch unit positioned in such air-gap opening 19 is operated. At the same time in the pole-piece arm 18, the coil flux aids the permanent magnet flux but since this arm is already almost or entirely saturated due to the flux generated by the permanent magnet 22, the increase in flux in this arm will be slight or nil and the flow of flux across the air-gap through the switch unit positioned in the opening 21 will not cause the operation of such unit. The unit positioned in the air-gap opening 20 between the pole-piece of the core arm 2 and the yoke being uninfluenced by the permanent magnet 22 will also be operated by the coil flux. A current of the opposite polarity in the coil 8 will reverse the direction of the coil flux and thereby cause the operation of the switch units 20 and 21 but not the operation of the switch unit 19.

The same general type of construction may be employed for a non-polar relay as disclosed in Fig. 8 in which case the cross-piece 16 and permanent magnet 22 are omitted and the spacing between the core arm 2 and the side arms 3 and 4 is reduced so that switch units may be supported between the sides and the end of the protruding forward end of the core arm and the inner edges of the side arms 3 and 4 and yoke 6. For this purpose the sides and end of the core arm 2 are provided with arcuate notches cooperating with similar arcuate notches formed in the inner edges of the side arms 3 and 4 and the yoke 6.

The structure is not necessarily limited to the assembly of three such units therewith, since by lengthening the core arm and the side arms to extend to a greater distance beyond the front spoolhead, two or more such arcuate notches in each side edge of the core arm and cooperating notches in the inner edges of the side arms could be provided whereby five or more switch units could be assembled therein for operation by the same operating coil.

When more than three switch units are required to be operated by the same operating coil, the units may be assembled in the magnetic circuit of a relay structure such as is disclosed in Figs. 4 to 7, inclusive, to secure a more efficient operation. In this modified form of the relay, the magnetic circuit member 23 is stamped from a sheet of magnetic material into a substantially rectangular shape with the central portion thereof cut way to provide an oval opening therethrough and thus, with the longitudinal edges of the member, to form two side arms 24 and 25. The outer end of the member 23 is cut concentric to the end wall of the oval opening to form an end yoke 26 joining the outer ends of the side arms 24 and 25. The rear end 27 of the member 23 serves as a support by which the relay may be secured to any desired mounting plate or apparatus rack. The side arms 24 and 25 together with the end yoke 26 and the support portion 27 constitute the return flux paths for the relay.

The coil assembly comprises a coil 28 having forward and rear spoolheads 29 and 30 of insulating material such as phenol linen or hard rubber cemented or otherwise secured to its ends. The coil and spoolheads are provided with aligned rectangular holes extending axially therethrough in which a core 31 is supported. The ends of the core extend beyond the spoolheads and such projecting portions are slightly reduced in width. Positioned outside the spoolheads and adjacent thereto are two thin locking washers 32 and 33 of non-magnetic material such as nickel-silver. Each of these washers is substantially circular in outline as disclosed in Fig. 7 and is provided with a central rectangular hole therein through which a reduced end of the core 31 extends. Each washer when positioned with its inner surface against the outer surface of the adjacent spoolhead also engages the shoulders formed at the junction of the main portion of the core extending through the coil and spoolhead and the reduced end portion of such core. Each washer is also provided with shoulders 34 and with two ears 35 struck up at right angles at oppositely disposed portions of its edge as best disclosed in Fig. 5 for a purpose to be hereinafter described.

The vertical edges of the spoolheads 29 and 30 are slotted as best disclosed in Fig. 7 in which slots are seated a plurality of flat terminal strips 36 of nickel-silver or other suitable metal to which the terminals of switch units and outside wiring may be soldered or otherwise connected and the vertical edges of the spoolheads are also made narrower beneath the notched portions thereof to provide shoulders 37 which rest upon the upper surface of the side arms 24 and 25 of the member 23 when the coil assembly is mounted thereon. The side arms 24 and 25 are narrowed slightly as indicated at 38 for a distance equal to the over-all length of the coil, its spoolheads and the locking washers 32 and 33 assembled therewith so that the distance between the side arms is only slightly greater than the width of the narrowed portion of the spoolheads and the width of the washers at a point just beneath the shoulders 34 thereof.

In assembling the coil assembly on the magnetic circuit member 23, it is inserted within the widened opening between the side arms 24 and 25 with the shoulders 37 of its spoolheads and the shoulders 34 of the washers 32 and 33 en-

gaged against the upper surfaces of the side arms 24 and 25 and with the outer surfaces of the washers engaged against the shoulders 39 formed in the side arms at the ends of the reduced portions thereof. The coil assembly is thus centralized within the opening in the member 23 and prevented from moving longitudinally with respect thereto. After having been thus positioned, the ears 35 of the washers 32 and 33 are bent back into the plane of such washers and beneath the lower surfaces of the side arms 24 and 25, thereby locking the coil assembly to the member 23. It is to be noted that the core 31 is now positioned with its axis lying in the plane of the axis of the member 23. Each projecting end of the core 31 is provided on the sides and end thereof with arcuate notches 40 and corresponding arcuate notches 41 are formed in the inner edges of the arms 24 and 25, yoke 26 and support portion 27 of the magnetic circuit member, thereby providing three circular openings at each end of the coil assembly in which switch units may be positioned as indicated by the dotted lines in Figs. 4, 6 and 7.

While the invention has been shown and described in connection with certain specific embodiments thereof, it is to be understood that the general features of the invention might be illustrated in other embodiments within the spirit and scope of the appended claims.

What is claimed is:

1. In a relay structure, a flat return pole-piece member having an opening therein to form two side arms united at their rear ends by a portion serving as a support and united at their front ends by a yoke, a coil supported between said side arms, a flat core extending through said coil and lying in the plane of said member, said core being shorter than the length of said opening and having arcuate notches in its edges adjacent to one end which, with corresponding arcuate notches in the inner edges of the side arms and yoke of said member, form circular air-gaps, and switch units having armatures positioned in said air-gaps.

2. In a relay structure, a flat return pole-piece member having three parallel arms joined at their rear ends to form a support portion, the outer two of said arms being joined at their forward ends to form a yoke and the center one of said arms serving as a core, a coil on said core arm, said core arm having arcuate notches in the edges of the forward end thereof which, with corresponding arcuate notches in the inner edges of the side arms and yoke of said member, form circular air-gaps, and switch units having armatures positioned in said air-gaps.

3. In a relay structure, a flat return pole-piece member having three parallel arms joined at their rear ends to form a support portion, the outer two of said arms being joined at their forward ends to form a yoke and the center one of said arms serving as a core, a coil assembly supported on said core arm comprising a coil, front and rear spoolheads of insulating material secured to the ends thereof and having aligned notches in their vertical edges and terminal strips positioned in said notches, said core arm having arcuate notches in the edges of the forward end thereof which, with corresponding arcuate notches in the inner edges of the side arms and yoke of said member, form circular air-gaps, and switch units having armatures positioned in said air-gaps.

4. In a relay structure, a flat return pole-piece member having three parallel arms joined at their rear ends to form a support portion, the outer two of said arms being joined at their forward ends to form a yoke and the center one of said arms serving as a core, a coil on said core arm, a cross-piece of magnetic material secured to the forward end of said core arm, a permanent magnet having its polar ends engaged with the ends of said cross-piece whereby said ends are oppositely polarized, said cross-piece and said core having arcuate notches in the ends thereof which, with corresponding arcuate notches in the inner edges of the side arms and yoke of said member, form circular air-gaps, and switch units having armatures positioned in said air-gap.

5. In a relay structure, a flat return pole-piece member having three parallel arms joined at their rear ends to form a support portion, the outer two of said arms being joined at their forward ends to form a yoke and the center one of said arms serving as a core, a coil on said core arm, an H-shaped cross-piece secured to the forward end of said core arm with its parallel arms positioned parallel to said core arm, a permanent magnet having its polar ends engaged with the arms of said cross member whereby said arms are oppositely polarized, the forward ends of said cross-piece arms and the end of said core arm having arcuate notches therein, which with corresponding arcuate notches in the inner edges of the side arms and yoke of said member, form circular air-gaps, and switch units having armatures positioned in said air-gaps.

6. In a relay structure, a flat return pole-piece member having an opening therein to form two side arms united at their rear ends by a portion serving as a support and united at their front ends by a yoke, a coil supported between said side arms, a flat core extending through said coil and lying in the plane of said member, said core being shorter than the length of said opening and having arcuate notches in its edges adjacent to each end thereof which, with corresponding arcuate notches in the inner edges of said side arms, support portion and yoke, form a plurality of circular air-gaps at each end of said coil, and switch units having armatures positioned in said air-gaps.

7. In a relay structure, a flat return pole-piece member having an opening therein to form two side arms united at their rear ends by a portion serving as a support and united at their front ends by a yoke, a coil assembly supported between said side arms comprising a coil, spoolheads secured to the ends thereof and having shouldered portions resting upon the side arms

of said member and washers having ears bendable beneath said side arms for locking said assembly to said member, a flat core extending through said coil assembly, said core being shorter than the length of said opening and having arcuate notches in the side and end edges of each end thereof which, with corresponding arcuate notches in the inner edges of said side arms, support portion and yoke, form a plurality of circular air-gaps at each end of said coil, and switch units having armatures positioned in said air-gaps.

8. In a relay structure, a flat return pole-piece member having an opening therein to form two side arms united at their rear ends by a portion serving as a support and united at their front ends by a yoke, said side arms having longitudinally extending notches in their inner edges of a length substantially equal to the over-all length of the coil assembly, a coil assembly positioned within the notched portion of said side arms comprising a coil, spoolheads secured to the ends thereof and having shouldered portions resting upon the side arms of said member and washers having ears bendable beneath said side arms for locking said assembly to said member, a flat core extending through said coil assembly, said core being shorter than the length of said opening and having arcuate notches in the sides and end edges of each end thereof which, with corresponding arcuate notches in the inner edges of said side arm, support portion and yoke, form a plurality of circular air-gaps at each end of said coil, and switch units having armatures positioned in said air-gaps.

9. In a relay structure, a flat return pole-piece member having an opening therein to form two side arms united at their rear ends by a portion serving as a support and united at their front ends by a yoke, a coil assembly supported between said side arms comprising a coil, spoolheads secured to the ends thereof having aligned notches in their vertical edges and having shouldered portions resting upon the side arms of said member, terminal strips positioned in said notches and washers having ears bendable beneath said side arms for locking said assembly to said member, a flat core extending through said coil assembly, said core being shorter than the length of said opening and having arcuate notches in the side and end edges of each end thereof which, with corresponding arcuate notches in the inner edges of said side arms, support portion and yoke, form a plurality of air-gaps at each end of said coil, and switch units having armatures positioned in said air-gaps.

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