

July 11, 1939.

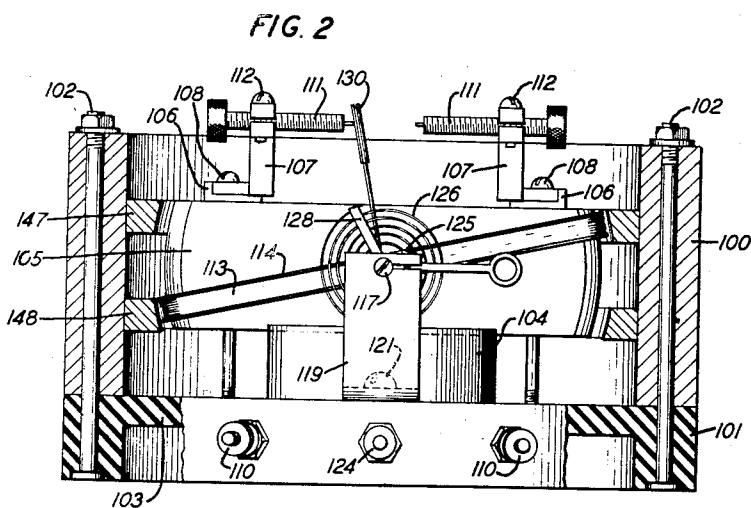
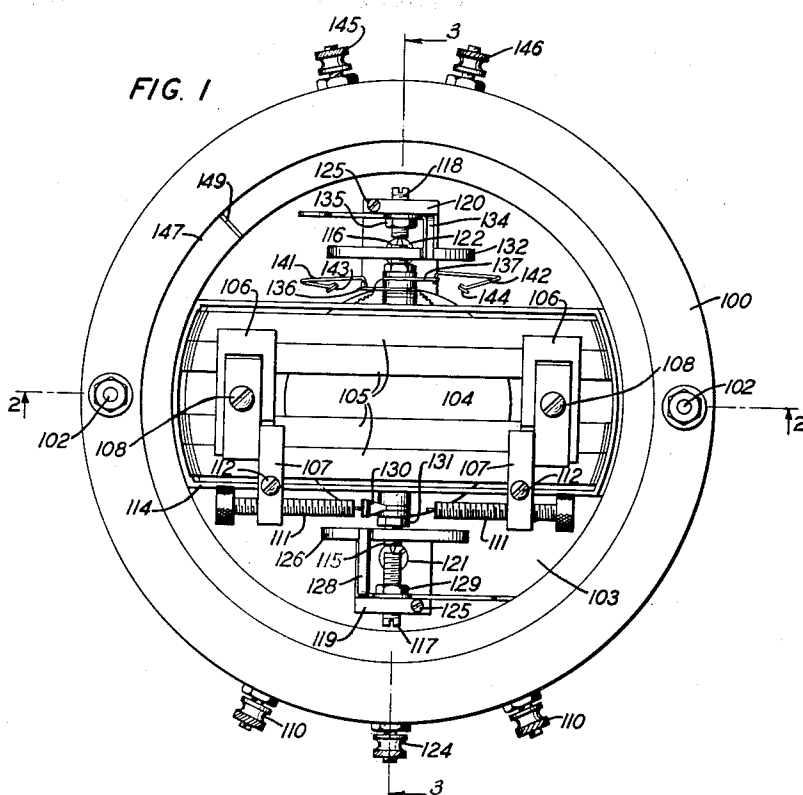
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2,165,798

RELAY

Filed Jan. 21, 1937

3 Sheets-Sheet 1



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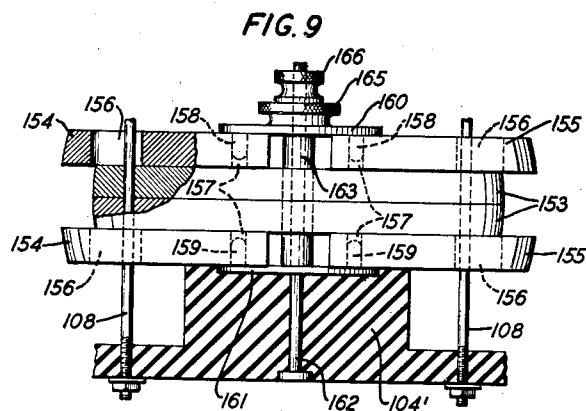
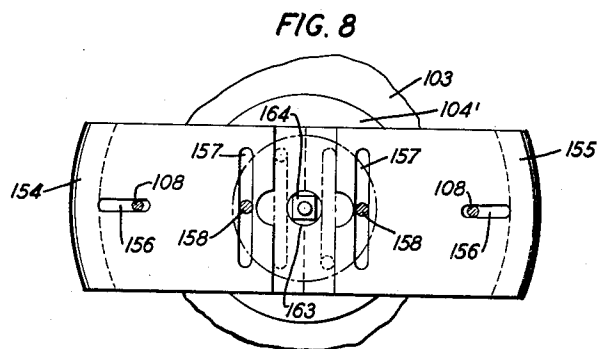
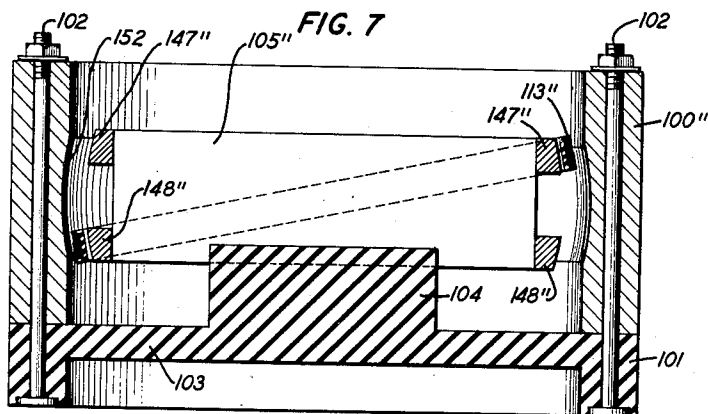
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RELAY

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3 Sheets-Sheet 3



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2,165,798

RELAY

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Application January 21, 1937, Serial No. 121,600

10 Claims. (Cl. 175—340)

This invention relates to electromagnetic devices and more particularly to relays of the meter type.

The object of the invention is to provide a relay of the meter type which shall be sensitive and accurate and shall have very positive contact pressure.

The relay in accordance with the invention comprises a fixed permanent magnet supported along the diameter and within an annular field yoke and an armature coil surrounding the permanent magnet and so mounted on spindles that it may swing between the poles of the magnet and the inner periphery of the yoke. Each spindle is pivoted in a fixed bearing and is provided with a helical restoring spring. One of the spindles carries a contact arm which in each of its extreme positions of movement engages with a fixed terminal. The restoring springs are so arranged that the armature coil is normally held in a neutral position with respect to the permanent magnet and the contact arm is positioned at a point midway between the fixed terminals.

To insure a positive pressure between the contact arm and either of the fixed terminals when the armature coil reaches the extreme of its movement in either direction, two split iron rings are adjustably positioned on the inner periphery of the yoke and serve to decrease the air-gaps between the yoke and the poles of the permanent magnet. These rings are so positioned that when the armature coil approaches a position in which the contact arm engages with one of the fixed terminals, it enters the reduced air-gap areas between the ring and the poles of the permanent magnet and thus the magnetic pull on the coil is increased to thereby increase the contact pressure between the contact arm and the fixed terminal with which it is engaged. Since the annular rings are split like piston rings they may be readily moved along the inner periphery of the yoke to positions where they are most effective and then maintain themselves set in the positions to which they have been moved.

As alternative constructions, shoes may be placed on the poles of the permanent magnet in lieu of rings on the inner periphery of the yoke, or the permanent magnet may be laminated with the outer laminations extensible toward the inner periphery of the yoke thereby affording means for adjustably decreasing the width of the air-gaps through which the armature coil swings.

For a clearer understanding of the invention reference may be had to the following detailed

description taken in connection with the accompanying drawings in which:

Fig. 1 is a plan view of a relay embodying the invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is an enlarged sectional view of the left-hand armature coil spindle and bearing as viewed in Fig. 3;

Fig. 5 is an enlarged sectional view of the right-hand armature coil spindle and bearing as viewed in Fig. 3;

Fig. 6 is a sectional view corresponding to Fig. 2, with parts of the relay omitted, showing modified forms of the armature coil and adjustable yoke rings;

Fig. 7 is a sectional view corresponding to Fig. 2, with parts of the relay omitted, showing a further modification of the yoke, permanent magnet and adjustable magnet shoes;

Fig. 8 is a plan view of a modified form of the permanent magnet for use in the structure of Fig. 7; and

Fig. 9 is a side view of the permanent magnet shown in Fig. 8.

Referring now more in detail to the drawings, Figs. 1 to 5 inclusive, illustrate one embodiment of the relay in accordance with the invention. The annular field yoke 100 is mounted on a base 101 of Bakelite or other suitable insulating material and is secured thereto by bolts 102 which pass through the base and through the yoke. The base is annular in conformation and is provided with a web 103 having a centrally disposed cylindrical support 104 on which are disposed a plurality of bar magnets 105 which form a permanent magnet assembly for the relay. The bar magnets may be made of cobalt steel or other suitable permanent magnet material having a high remanence and high coercive force.

The bar magnets are held in place in grooves in the upper surface of the cylindrical support 104 as most clearly shown in Fig. 3, by two clamping plates 106 of insulating material. These clamping plates are provided with grooves in which the terminal posts 107 are adjustably positioned. Bolts 108 extend through apertures in the bases of posts 107, plates 106 and the web 103 of base 101 for securing the bar magnets in place and for holding the terminal posts in adjusted position. The terminal posts 107 are electrically connected through the bolts 108 and straps 109 to binding posts 110 which are secured in the

annular walls of the base 101. Each of the terminal posts 107 has a terminal screw 111, provided with a knurled adjusting head, threaded through the bifurcated upper end thereof. For clamping the bifurcated portions of the ends of each post together for holding the terminal screw 111 in its adjusted position, screws 112 are provided.

The bar magnets 105 are provided with arcuate ends forming a composite arc about the center of yoke 100 about which the movable coil 113 swings. This coil consists of a plurality of convolutions of insulated wire wound on a channel-shaped frame 114 of aluminum or other suitable material. The frame is of substantially the same configuration as the permanent magnet assembly and is cemented or otherwise secured at the centers of its parallel sides to spindles 115 and 116 which carry pivot points adapted to be journaled in jewelled bearings carried by the bearing screws 117 and 118. The bearing screws 117 and 118 are threaded through the upper bifurcated ends of supports 119 and 120 which are secured at their lower ends to the web 103 of base 101 by bolts 121 and 122. The bearing support 119 is electrically connected through the bolt 121 and strap 123 to the binding post 124 which is secured in the annular wall of base 101, as shown in Fig. 3. For holding each bearing screw 117 or 118 in adjusted position, screws 125 are provided for clamping the bifurcated ends of the supports 119 and 120 together.

Surrounding the spindle 115 is a light helical restoring spring 126, the inner end of which is secured to a bracket 127 mounted on the spindle 115 and the outer end of which is secured to an adjustable bracket 129 mounted on the bearing screw 117. The bracket 128 is clamped against the bearing support 119 by the lock nut 129 and may be rotated on the screw 117, when the nut 129 is loosened, to adjust the tension of the spring 126. The bracket 127, together with the contact arm 130, is clamped upon the spindle 115 by the lock nut 131. The contact arm 30 is positioned in alignment with and between the contact ends of the terminal screws 111 and is electrically connected through the spindle 115, bearing screw 117, support 119, screw 121 and strap 123 to binding post 124. Thus, upon the movement of the coil 113 the contact arm 130 may engage either of the terminal screws 111 as the current in the coil 113 varies between predetermined limits.

Surrounding the spindle 116 is a second light helical restoring spring 132 wound oppositely to spring 126, the inner end of which is secured to a bracket 133 mounted on the spindle 116 and the outer end of which is secured to an adjustable bracket 134 mounted on the bearing screw 118. The bracket 134 is clamped against the bearing support 120 by the lock nut 135 and may be rotated on the screw 118, when lock nut 135 is loosened, to adjust the tension of spring 132. The bracket 133, together with washers 136 and 137, is clamped upon the spindle 116 by the lock nut 139. The washers 136 and 137 are insulated from each other and from the spindle 116 by insulating washers 139 and insulating sleeve 140 as most clearly shown in Fig. 5. The washers 136 and 137 are electrically connected to the terminals of the coil 113 and also by flexible connections 141 and 142 to the upper ends of posts 143 and 144 which are in turn connected to the binding posts 145 and 146 mounted in the annular wall of the base 101. The circuit for coil 113 thus extends from the binding post 145 through

post 143, flexible connection 141, washer 136, through the coil, washer 137, flexible connection 142, post 144 to binding post 146.

For adjusting the width of the air-gaps between the poles of the permanent magnet assembly and the inner peripheral surface of the field yoke 100, two iron rings 147 and 148 are provided. Each ring is split like a piston ring, as shown at 149, and is so tensioned as to grip the inner surface of the yoke. The inner surfaces of the rings are bevelled on an arc concentric to the arcuate ends of the permanent magnet assembly. Due to their split construction the rings may be adjustably positioned on the inner surface of the yoke 100 at such points thereon that they afford reduced air-gaps between the yoke and the poles of the permanent magnet assembly into which the ends of the coil 113 move as the coil approaches the extreme of its swinging movement in either direction. With the air-gaps thus reduced the force exerted on the coil 113 is increased as the coil approaches either extreme of its movement and thereby the contact arm 130, which follows the swinging movement of the coil, is brought into firm engagement with the terminal screw 111 with which it engages.

In Fig. 6 modified forms of the coil and iron field rings are disclosed. In accordance with this modification, the field yoke 100 is identical with that disclosed in Fig. 2, but the permanent magnet assembly 105' is made slightly shorter to accommodate a coil 113' wound in pancake form. The adjustable iron rings 147' and 148' are also changed in cross-section to present narrow or line surfaces 150 and 151 to the ends of coil 113' as the coil reaches the extreme of its swinging movement in either direction. To simplify the disclosure the other elements of the modified relay structure have not been illustrated, but would be identical with those disclosed in Figs. 1 to 5 inclusive.

Fig. 7 illustrates a further modification of the relay structure. In accordance with this modification the base 101 is identical with that disclosed in Fig. 2, but the field yoke 100'' is slightly modified to provide a spherical inner surface 152 within which the coil 113'' swings, there being a very narrow air-gap between the surface 152 and the ends of the coil. The permanent magnet assembly 105'' is made shorter and with arcuate ends concentric to the inner surface 152 of the yoke 100''. In this modification shoes 147'' and 148'' of magnetic material are adjustably mounted on the permanent magnet assembly and have their outer surfaces beveled on an arc concentric to the surface 152 of the yoke 100''. The shoes may be adjustably positioned on the permanent magnet assembly at such points thereon that they afford reduced air-gaps between the surface 152 of the yoke and the poles of the permanent magnet assembly. To simplify the disclosure, the other elements of the modified relay structure have not been illustrated, but would be identical with those disclosed in Figs. 1 to 5 inclusive.

Figs. 8 and 9 illustrate a further modification of the permanent magnet assembly suitable for use with the field yoke 100'' and coil 113'' of Fig. 7. In accordance with this modification, the permanent magnet assembly comprises a plurality of horizontally disposed bar magnets, two inside magnets 153 and two outside magnets each divided into two similar sections 154 and 155. Each of the sections 154 and 155 is provided with a longitudinally extending slot 156 aligned with holes

in the inside magnets 153 through which the clamping bolts 108 pass for holding the magnet assembly on the cylindrical support 104' of the base 101. The sections 154 and 155 are also provided with transversely extending cam slots 157 in which studs 158 and 159 carried by the discs 160 and 161 engage.

The discs are preferably of brass or other non-magnetic material, disc 161 being disposed in a depression in the upper end of cylindrical support 104' of the base and underlying the two lower magnet sections 154 and 155 and the disc 160 being disposed above the two upper magnet sections 154 and 155. The discs are journaled for rotation as a unit on the central bolt 162 extending upwardly through the support 104' and magnet assembly by the sleeve 163 of non-magnetic material. The ends of the sleeve 163 are provided with squared portions 164 which fit into squared openings in the discs 160 and 161 whereby when the disc 160 is turned by the knurled knob 165 attached thereto, the rotation of disc 160 is transmitted through sleeve 163 to disc 161. The upper threaded end of bolt 162 is provided with a knurled lock nut 166 by means of which the discs 160 and 161 are held in their adjusted positions.

By means of the engagement of studs 158 and 159, carried by the discs 160 and 161 in the cam slots 157, the magnet section 154 and 155 may be extended beyond the ends of magnets 153, as disclosed, or withdrawn toward each other into the positions indicated by the dotted lines of Fig. 8, through the rotation of discs 160 and 161 by the knob 165. The longitudinal slots 156 in the magnet sections 154 and 155 permit of this movement when the clamping bolts 108 and the central bolt 162 are loosened. By this construction of the permanent magnet assembly it is possible to widen or narrow the air-gaps between the pole ends of the permanent magnet assembly and the inside surface of the field yoke at the points where the ends of the armature coils reach their extreme of movement in either direction.

From the foregoing description it will be apparent that a relay structure of the meter type is provided which is sensitive and accurate in operation and in which a very positive engagement of the contacts is attained with no sacrifice to the sensitivity.

What is claimed is:

1. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, and means for adjusting the width of said air-gaps at points adjacent to the extremes of movement of said coil.

2. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, and members of magnetic material adjustably supported in said air-gaps at points adjacent to the extremes of movement of said coil.

3. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, and split rings of magnetic material adjustably supported on the

inner surface of said yoke for reducing the width of said air-gaps at points adjacent to the extremes of movement of said coil.

4. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, and rings of magnetic material adjustably supported on the inner surface of said yoke for reducing the width of said air-gaps at points adjacent to the extremes of movement of said coil.

5. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, said coil being wound in pancake form, and split rings of magnetic material adjustably supported on the inner surface of said yoke for reducing the width of said air-gaps and of such cross-section as to present narrow air-gap surfaces to the edges of said coil at points adjacent to the extremes of movement of said coil.

6. An electromagnetic device comprising a magnet, a yoke of magnetic material surrounding said magnet and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet and rotatable upon its energization through said air-gaps, and shoes of magnetic material adjustably supported on the poles of said magnet for reducing the air-gaps at points adjacent to the extremes of movement of said coil.

7. An electromagnetic device comprising a plurality of bar magnets forming a permanent magnet assembly, a yoke of magnetic material surrounding said magnet assembly and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet assembly and rotatable upon its energization through said air-gaps, and means for adjustably moving certain of said bar magnets for reducing the width of the air-gaps at points adjacent to the extremes of movement of said coil.

8. An electromagnetic device comprising a plurality of superimposed bar magnets forming a permanent magnet assembly, the outer ones of said bar magnets each being divided into two sections, a yoke of magnetic material surrounding said magnet assembly and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet assembly and rotatable upon its energization through said air-gaps, and means for moving the sections of each of said outside magnets toward or away from each other for adjusting the width of the air-gaps at points adjacent to the extremes of movement of said coil.

9. An electromagnetic device comprising a plurality of superimposed bar magnets forming a permanent magnet assembly, the outer ones of said bar magnets each being divided into two slidable sections, a yoke of magnetic material surrounding said magnet assembly and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet assembly and rotatable upon its energization through said air-gaps, and means for sliding the sections of each of said outside magnets toward or away from each other for adjusting the width of the air-gaps at points adjacent the extremes of movement of said coil, said means comprising rotatable cams.

10. An electromagnetic device comprising a plurality of superimposed bar magnets forming a permanent magnet assembly, the outer ones of said bar magnets each being divided into two
5 slidable sections, a yoke of magnetic material surrounding said magnet assembly and forming air-gaps with the poles thereof, a rotatably supported coil surrounding said magnet assembly and rotatable upon its energization through said
10 air-gaps, and means for sliding the sections of

each of said outside magnets toward or away from each other for adjusting the width of the air-gaps at points adjacent to the extremes of movement of said coil, said means comprising two interconnected rotatable discs associated re-
5 spectively with the two sections of each outside magnet, and studs carried by each disc and engaged in cam slots in the magnet sections with which said disc is associated.

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