Dec. 17, 1963 L. A. RICE 3,114,862

LATCHING RELAY

Filed March 18, 1960

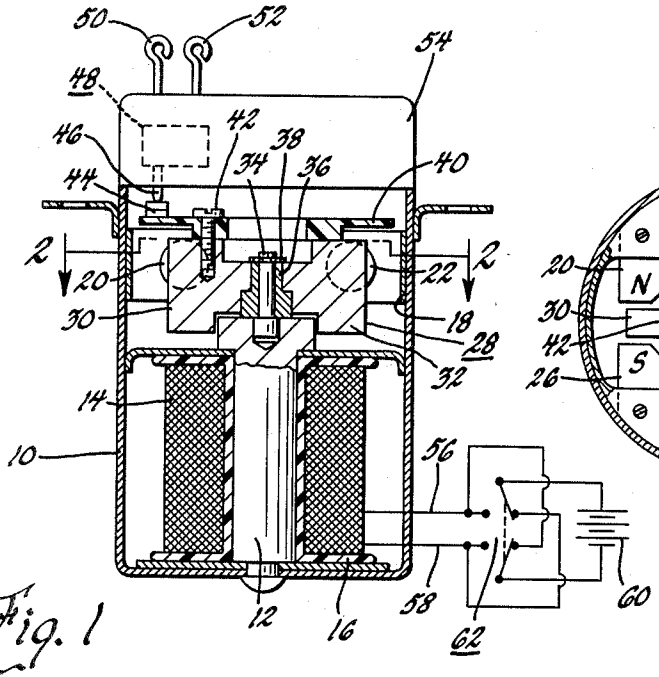

Fig. 1

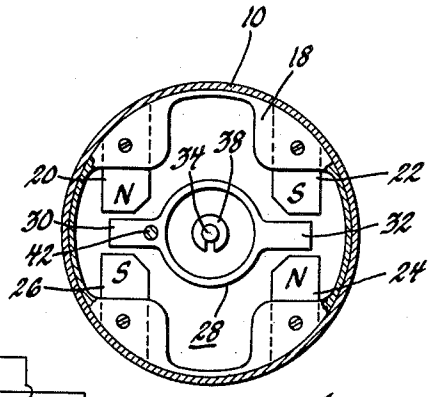

Fig. 2

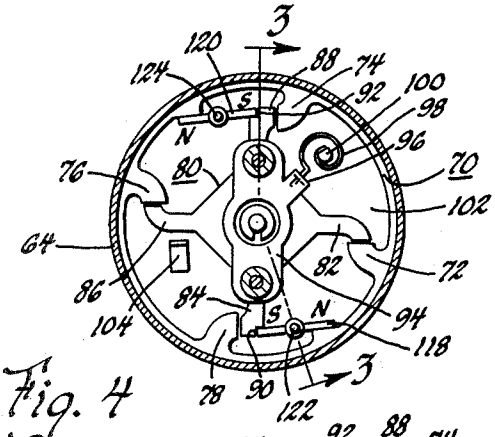

Fig. 4

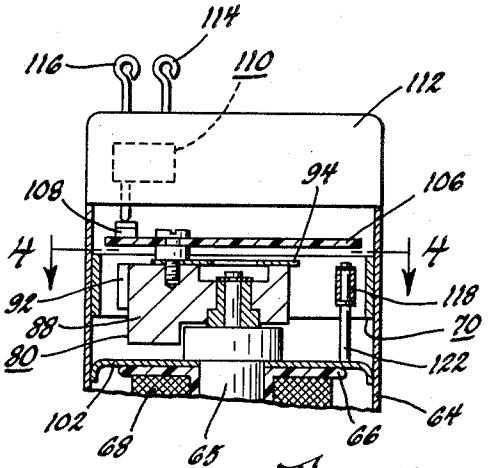

Fig. 3

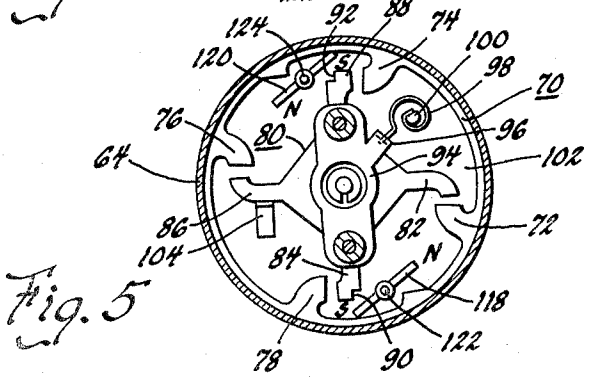

Fig. 5

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LATCHING RELAY

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This invention relates to electromagnetic relays and more particularly to an electromagnetic relay having an armature that is latched in predetermined positions by permanent magnets.

One of the objects of this invention is to provide a latching relay that includes a shiftable armature, an electromagnet and a plurality of permanent magnets, the electromagnet being operative when energized to cause shifting of the armature and the permanent magnets being operative to latch the armature in a predetermined position and to hold it in this position after the electromagnet is deenergized.

Another object of this invention is to provide a latching relay which is caused to become latched when a current flows through the electromagnet's coil winding in one direction and becomes unlatched when current is flowing through the coil winding of the electromagnet in an opposite direction.

A further object of this invention is to provide a latching relay that includes a rotatable armature, an electromagnet, a pole piece, and one or more pivotally mounted permanent magnets, the permanent magnets causing the armature to be latched between the permanent magnets and the pole piece when the electromagnet is being energized, and the electromagnet causing an unlatching of the armature when the current is reversed through the coil winding of the electromagnet.

Still another object of this invention is to provide a latching relay including a rotatable armature, an electromagnet and a pole piece containing a plurality of permanent magnets, the electromagnet causing rotation of the armature in one direction into contact with the permanent magnets when current flows through the electromagnet coil winding in one direction, the armature being held by said permanent magnets when the electromagnet is deenergized, and further wherein the armature is shifted into contact with other permanent magnets when the current flow is in an opposite direction through the coil of the electromagnet, the armature being held by the other permanent magnet when the electromagnet is once more deenergized.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein preferred embodiments of the invention are clearly shown.

In the drawings:

FIGURE 1 is a view partly in section illustrating a latching relay made in accordance with this invention.

FIGURE 2 is a sectional view taken along lines 2—2 of FIGURE 1.

FIGURE 3 is a view partly in section of a modified latching relay made in accordance with this invention.

FIGURE 4 is a sectional view taken along line 4—4 of FIGURE 3.

FIGURE 5 is a view similar to FIGURE 4 showing the relay in an unlatched position.

Referring to the drawings and more particularly to FIGURE 1, it is seen that the latching relay of this invention comprises a metal can 10 which is formed of magnetic material. The can 10 contains a core member 12 likewise formed of magnetic material, there being a coil winding 14 disposed within the can and wound on a spool 16 embracing the core 12. The can 10 supports a pole

piece 18 formed of magnetic material which is welded or otherwise secured to the can 10. The pole piece 18 carries a plurality of permanent magnets 20, 22, 24 and 26 having their tip ends of a magnetic polarity as indicated in FIGURE 2.

The latching relay of this invention further includes an armature generally designated by reference numeral 28 which is formed to have an arm 30 positioned between permanent magnets 20 and 26 and an arm 32 positioned between permanent magnets 22 and 24. The armature 28 is rotatably carried by the top end of core 12 by means of a pin 34, a non-magnetic bearing 36 and a retaining ring 38. The armature 28 carries an insulator member 40 which is fixed to the armature 28 by a fastener 42. The insulator plate 40 has a projection 44 which engages the actuator 46 of an electric switch which is generally designated by reference numeral 48. The switch 48 has terminals 50 and 52 supported by a cover 54. The switch 48 may be of any conventional type and is preferably supported by the cover 54.

The coil winding 14 of the electromagnetic relay is connected with lead wires 56 and 58 and these lead wires are connected with a battery 60 through a conventional reversing switch designated in its entirety by reference numeral 62. The switch 62 when in one closed position causes the lead wires 56 to be positive and the lead wire 58 negative and in the other closed position the electrical polarities of the lead wires 56 and 58 are reversed.

If it is assumed that the switch 62 is in one of its closed positions, it can be seen that a magnetic flux is generated which will pass through the can 10 through the pole piece 18, through the permanent magnets, through the armature 28 and thence back to the core member 12. If it is assumed that the armature is polarized north, the net effect of the flux will cause the armature to be attracted toward the permanent magnets 22 and 26 since their pole tips are of a south polarity. The armature will then rotate to a position wherein the arm portion 32 contacts the end of permanent magnet 22 and the arm 30 will engage the end of permanent magnet 26. If the switch 62 is now shifted to a position wherein the coil winding 14 is deenergized, the armature 28 will remain shifted into engagement with the tips of permanent magnets 22 and 26 and will be held there by the magnetic effect of these permanent magnets.

If the switch 62 is now shifted to change the direction of current flow through the coil winding 14 or in other words to reverse the current flow, the armature 28 will have a south polarity and will therefore be shifted into engagement with the tips of permanent magnets 20 and 24 which have a north polarity. If the coil winding 14 is now once more deenergized, the armature 28 will be held in contact with the tips of permanent magnets 20 and 24 due to the magnetic effect of these permanent magnets. When the armature 28 shifts, it operates the switch 48 in any desired sequence. Thus, during rotation of the armature 28 in one direction, the switch 48 may be caused to be closed and during the other rotation it may be caused to be opened. It will be appreciated that the latching relay of this invention might be used to operate devices other than electric switches. It will also be appreciated that once the armature 28 is shifted, it is no longer necessary to supply power to the coil winding 14 in order to hold the armature in a shifted position.

Referring now more particularly to FIGURES 3 through 5, a modified latching relay made in accordance with this invention is illustrated. In this relay, a metal can 64 formed of magnetic material encloses a core 65, a spool 66 and a coil winding 68. It is to be understood that the lower part of the relay which is not il-

lustrated in FIGURE 3 is identical with the lower part of the relay illustrated in FIGURE 1. The relay of FIGURES 3 through 5 has a pole piece 70 which is welded or otherwise secured to the can 64, the pole piece including pole tips 72, 74, 76 and 78. The pole piece 70 and its pole tips cooperate with an armature generally designated by reference numeral 80 which has arms 82, 84, 86 and 88. The arms 84 and 88 are formed with notched out portions 90 and 92 as is clearly apparent from an inspection of FIGURES 4 and 5. The armature 80 is rotatably mounted with respect to the core 65 in a manner identical with the mounting of armature 28 with respect to core 12 in FIGURE 1.

The armature 80 carries a plate member 94 having an ear 96 engaging one end of a spring 98. The opposite end of the spring 98 is fixed to a post 100 which is supported by the plate member 102. A stop member 104 is provided which at times engages the arm 86 of armature 80, the stop 104 likewise being supported by the plate 102.

The armature 80 also carries a plate 106 formed of insulating material which has a projection 108 for operating an electric switch 110. The switch 110 is supported within a cover 112 and is connected with terminals 114 and 116 which may be connected with some device to be controlled.

The latching relay of FIGURES 3, 4 and 5 includes a pair of permanent magnets 118 and 120 which are pivotally supported on posts 122 and 124. These posts are suitably supported by the plate member 102 and are preferably formed of non-magnetic material. The permanent magnets 118 and 120 are polarized as shown in FIGURES 4 and 5.

In operating the latching relay of FIGURES 3, 4 and 5, the coil winding 68 is connected with a reversing switch and with the battery in a manner illustrated in FIGURE 1. Assuming now that the current flow through the coil winding 68 is such as to polarize the armature 80 as a north pole, the pole piece 70 will be a south pole and the armature will be magnetically urged to a position wherein the arms of the armature contact the pole tips 72 through 78. As the armature moves into engagement with the pole tips, the ends of the permanent magnets which are polarized as south poles will be attracted toward the arms 88 and 84 and will snap into the notches 90 and 92. If the coil winding 68 is now deenergized, the armature 80 will be latched in the FIGURE 4 position by the rotatable permanent magnets 118 and 120, the spring 98 tending to urge the armature 80 in a direction away from the pole tips and against the ends of the permanent magnets 118 and 120. In FIGURES 4 and 5, the spring tends to rotate the armature 80 in a counterclockwise direction. It thus is seen that after the coil winding 68 is deenergized the magnets 118 and 120.

If the coil winding 68 is now energized by current flowing in an opposite direction from its previous flow, the armature 80 will be polarized as a south pole and the pole piece 70 as a north pole. This will cause the armature 80 to move into engagement with the pole tips of the pole piece and will also cause the permanent magnets 118 and 120 to be rotated counterclockwise in FIGURES 4 and 5 out of engagement with the arms 84 and 88. This is true because the end of the permanent magnets 118 and 120 is now at the same magnetic polarity as the arms 88 and 90. This rotation of the permanent magnets out of the recesses 90 and 92 will also be aided by the fact that the pole piece 70 is now at a north polarity, and since the end of the permanet magnets adjacent the pole piece are at a north polarity they will be repelled away from the pole piece. If the coil winding 68 is now deenergized, the spring 98 will rotate the armature 80 into engagement with the stop 104 or to its fully counterclockwise position as illustrated in FIGURE 5.

It can be seen that the latching relay of this device thus has two positions which may be used to operate the switch 110 or any other device requiring multi-position movement. It will, of course, be appreciated that there is little or no frictional force to the rotation of the permanent magnets into or out of the recesses 90 and 92 since at the time they are moving the arms of the armature are in engagement with the tips of the pole piece, and the armature 80 therefore does not move into tight engagement with the permanent magnets 118 and 120 until the coil winding 68 is deenergized.

The flux path in the embodiment of FIGURES 1 and 2 and in the embodiment of FIGURES 3 through 5 is the same in that the flux passes from the core of the coil winding, thence through the can, thence through the pole piece, thence into the armature and then from the armature back into the top end of the core.

While the embodiments of the invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A latching relay comprising, a metal can member formed of magnetic material, a unitary pole piece carried by said can member, an electromagnet positioned within said can member including a coil winding and a core, an armature pivotally supported on the end of said core and cooperating with said pole piece, and means for latching said armature in a predetermined position after it has been shifted to said position by energization of said coil winding including a permanent magnet rigidly secured to said pole piece, said permanent magnet being operative to hold said armature in said predetermined position after said coil winding is deenergized, said metal can forming a magnetic circuit between one end of said core and said pole piece.

2. A latching relay comprising, a container formed of magnetic material, an electromagnet in said container including a coil winding and a core, a pole piece supported by said container, an armature pivotally mounted on said core, and a plurality of permanent magnets carried by and immovably secured to said pole piece and positioned on opposite sides of said armature for holding said armature in predetermined positions after the coil winding of said electromagnet has been energized to shift the armature and then deenergized said container forming a magnetic circuit between one end of said core and said pole piece.

3. A latching relay comprising, a container formed of magnetic material, an electromagnet supported by said container including a core member and a coil winding, a pole piece supported by said container, an armature pivotally supported on the end of said core member and positioned within said pole piece, and a plurality of permanent magnets positioned within openings in said pole piece and secured thereto said armature having oppositely directed arms extending between permanent magnets of opposite polarities, said container forming a magnetic circuit between one end of said core member and said pole piece.

4. A latching relay comprising, a container formed of magnetic material, an electromagnet supported by said container including a core member and a coil winding, a pole piece supported by said container, an armature pivotally supported by said core member and positioned to be attracted to said pole piece, and a pair of permanent magnets pivotally supported and having ends adapted to be wedged into engagement with said armature to latch said armature in place when it has been shifted to a predetermined position by energization of said coil winding.

5. A latching relay comprising, an electromagnet, a rotatable armature having oppositely directed arms each formed with a notch, means magnetically connecting said electromagnet and said armature whereby said armature

is shifted in one direction when said electromagnet is energized, and a pair of rotatable permanent magnets having end portions adapted to fit in said notches for latching said armature in a predetermined position, said permanent magnets being attracted toward said armature when the current flow through the coil winding of the electromagnet is in one direction and being repelled from said armature when the current through the coil winding is in an opposite direction.

6. A latching relay comprising, a container formed of magnetic material, an electromagnet supported by said container including a core member and a coil winding, a pole piece supported by said container, an armature pivotally supported on the top end of said core member and positioned to cooperate with said pole piece, said armature having oppositely directed arms, each having a notch formed therein, and a pair of permanent magnets supported for pivotal movement having end portions adapted to be attracted into said notches when the current flow through said coil winding is in a predetermined direction, said permanent magnets being repelled from said armature when the current flow through said coil winding is in a reverse direction to unlatch said relay.

7. A latching relay comprising, an electromagnet, a rotatable armature having oppositely directed arms at least one of which is formed with shoulder means, means magnetically connecting said electromagnet and said armature whereby said armature is shifted in one direction when said electromagnet is energized, and a permanent

magnet, said permanent magnet being pivotally mounted on pivot means that is spaced from said armature and having an end portion adapted to engage said shoulder means for latching said armature in a predetermined position, said permanent magnet being attracted toward said armature when the current flow through the coil winding of the electromagnet is in one direction and being repelled from said armature when the current through the coil winding is in an opposite direction.

8. A latching relay comprising, an electromagnet including a metal core and a coil winding encircling said core, an armature pivotally supported on one end of said core, a unitary pole piece encircling said armature, means magnetically connecting the opposite end of said core with said pole piece, and a plurality of permanent magnets rigidly supported by said pole piece and forming pole faces projecting from said pole piece toward said armature, said permanent magnets being adapted to hold said armature in a predetermined position after said coil winding is deenergized and following shifting of said armature by the energization of said coil winding.

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