June 10, 1941. E. DICKTEN, JR 2,245,391

POLARIZED RELAY

Filed July 11, 1940

FIG. 1

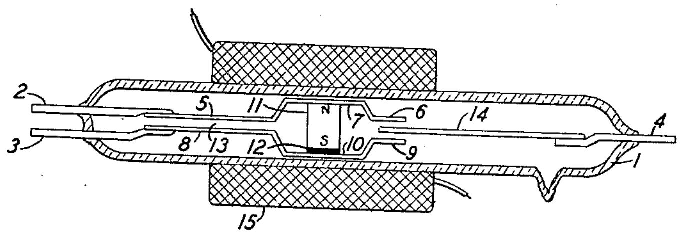


FIG. 2

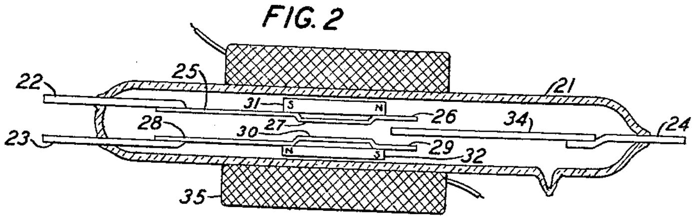
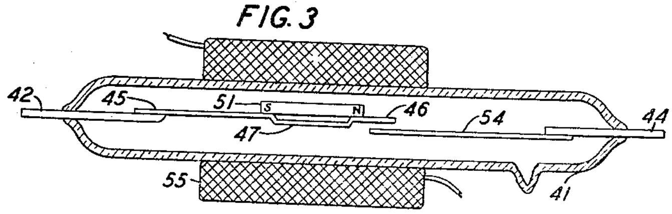


FIG. 3



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POLARIZED RELAY

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Application July 11, 1940, Serial No. 344,901

8 Claims. (Cl. 200—93)

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

It is an object of the present invention to provide a relay structure of the polarized type which has a suitable margin of safety against false operation when a high percentage of the operating current is flowing and the relay is at the same time subject to vibration.

It is a further object of the invention to reduce the cost and to increase the utility, durability and the reliability of a polarized relay.

In accordance with the present invention, these objects are attained by the use of saturated iron as a magnetic rectifier to admit or to impede the flow of magnetic flux according to its polarity. In its more general aspects the magnetic rectifier is disclosed in my application Serial No. 344,898, filed July 11, 1940. In the present invention the magnetic rectifier has been illustrated as applied to a relay structure of the type disclosed in application Serial No. 198,629, of W. B. Ellwood, filed March 29, 1938. One of the chief advantages of this invention is that it eliminates the complicated mechanical and magnetic structures of the usual polarized relays and enables these to be replaced by three magnetic contact springs and one or two small permanent magnets whereby the magnetic contact springs perform both the magnetic and electrical functions essential to a polarized relay structure. By enclosing the contacts in an evacuated vessel or in a vessel having an atmosphere of inert gas, it is possible to use a magnetic material such as iron for the contacts or precious metal contacts may be used.

For a more comprehensive understanding of the invention reference may be had to the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 shows one embodiment of the invention partly in cross-section;

Fig. 2 shows a second embodiment of the invention partly in cross-section; and,

Fig. 3 shows the invention embodied in a relay structure for enabling the closure of its contacts only in response to current of one polarity applied to its operating coil.

Referring first to Fig. 1 of the drawing, 1 is a glass vessel through one end of which terminals 2 and 3 are sealed and through the other end of which a single terminal 4 is sealed. To the inner end of terminal 2 is welded or otherwise secured, a strip 5 of pure iron which is provided between its free or contact end 6 and its point of attachment to the terminal 2 with a raised portion 7. Similarly secured to the inner end of terminal 3 is a second strip 8 of pure iron which is also provided between its free or contact end 9 and its point of attachment to the terminal 3 with a raised portion 10. The raised portions 7 and 10 extend away from each other approximately into engagement with the inner wall of the vessel 1 and are joined by a short permanent bar magnet 11. The north pole of magnet 11 is shown in magnetic engagement with the raised portion 7 of strip 5 and the south pole is conductively but not magnetically separated from the raised portion 10 of strip 8 as indicated at 12 by an insulating cement such as, for example, aluminum oxide. The main portions of the strips 5 and 8 are electrically separated from each other by a low reluctance air-gap 13.

Similarly secured to the inner end of terminal 4 is a flexible strip 14 of pure iron, the inner end of which lies midway between the contact ends 6 and 9 of the strips 5 and 8 and normally separated therefrom by air-gaps. The vessel 1 may contain any suitable inert and non-corrosive gas such as helium, argon or neon or may be evacuated.

The pressure of the enclosed gas may be adjusted before the vessel is sealed to the best operating condition. Surrounding the vessel 1 is an operating coil 15.

Considering the operation of this relay, the strips 5 and 8 separated as they are by a very low reluctance air-gap 13 serve as a keeper for the permanent magnet 11 so that a flux density is normally produced in the strips 5 and 8 sufficiently large to operate the iron thereof in the vicinity of the knee of the saturation curve. In this high flux density condition strips 5 and 8 will still have a low reluctance as compared with that of the air-gaps between their contact ends 6 and 9 and the strip 14. The flux from the permanent magnet may be visualized as leaving the north pole of the magnet entering the strip 5 flowing across the narrow air-gap 13 to the strip 8 and entering the magnet at its south pole.

When the coil 15 is energized, electromagnetic lines of force are caused to flow into the core of the coil, some of which tend to flow in strip 5 and some of which tend to flow in strip 8, and then across the air-gaps to the strip 14, thence out of the core of the coil or, reversely, dependent upon the polarity of the current by which the coil 15 is energized.

If the direction of the flux due to current in the coil 15 is pictured as entering the core of the coil by the strips 5 and 8 and as leaving by the strip 14, the coil flux opposes the permanent magnet flux in the strip 5 and the flux density in this strip is therefore decreased whereby flux readily flows across the air-gap between the contact end 6 of strip 5 and the strip 14 and therefore the strip 14 becomes attracted into engagement with the contact end 6 of strip 5. At the same time in the strip 8, the coil flux aids the permanent magnet flux but, since this strip is already almost or entirely saturated due to the permanent magnet flux, the increase in flux in this strip will be slight or nil and practically no flux will flow across the air-gap between the contact end 9 of this strip and strip 14 and therefore there will be no force tending to hold strip 14 from engagement with strip 5. The engagement between strips 5 and 14 electrically connects terminals 2 and 4.

A current of the opposite polarity through the coil 15, will cause flux to flow in the reverse direction through the strips 5 and 8 and in this case, since the coil flux in strip 8 opposes the permanent magnet flux therein and the coil flux in strip 5 aids the permanent magnet flux therein, the strip 14 will be attracted into electrical engagement with the contact end 9 of strip 8 thereby interconnecting terminals 3 and 4.

Fig. 2 illustrates a modified form of the invention in which the vessel 21, terminals 22, 23 and 24, flexible strip 34 and coil 35 may be identical with the similar parts of Fig. 1. Welded or otherwise secured to the inner end of terminal 22 is a flexible strip 25 of pure iron which is provided between its free or contact end 26 and its point of attachment to the terminal 22 with a recessed portion 27. Similarly secured to the inner end of terminal 23 is a flexible strip 28 of pure iron which is provided between its free or contact end 29 and its point of attachment to the terminal 23 with a recessed portion 30. The contact ends 26 and 29 of the strips 25 and 28 are positioned on either side of the end of strip 34 and are separated therefrom by air-gaps. A permanent bar magnet 31 is secured to the outer face of strip 25 in bridge of the recessed portion 27 thereof, whereby only the polar ends of the magnet are in engagement with the strip 25 and the recessed portion 27 thereby serves as a keeper for the magnet 31. A second permanent bar magnet 32 is secured to the outer face of strip 28 in bridge of the recessed portion 30 thereof whereby only the polar ends of the magnet are in engagement with the strip 28 and the recessed portion 30 thereby serves as a keeper for the magnet 32. The flux from magnet 31 may be visualized as leaving the north pole thereof flowing through the strip 25 toward the attached end thereof and entering the south pole of said magnet, and the flux from magnet 32 may be visualized as leaving the north pole thereof, flowing through the strip 28 toward the contact end 29 thereof and entering the south pole of such magnet.

Considering the operation of this modified form of relay, when the coil 35 is energized, electromagnetic lines of force are caused to flow into the core of the coil, some of which tend to flow in the strip 25 and some of which tend to flow in the strip 28 and across the air-gaps to the strip 34, thence out of the core of the coil or, reversely, dependent upon the polarity of the current by which the coil is energized.

If the direction of the flux due to current in the coil 35 is pictured as entering the core of the coil by the strips 25 and 28 and as leaving by the strip 34, the coil flux opposes the permanent magnet flux flowing from magnet 31 through strip 25 and the flux density in this strip is therefore decreased whereby flux readily flows across the air-gap between the contact end 26 of such strip and strip 34 and therefore strips 25 and 34 become attracted into engagement. At the same time in the strip 28, the coil flux aids the flux for magnet 32 but, since this strip is already almost or entirely saturated due to the flux from magnet 32, the increase in flux in this strip will be slight or nil and practically no flux will flow across the air-gap between the contact end 29 of strip 28 and the strip 34 and therefore there will be no force tending to hold strip 34 from engagement with strip 25. The engagement between strips 25 and 34 electrically connects terminals 22 and 24.

A current of the opposite polarity through the coil 35 will cause flux to flow in the reverse direction through the strips 25 and 28 and in this case, since the coil flux in the strip 28 opposes the flux from the permanent magnet 32 and the coil flux in strip 25 aids the flux from the permanent magnet 31, the strips 28 and 34 will be attracted into engagement thereby interconnecting terminals 23 and 24.

Fig. 3 shows the invention applied to a relay for enabling the contacts thereof to be closed only when the operating coil is energized by current of a predetermined polarity. Essentially the relay is of the same general construction as that disclosed in Fig. 2 with the exception that one of the flexible strips and associated permanent magnet have been omitted. Considering the operation of the relay of Fig. 3, if the coil 55 is energized by current of such polarity as to cause a flow of flux into its core through the strip 45 across the air-gap between the contact end 46 of such strip into strip 54, and thence out of the core of the coil, the flux through strip 45 will oppose the flux set up therethrough by magnet 51 and consequently flux will flow across the air-gap to strip 54 thereby causing the strips 45 and 54 to be attracted into engagement to interconnect terminals 42 and 44. If on the other hand the current flowing through coil 55 is reversed, thereby tending to cause flux to flow into the core of the coil through strip 54 across the air-gap and thence out of the core of the coil through strip 45, the coil flux through strip 45 will aid the permanent magnet flux and consequently insufficient flux will flow across the air-gap to cause the attraction of strips 45 and 54 into engagement.

What is claimed is:

1. In a circuit controlling device, a gas-tight vessel, a contact spring of magnetic material, a permanent magnet in bridge of a portion thereof, a second contact spring of magnetic material, said contact springs being enclosed in said vessel, and a coil outside said vessel operative to cause the engagement of the contacts of said springs only in response to its energization by current of one polarity.

2. In a circuit controlling device, a gas-tight vessel, a first contact spring of magnetic material having a recessed portion therein, a permanent magnet secured to said spring in bridge of said recessed portion, a second contact spring of magnetic material, said contact springs being enclosed in said vessel, and a coil outside said vessel operative to cause the engagement of the

contacts of said springs only in response to its energization by current of one polarity.

3. In a circuit controlling device, a gas-tight vessel, a terminal sealed through each end of said vessel, a first contact spring of magnetic material secured to one of said terminals and having a recessed portion therein, a permanent bar magnet having its polar ends secured to said spring and positioned in bridge of said recessed portion, a second contact spring of magnetic material secured to the other of said terminals, said contact springs being enclosed in said vessel with their free ends superimposed, and a coil surrounding said vessel operative to cause the engagement of the contacts of said springs only in response to its energization by current of one polarity.

4. In a circuit controlling device, a gas-tight vessel, a pair of spaced contact springs of magnetic material, each having a permanent magnet in bridge of a portion thereof, a third contact spring of magnetic material interposed between said spaced contact springs, said contact springs all being enclosed in said vessel, and a coil outside said vessel operative to cause the engagement of the contact of said third contact spring with the contact of one or the other of said spaced contact springs in response to its energization by currents of opposite polarity.

5. In a circuit controlling device, a gas-tight vessel, a pair of spaced contact springs of magnetic material, each having a recessed portion therein, a permanent magnet secured to each contact spring in bridge of the recessed portion thereof, a third contact spring of magnetic material interposed between said spaced contact springs, said contact springs all being enclosed in said vessel, and a coil outside said vessel operative to cause the engagement of the contact of said third contact spring with the contact of one or the other of said spaced contact springs in response to its energization by currents of opposite polarity.

6. In a circuit controlling device, a gas-tight vessel, a pair of terminals sealed through one end of said vessel, a third terminal sealed through the other end of said vessel, a pair of spaced contact springs of magnetic material secured respectively to said pair of terminals, each of said contact springs having a recessed portion, a permanent bar magnet having its polar ends secured to one of said contact springs and positioned in bridge of the recessed portion thereof, a second permanent bar magnet having its polar ends secured to the other of said contact springs and positioned in bridge of the recessed portion thereof, said magnets being oppositely poled with respect to the free ends of said springs, a third contact spring of magnetic material secured to said third terminal with its free end interposed between the free ends of said spaced contact springs, and a coil surrounding said vessel operative to cause the engagement of the contact of said third spring with the contact of one or the other of said spaced contact springs in response to its energization by currents of opposite polarity.

7. In a circuit controlling device, a gas-tight vessel, a pair of spaced contact springs of magnetic material, magnetic means for normally magnetically saturating portions of said springs, a third contact spring of magnetic material interposed between said spaced contact springs, said contact springs and said magnetic means being enclosed in said vessel, and a coil outside said vessel operative to cause the engagement of the contact of said third contact spring with the contact of one or the other of said spaced contact springs in response to its energization by currents of opposite polarity.

8. In a circuit controlling device, a gas-tight vessel, a pair of terminals sealed through one end of said vessel, a third terminal sealed through the other end of said vessel, a pair of spaced contact springs of magnetic material secured respectively to said pair of terminals and separated from each other near their points of support by a low reluctance air-gap, a permanent magnet insulatedly bridged between said springs near their free ends for normally magnetically saturating those portions of said springs extending between the poles of said magnet and said low reluctance air-gap, a third contact spring of magnetic material secured to said third terminal with its free end interposed between the free ends of said spaced springs, and a coil outside said vessel operative to cause the engagement of the contact of said third contact spring with the contact of one or the other of said spaced contact springs in response to its energization by currents of opposite polarity.

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