Oct. 11, 1932. J. R. FRY 1,881,460

RELAY

Filed Dec. 21, 1927

FIG. 1

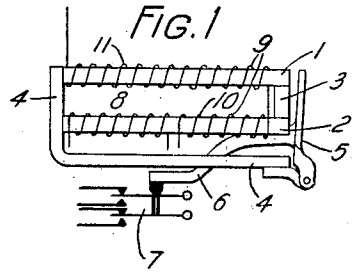


FIG. 3

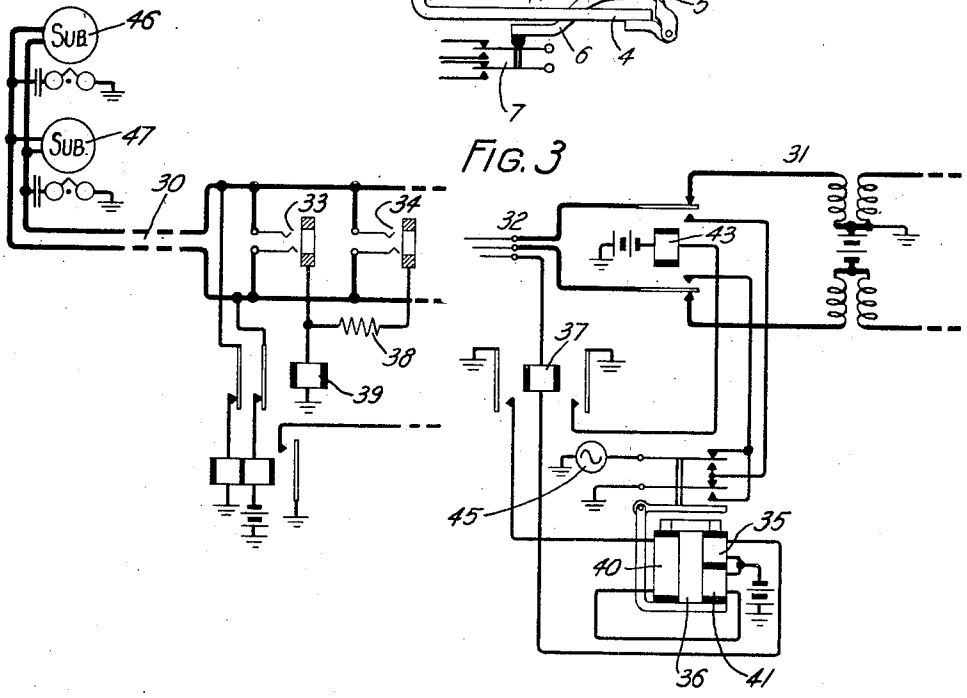
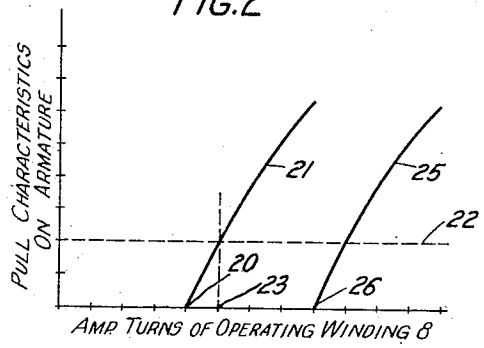


FIG. 2



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UNITED STATES PATENT OFFICE

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RELAY

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This invention relates to relays and its object is to improve the operating characteristics and efficiency of marginal relays.

Heretofore various types of marginal relays have been proposed. One objection to these prior devices is that the armature is subjected to an attractive force when current below the desired operating value is flowing through the relay winding. This tends to operate the armature and consequently makes it more difficult to maintain the required margin.

According to the present invention these difficulties are overcome by a relay having a magnetic structure comprising two cores forming a closed magnetic circuit, an armature and a separate magnetic circuit including the cores and armature. An operating winding is wound on one core and a polarizing winding partly on the same core and partly on the other core such that with current flowing in both windings substantially no flux passes through the armature until the operating current is increased to a definite value. When this occurs the magnetization produced by the operating winding overcomes that produced by that portion of the polarizing winding on the same core and thus causes sufficient flux to flow through the armature to operate it.

The invention has been illustrated in the accompanying drawing, in which Fig. 1 shows, in general, the physical arrangement of a relay embodying the invention. Fig. 2 is a graphic representation of the electromagnetic pull versus ampere turn characteristics of this relay, and Fig. 3 shows the use of this relay in a cord circuit.

Referring now to the drawing, a relay embodying operating characteristics in accordance with this invention may be designed along the lines shown in Fig. 1. For example, the relay may consist of two parallel magnetic cores 1 and 2 connected together at one end by member 3 of magnetic material and at the other end by member 4 of magnetic material to form a closed magnetic circuit. Member 4 also serves as a pole-piece for a separate magnetic circuit from the two cores through the air gap between cores and armature, the said pole-piece and the armature 5 which is pivoted to the free end of the pole-piece. The armature 5 is provided with an arm 6 for the control of contacts 7. The cores are provided with a polarizing winding 9, having a portion 11 on core 1 and a portion 10 on core 2, and an operating winding 8 on core 2.

The arrangement of the windings and the source of energizing current therefor may be such that substantially no electromagnetic pull is produced to attract the armature 5 until the ampere turns of the operating winding 8 exceed the ampere turns of the portion 10 of the polarizing winding 9. On further increases of the ampere turns of the operating winding 8 the electromagnetic pull on the armature 5 will increase in the usual manner.

To secure this effect the portion 10 of the polarizing winding 9 is wound so that the current therethrough will produce a magnetization of core 2 in a series aiding direction with the magnetization produced by portion 11 on core 1 around the closed magnetic circuit formed by the two cores and connecting members 3 and 4, and in a direction to oppose that produced by the operating winding 8 on core 2. If now the current in winding 8 is of such value that the magnetizing effect thereof is equal to or less than that produced by portion 10 of winding 9, the net magnetizing effect of windings on core 2 will be either zero or will have a value in a direction of that produced by portion 10. Under this condition the cores 1 and 2 will be magnetized in a series aiding direction around the closed magnetic circuit formed by said cores and connecting members 3 and 4, and substantially no magnetic flux will pass across the air gap between cores and armature 5 and consequently there will be no effect on the armature of the relay. On the other hand if the current in winding 8 is increased such that its magnetizing effect is greater than that of portion 10 of winding 9, the net magnetizing effect of windings on core 2 will be in a direction of that produced by winding 8. Under this condition magnetization of core 2 will be opposed by that

of core 1 with respect to a series aiding direction around the closed magnetic circuit and electromagnetic flux will pass from said cores through the air gap between cores and armature to armature 5 and return pole piece 4, and cause attraction of the armature. As the current in winding 8 is further increased it will cause a further increase in the magnetic flux through the air gap to the armature and consequently increase the force of attraction on the armature.

This point is illustrated in Fig. 2 where the pull characteristics on the armature have been plotted against the ampere turns of the operating winding 8 with various fixed values of current in winding 9. For example, as the ampere turns on winding 8 are increased from zero there will be no pull effective on the armature until the ampere turns of winding 8 become equal to the ampere turns of portion 10 of winding 9, which value is represented by the point 20. If the ampere turns of the winding 8 are greater a pull will be produced in the armature in accordance with the curve 21. If, for example, the pull required to attract the armature is represented by line 22, the ampere turns of the winding 8 will have to be increased to the point 23 before the armature will be attracted. It follows therefore that the ampere turns of the winding 8 have to have a value equal to the point 20 before any pull at all can be produced on the armature and to reach point 23 before the armature is attracted. Hence in relays designed in accordance with this invention the exact point at which pull should be exerted on the armature may be definitely established by the ampere turns of the portion 10. As the ampere turns of this portion can be permanently fixed the relay will not operate before the ampere turns of the operating winding has reached the desired definite value. It follows that this point, at which the relay shall operate, may be shifted by changing the ampere turns of the portion 10 and that no attractive force will be exerted on the armature until this point is reached. The curve 25 represents the pull characteristics for the armature when the value of the ampere turns of the portion 10 has been increased four spaces to the point 26.

A circuit arrangement illustrating the use of a relay of this character has been shown in Fig. 3, where a subscriber's party line 30 is shown and a cord circuit 31 with means for calling either of the two parties of line 30 by inserting the plug 32 into either of the jacks 33 or 34. When plug 32 is inserted in jack 34 a sleeve circuit is completed from battery, through the operating winding 35 of relay 36, winding of relay 37, the sleeve terminals of plug 32 and jack 34, resistance 38, winding of cut-off relay 39 to ground. Relays 39 and 37 operate in this circuit, relay 37 to close a circuit for the polarizing winding of relay 36. This winding as shown, is divided in two portions 40 and 41, portion 41 being on the same core as the operating winding 35. Relay 36 is designed in accordance with this invention and under these circumstances, due to the presence of the resistance 38, the ampere turns of the operating winding 35 will be equal to or less than the ampere turns of winding 41. Hence, relay 36 will not attract its armature. Relay 37 in operating closes an obvious energizing circuit for relay 43 which in operating connects the alternating current source 45 to the ring conductor and ground to the tip conductor of the cord 31 and line 30 to cause the operation of the bell of the subscriber at 46 in the usual manner.

If the subscriber at 47 is to be called, plug 32 will be inserted in jack 33. It will be noted that the sleeve circuit in this case has no resistance, such as 38, so that the ampere turns of the operating winding 35 will now be of a sufficiently high value to be greater than that of winding 41. Consequently, relay 36 will operate in this circuit and cause the alternating current source 45 to be connected to the tip conductor and ground to the ring conductor of cord 31 and line 30 to operate the bell of the subscriber at 47.

It is readily seen that with a resistance such as 38 in the sleeve circuit to secure the marginal operating characteristics, if an ordinary marginal relay had been used in place of relay 36, a certain amount of pull would have been exerted on the armature. If the voltage of the operating current is not properly balanced in relation to the resistance the reliability of operation of the marginal relay would be affected. In the case of the relay 36 considerable variation in the voltage of the operating current may exist, without affecting the operate or non-operate characteristics of the relay.

It should be understood that the use of a relay of this character is not limited to the circuit shown but that it may be used in other systems where marginal operating characteristics are desired and that the operating characteristics may be varied to suit different requirements without departing from the spirit of the invention.

What is claimed is:

1. A relay having two cores magnetically connected at each end, an armature, a separate magnetic connecting link between the cores and the armature, an operating winding on one core, a polarizing winding with a portion of its turns on each of the cores, and means whereby if the windings are energized to set up flux in the magnetic connection through the cores only the armature is not attracted and if energized also to set up flux in the separate magnetic connecting link the armature is attracted.

2. A relay having two cores, an armature, an operating winding on one core, a polarizing winding with a portion of its turns on each of the cores, and means associated with said cores whereby the armature will only be subjected to an attractive force from flux produced by said windings when the energization of the operating winding is increased to exceed a certain value.

3. A relay having two cores, an armature, an operating winding on one core, a polarizing winding with a portion of its turns on each of the cores, and means associated with said cores whereby when the windings are energized, flux is produced in said cores to prevent an attractive force from acting on the armature until the ampere turns of the operating winding exceeds those of the polarizing winding.

4. A relay having two cores, a winding on one core, another winding with a portion of its turns on each of the two cores, an armature, a magnetic circuit excluding the armature, a magnetic circuit including the armature, means for energizing said windings to different degrees, said windings being so arranged on said cores that in response to the energization of the first mentioned winding below a certain degree in relation to the energization of the other winding, magnetic flux in the first magnetic circuit prevents the attraction of the armature and that in response to the energization of said first mentioned winding above this degree in relation to the energization of the other winding, magnetic flux in the second magnetic circuit attracts the armature.

5. A relay having two cores, an operating winding on one core, a polarizing winding with a portion of its turns on each of the two cores, and means whereby the armature is not subject to an attractive force when said windings are subjected to certain variable relative energizations and the armature is attracted when said windings are subjected to certain other variable relative energizations with the current always in the same direction.

6. A relay having two cores, an armature, an operating winding on one core, a polarizing winding with a portion of its turns on each of the cores, means for energizing said windings with currents flowing in one direction only through said windings, and means whereby the windings when energized to certain relative values of said currents, the flux produced by said energizations is directed so as to prevent it acting on the armature, and when energized to certain other relative values of said currents the flux produced by said energizations is directed so as to act on the armature.

7. A relay having two cores, a winding on one core, another winding with a portion of its turns on each of the two cores, an armature, a magnetic circuit including the armature, a magnetic circuit excluding the armature, means for energizing said windings in the same direction to different degrees, the winding with a portion of its turns on each of the two cores being so arranged on said cores that in response to the changes in relative degree of energization of both windings, flux in the magnetic circuits is deflected from one to the other of said magnetic circuits.

In witness whereof, I hereunto subscribe my name this 13th day of December, A. D. 1927.

JACOB R. FRY.