Feb. 14, 1933. J. R. FRY 1,897,045

RELAY

Filed Dec. 23, 1927

FIG. 1

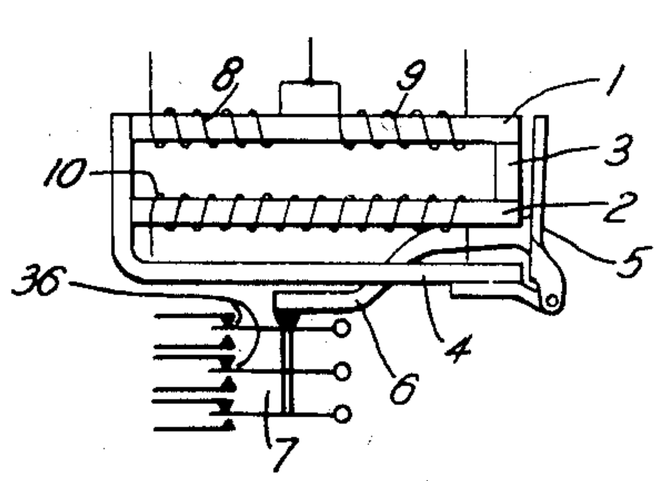


FIG. 3

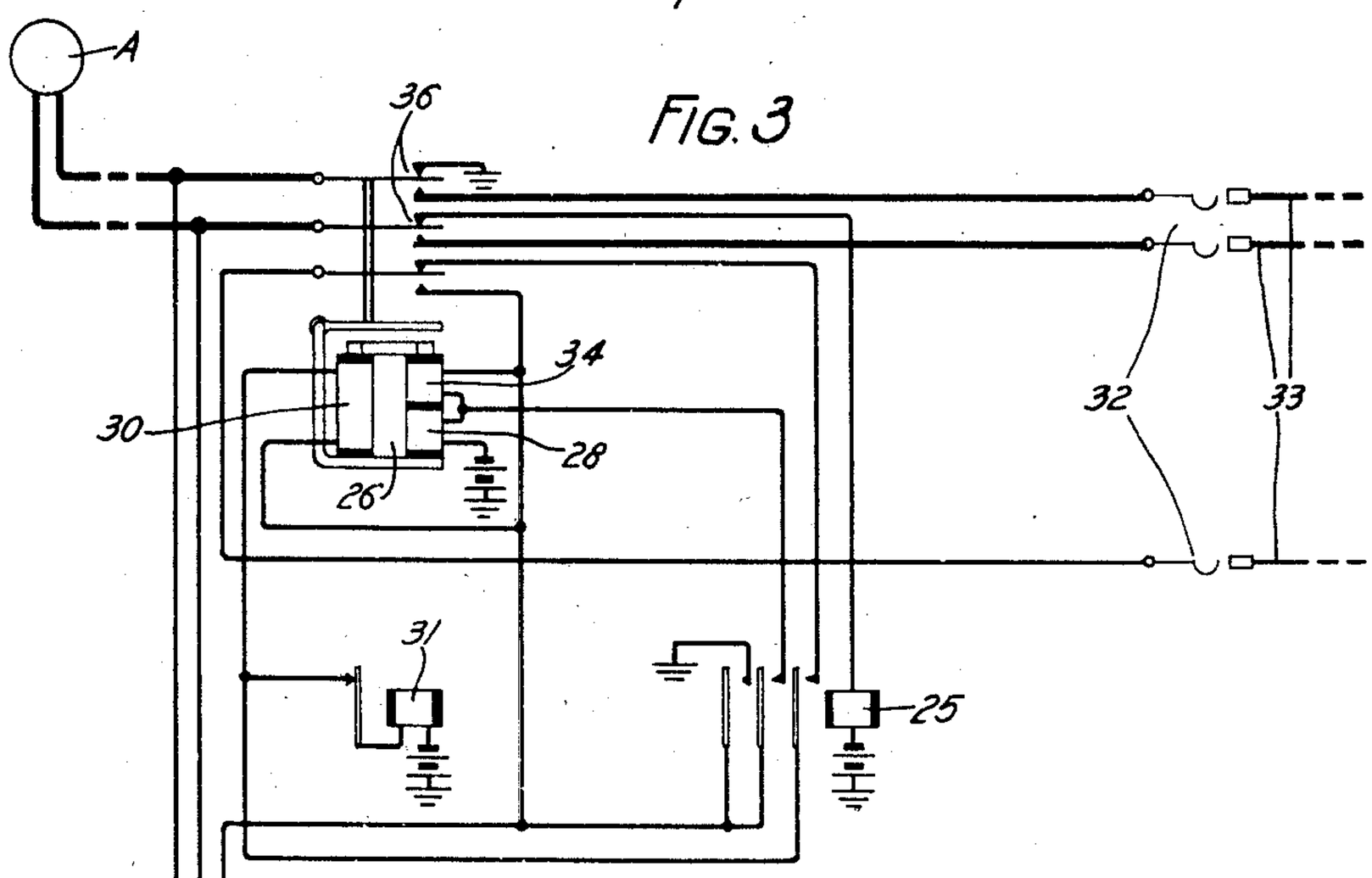
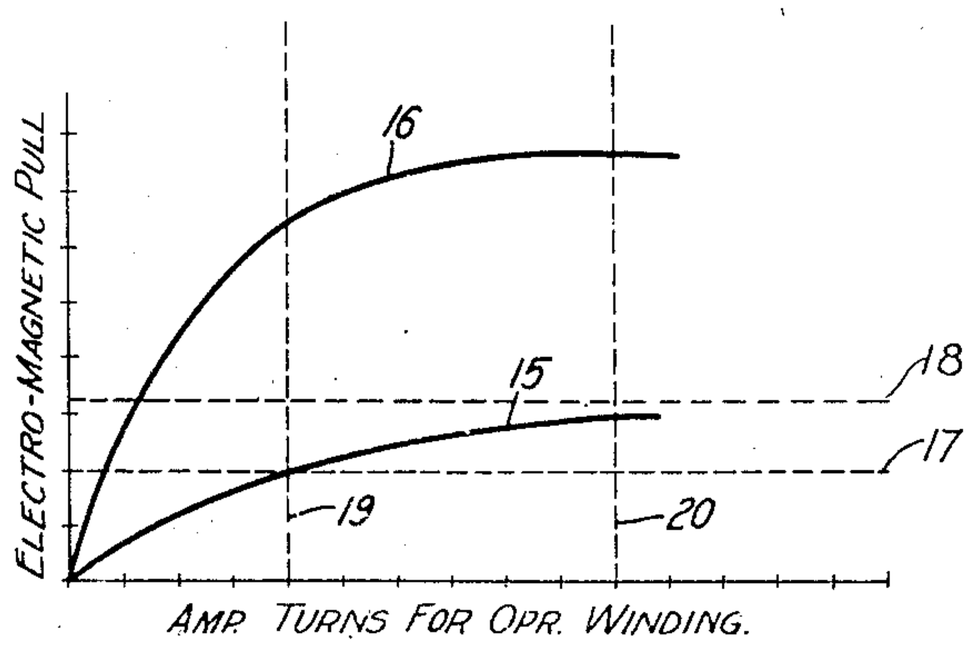


FIG. 2



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RELAY

Application filed December 22, 1927. Serial No. 242,112.

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

Heretofore polarized relays have been known having a magnetic structure comprising two cores forming a closed magnetic circuit, an armature and a separate magnetic circuit including the cores and armature.

A feature of this invention is a structure of this kind with an operating winding on one core and one or more polarizing windings on the other core so arranged that with the energization of the operating winding within certain limits and the energization of the polarizing winding or windings to produce flux of a certain degree in the core on which said polarizing windings are wound, a partial operation of the armature will take place, while with the energization of the operating winding within said limits and the energization of the polarizing winding or windings to cause flux of a certain other degree in the core, a complete operation of the armature will take place.

According to this invention a structure of this kind is provided with an operating winding on one core and two polarizing windings on the other core such that the energization of the operating winding and both polarizing windings causes a partial operation of the armature while energization of the operating winding and one polarizing winding causes complete operation of the armature. By this arrangement the operation of the relay is made more independent of variations in the current supply for the operating winding.

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, while Fig. 3 shows the use of this relay in a line switch circuit. For circuit arrangements including line switches of the type shown in Fig. 3 and selectors and connectors that may function therewith reference may be had to Patents 1,725,152 August 20, 1929 to C. E. Lomax and 1,742,334 January 27, 1930 to J. Wicks.

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 a member 3 of magnetic material and at the other end by a 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 armature 5, which is pivoted to the free end of the pole piece 4. The armature 5 is provided with an arm 6 for control of the contacts 7. Core 1 is provided with polarizing windings 8 and 9 and core 2 with an operating winding 10.

The arrangement of the windings and the sources of energizing current therefor may be such that the energization of the operating winding and the energization of the two polarizing windings in a series aiding relation will cause the armature to be attracted with a certain electromagnetic pull to produce a corresponding effect on the switching contacts. For example, this electromagnetic pull may cause the armature to move only a definite distance, against a suitable yielding means such as a spring for holding it in normal position, to open certain contacts only. On the other hand, the arrangement is such that if the operating winding and only one of the polarizing windings are energized, the armature will be attracted with a different electromagnetic pull to cause all of the contacts normally closed to open and the contacts normally opened to close.

To secure these two different effects on the armature, the polarizing windings are so arranged that when they are both energized in a series aiding relation less ampere turns are effective on the core than when only one of these windings is energized. In other words, if the same battery is used for energizing both windings and winding 8 is of less resistance than winding 9, it follows that when both windings are energized the

current therethrough may be less than the current through winding 8 when energized alone. Hence although the turns are increased when both windings are energized the amperage may be decreased in greater proportion than the turns are increased. The total magnetizing effect is therefore less than the corresponding magnetizing effect when winding 8 alone is energized. The electromagnetic flux produced in core 2 by the operating winding 10 may be shunted through the closed magnetic circuit formed by the two cores and the connecting members 3 and 4, or a portion thereof may pass through the path formed by the air gap, the armature 5 and the pole piece 4. The degree to which the core 1 shunts the flux produced by winding 10 on core 2 from the air gap and armature 5 depends upon the intensity of the opposing magnetization produced by windings on core 1, the shunting action becoming less as the magnetization produced by the polarizing windings on core 1 is increased. That is, if the flux in core 1, opposing the flux in core 2, is of a lower value it offers less opposition to the flux of core 2 passing through core 1 than if the flux in core 1 is of a higher value. Thus, for example, when both polarizing windings are energized the shunting action of core 1 is greater and the flux produced by winding 10 on core 2 is less effective on the armature 5 than when only one of the polarizing windings is energized.

It is obvious that this result can be obtained by other winding arrangements than the one shown, which is a preferred form. For example a greater intensity of magnetization on core 1 might be produced when the two windings 8 and 9 are energized than when only one of these windings is energized. With this arrangement, and the operating winding 10 energized, the relay will fully operate when both polarizing windings are energized and partially operate when one of the polarizing windings is energized. As another example, a single polarizing winding on core 1 may be utilized for producing different degrees of magnetization by providing any well-known means for changing the current characteristics therein.

It follows that the operating current for the winding 10 may change within comparatively wide limits without affecting the operating characteristics of the relay. Fig. 2 illustrates this point. If the curve 15 represents the electromagnetic pull characteristics when both of the polarizing windings are energized and curve 16 represents the electromagnetic pull characteristics when only one of the polarizing windings is energized, it will be seen that the difference between the two pull characteristics will remain practically constant for a considerable variation in ampere turns for the operating winding. Thus, as long as the pull represented by the curve 15 is sufficient to cause the desired effect on the armature, which may be represented by the line 17, and yet not exceed a certain amount, represented by the line 18, it is evident that the operating current or the ampere turns for the winding 10 may vary between the lines 19 and 20 without destroying the marginal characteristics of the relay. It should be understood that the pull represented by the curve 16 should at the point crossed by line 19, be sufficient to fully attract the armature.

A relay of this kind may be employed in a variety of circuit arrangements where definite and reliable distinctions between the two conditions of operations are desirable, even though the operating current for the operating winding may vary to a considerable extent. This would be the case in circuits where the operating current is supplied from lines of different lengths having different attenuation characteristics.

A circuit arrangement showing how a relay of this character may be used is illustrated in Fig. 3. This circuit is an ordinary line switch circuit, of the type shown in the above mentioned reference patents, with a relay as shown in Fig. 1 replacing the usual two-step relay. This relay is marked 26 with the operating winding 30 and windings 28 and 34 corresponding to windings 10, 8 and 9 respectively of the relay shown in Fig. 1. The operation of the circuit may be outlined as follows: If the subscriber of station A desires to establish a connection to central office, the removal of the receiver from the hook causes the operation of line relay 25. The circuit for this relay is extended through the two outer armatures and back contacts of the two-step relay 26. Relay 25 in operating places ground on the conductor 27 leading to the usual connector multiple terminals to guard against intrusion from incoming calls. This relay also completes a circuit for energizing the polarizing winding 28 of relay 26 from battery, through winding 28, the middle and outer armatures and front contacts of relay 25, to ground. Another circuit closed by the operation of relay 25 is the circuit for the operating winding 30 from battery, through the winding, armature and back contact of the stepping magnet 31, winding 30, outer left hand armature and front contact of relay 25, to ground. Whether the relay 26 or the stepping magnet 31 are to be operated in this circuit depends on whether the brushes 32 of the line switch are associated with terminals of an idle or busy selector circuit. The terminals of one of these circuits are indicated at 33 and may be connected to the usual selector of the type shown in the above mentioned reference patents.

Assuming that the brushes 32 are on the

terminals of a busy selector, it is well known in the art as shown in the above mentioned reference patents that the busy condition is electrically identified, by a ground potential on the sleeve conductor. Under this condition, the two-step relay 26 will not operate since the operating winding is shunted by the ground on the sleeve conductor of the line switch which is connected through the upper inner armature and back contact of relay 26 and inner armature and front contact of relay 25. The stepping magnet 31, however, is energized from this ground over a circuit as follows: battery, winding, armature and back contact of stepping magnet 31, inner left hand armature and front contact of relay 25, inner armature and back contact of relay 26, to the sleeve conductor of the busy selector to ground. The stepping magnet 31 will now operate and continue to step, due to its self-interrupting contacts, until the brushes 32 are advanced to an idle selector.

When an idle selector having no ground on its sleeve terminal is found, the shunt for the operating winding 30 of relay 26 will be removed so this relay is operated from the battery supplied through the winding of the stepping magnet 31 over the circuit hereinbefore traced terminating at a ground on the outer armature and front contact of relay 25. The electrical characteristics of the stepping magnet 31 are such that this magnet will not operate to advance its brushes when its circuit is in series with the operating winding of the relay 26. The line switch consequently stops with its brushes on the terminals of this idle selector. In this case, therefore, relay 26 energizes to attract its armature fully, as a large pull will be developed due to the fact that only one of the polarizing windings is energized.

The subscriber's line is now extended through to the idle selector, which as shown in the above mentioned reference patents supplies battery and ground to the subscriber's line and a ground on the sleeve conductor. This latter ground is supplied before the line relay 25 releases. Relay 25 is released when its circuit is opened through the operation of relay 26. Relay 26 will now be held in an operating position by a circuit completed from battery, through the winding armature and back contact of the stepping magnet 31, the operating winding 30, upper inner armature and front contact of relay 26 to the ground on the sleeve conductor of the connected selector, and also through a circuit from battery, the two polarizing windings in series to the ground on the sleeve conductor. Since relay 26 is in operated position it will be held operated even though the polarizing circuit is changed from winding 28 to include winding 34. Relay 26 is held operated until released at the end of the call under control of the subscriber, as shown in the above mentioned reference patents.

The operation of the circuit for a call incoming to the subscriber is as follows: When a connector seizes the terminals associated with the subscriber's line at 35 ground is placed on conductor 27 as is well known in the art and shown in the above mentioned reference Patent No. 1,725,152. The two-step relay 26 is thereby energized from battery, through the polarizing windings 28 and 34 in series aiding, to ground on the conductor 27 and through the operating winding from battery, stepping relay 31, the operating winding 30, to the ground on conductor 27. Since the polarizing windings are in series aiding relation, and windings 28 and 34 are assumed to have the same characteristics as windings 8 and 9 respectively of the relay shown in Fig. 1, the relay will develop a relatively small pull and operate partially to open the connection at the contacts 36 from the subscriber's line to the line relay 25, and ground. Relay 26 will now be held in this position until the end of the call when it is restored by the removal of the ground on conductor 27.

It should be understood that the use of a relay of this character is not limited to the circuit shown but may be used to advantage in other systems where a relay having an action of this kind is desired, and the two operating characteristics of the relay may be varied to suit different requirements without departing from the spirit of the invention.

What is claimed is:

1. A relay having an armature, operating and polarizing windings, and means whereby when said windings are energized in one manner the armature is partially attracted and when energized in another manner the armature is fully attracted.

2. A relay having an armature, an operating winding and a polarizing winding, and means including said windings whereby when said windings are energized in one manner the armature is partially attracted and when energized in another manner the armature is fully attracted.

3. A relay having an armature, an operating winding and two polarizing windings and means including said windings whereby when all three windings are energized the armature is partially attracted and when the operating winding and a certain one of the polarizing windings are energized the armature is fully attracted.

4. A relay having two cores magnetically connected at each end, an armature, a separate magnetic connection between the cores and the armature, an operating winding on one core, two polarizing windings on the other core and means including said core structure and windings whereby when all three

windings are energized the armature is partially attracted towards the cores and when the operating winding and a certain one of the polarizing windings are energized the armature is fully attracted.

5. A relay having an armature, an operating winding, and two polarizing windings, said polarizing windings when energized in a series aiding relation producing a less magnetizing force than when only one of said polarizing windings is energized, and means including said windings whereby when the operating winding is energized and the two polarizing windings are energized in the series aiding relation the armature is only partially attracted and when the operating winding and a certain one of said polarizing windings is energized the armature is fully attracted.

6. A relay having an armature, an operating winding and two polarizing windings and means including said windings whereby the armature is moved with a less magnetizing force when all three windings are energized than when only the operating winding and a certain one of the polarizing windings are energized.

7. A relay having an armature, and means including three separate windings for moving the armature with less magnetic flux when all of said windings are energized than when a certain two of said windings are energized.

8. A relay having an armature, an operating winding and two polarizing windings, and means including said windings for moving the armature a certain distance when all three windings are energized and for moving said armature a certain other greater distance when only the operating winding and a certain one of the polarizing windings are energized.

9. A relay having an armature and means including three separate windings for moving the armature a certain distance when all of said windings are energized and for moving the armature a certain other greater distance when a certain two of said windings are energized.

In witness whereof, I hereunto subscribe my name this 21 day of December A. D., 1927.

JACOB R. FRY.