July 15, 1941. R. L. PEEK, JR. 2,249,577

POLARIZED RELAY

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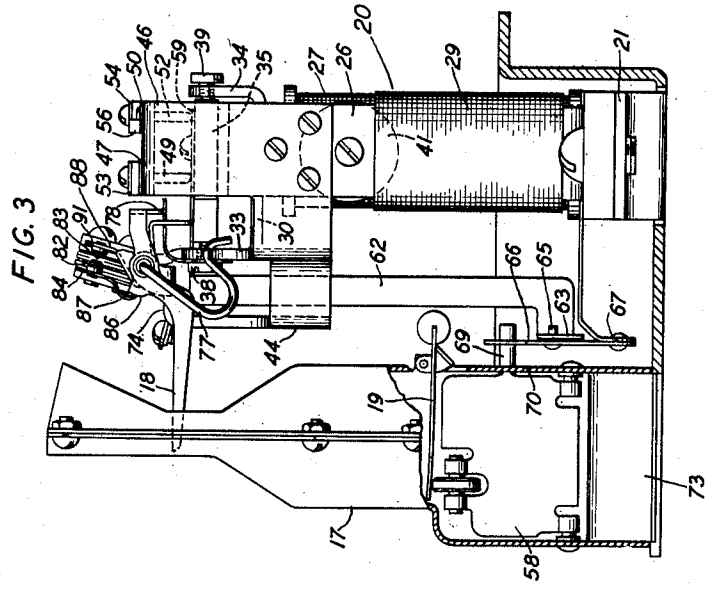

FIG. 3

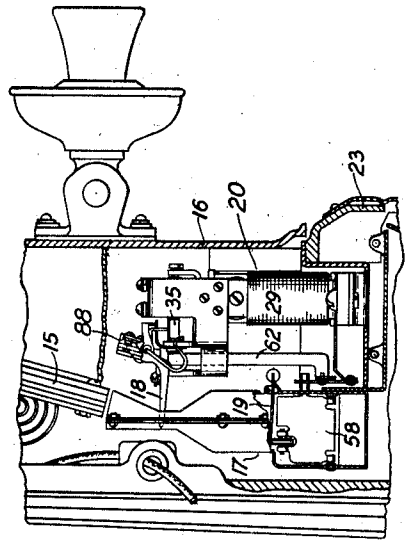

FIG. 1

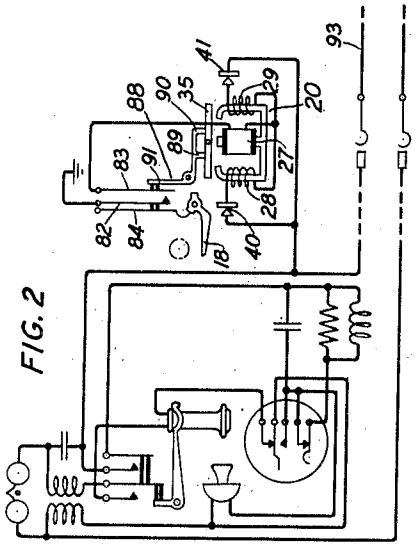

FIG. 2

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FIG. 5

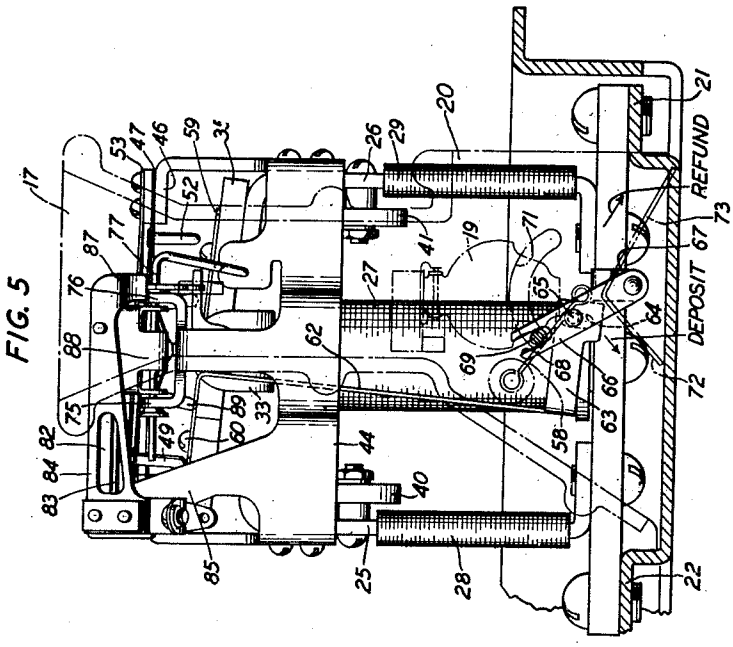
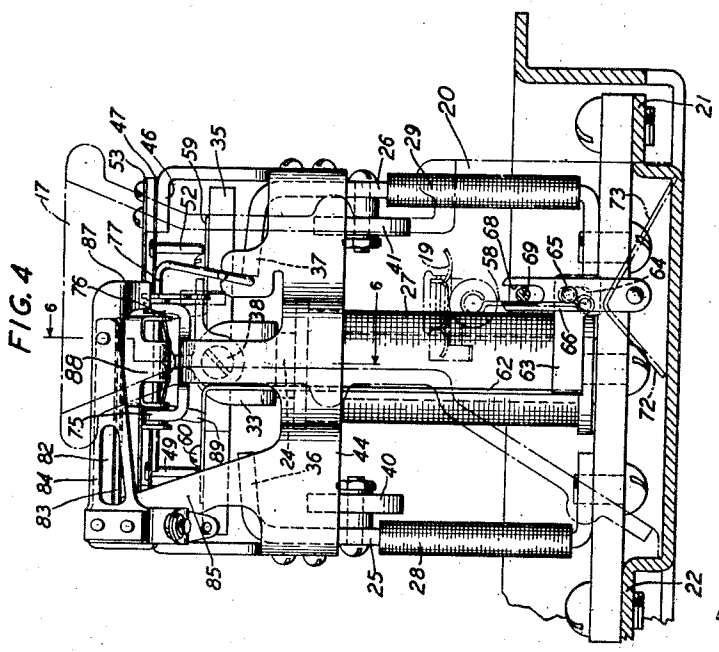


FIG. 4



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POLARIZED RELAY

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FIG. 7

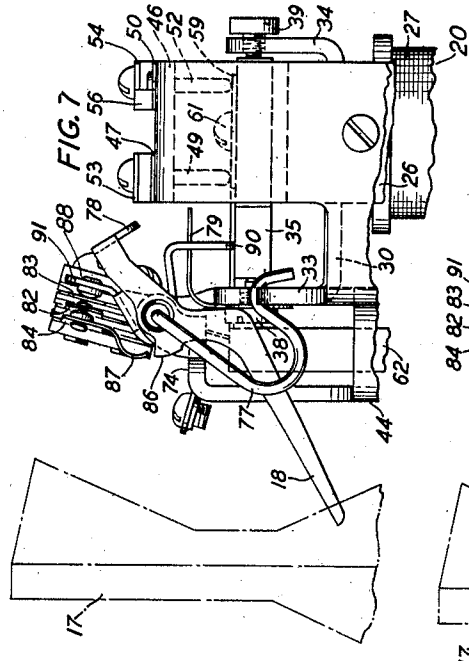


FIG. 6

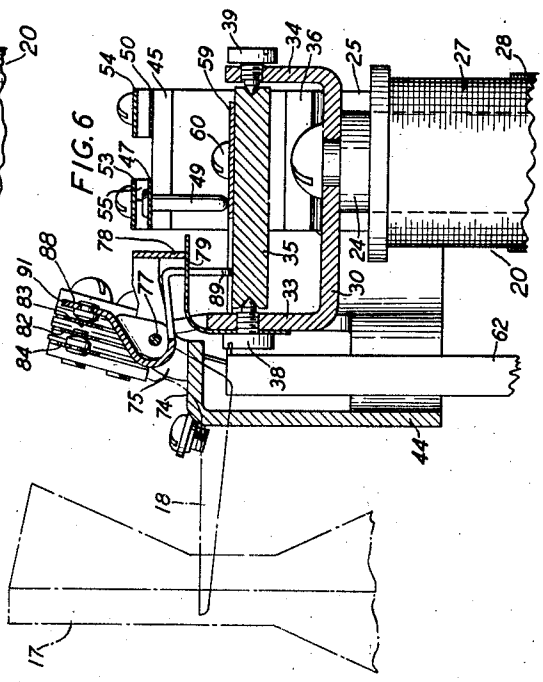
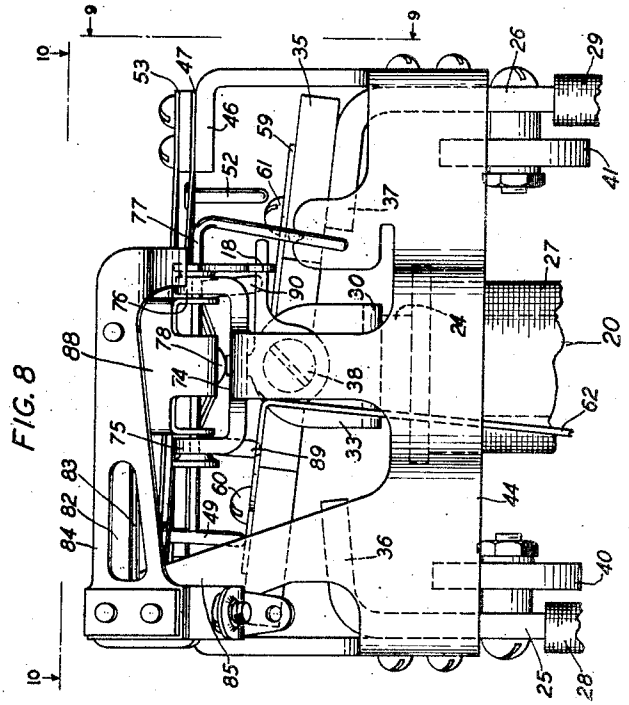


FIG. 8



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POLARIZED RELAY

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FIG. 10

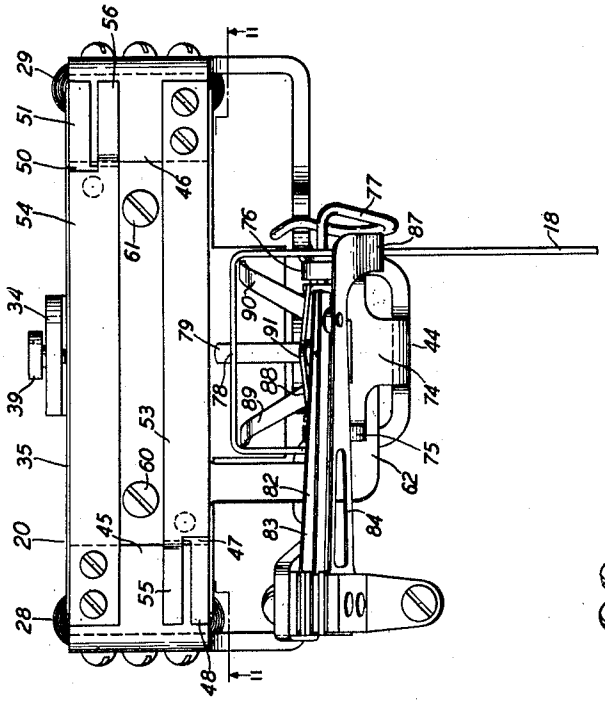


FIG. 9

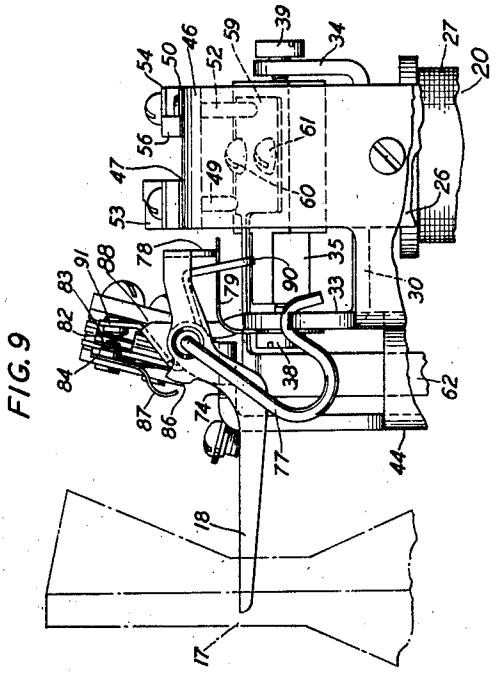
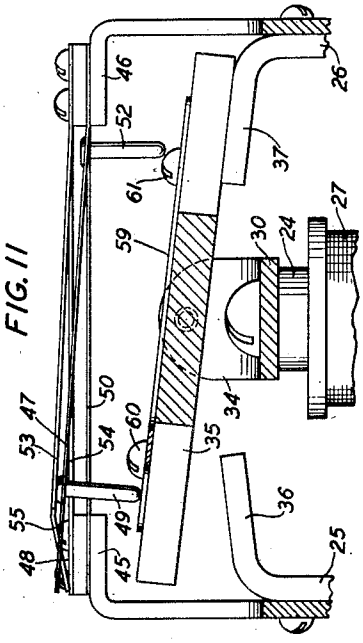


FIG. 11



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Patented July 15, 1941 2,249,577

UNITED STATES PATENT OFFICE

2,249,577

POLARIZED RELAY

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Application November 16, 1938, Serial No. 240,687

3 Claims. (Cl. 175—320)

This invention relates to polarized relays particularly of the type wherein the relay is polarized by means of asymmetrical conducting devices.

The invention is particularly suitable for use in a telephone pay station of the type illustrated in the O. F. Forsberg U. S. Patent 1,043,219, issued November 5, 1912, wherein a deposited coin is temporarily held upon a pivoted coin trap after the coin has actuated a coin trigger for causing the operation of a signal at the central office to indicate that communication is desired and for establishing an energizing circuit for a polarized relay utilized subsequently in the disposition of the deposited coin. At the termination of the conversation, battery potential at the central office may be applied to energize the coin relay whereby the actuation of its armature serves to collect the coin if the applied voltage is of one polarity and to refund the coin if the applied voltage is of the opposite polarity. The coin trap upon which the coin is temporarily held may be supported by a pivoted vane controlled by the relay to release the trap and direct the coin into the desired collect or refund channel. The operation of the relay also serves to restore the coin trigger to normal thereby reopening the electrical contacts controlled thereby.

An object of this invention is to simplify the construction and reduce the cost of manufacture of a coin relay while providing for efficient operation over a wide range in energizing current and load.

A further object is to provide a polarized relay having a close margin between operate and non-operate voltages.

In a preferred form of the invention the relay comprises magnetic material providing three vertical cores with a common base plate together with an armature pivoted on the center core and free to move so as to close the gap to either side core and open the gap to the other. The center core carries the main winding while two small auxiliary windings each in series with an asymmetrical conducting device are placed on the side cores. When voltage is applied to the relay, current flows through the main coil and one or the other of the side coils depending upon the polarity of the applied voltage. The pull on the armature is primarily due to the main coil except in the neutral position where it produces equal flux and pull at each gap. Whichever side coil is receiving current serves to unbalance the flux and thus produce a net pull in one direction. This small initial pull is opposed by tensioning springs which hold the armature in the neutral position for voltages below that at which operation is desired.

When such a relay is employed in a telephone coin collector it is preferable that the armature actuate the coin trap by means of a flexible arm of such stiffness that the armature can move through approximately half its total travel before sufficient force is developed at the trap to overcome the maximum coin load. The load which such a flexible arm applies to the armature will vary linearly from zero at neutral position to a maximum at whatever point sufficient force is developed to trip the coin trap. With such an arrangement the pull required to operate the relay and hence the operating current is independent of the coin load and is controlled solely by the tension of the springs which hold the armature in neutral position.

The form of the invention just described provides a polarized relay with a close margin between operate and non-operate voltages, not only because the operate voltage is independent of the coin load but also because the pull developed in the neutral position is proportional to the square of the current instead of being directly proportional to the current as in a relay employing a permanent magnet for polarization.

Referring to the drawings,

Fig. 1 is a view partly in section of the central portion of a telephone coin collector of the general type disclosed in the Forsberg patent;

Fig. 2 is a wiring diagram of such a collector employing a polarized relay in accordance with this invention;

Fig. 3 is a side view of the polarized relay of this invention associated with the coin hopper;

Fig. 4 is a rear view of the polarized relay with the armature in neutral position;

Fig. 5 is similar to Fig. 4 except that the armature is in one of its operated positions;

Fig. 6 is a view partly in section of the upper portion of the relay taken along the line 6—6 of Fig. 4;

Fig. 7 is a view of the upper portion of the relay with the associated coin trigger in coin operated position;

Fig. 8 is an enlarged rear view of the upper portion of the relay and spring contacts associated therewith where the armature is shown in an operated position;

Fig. 9 is a side view of the apparatus of Fig. 8;

Fig. 10 is a top view of the apparatus of Fig. 8; and

Fig. 11 is a side view partly in section of the tensioning arrangement for the relay armature.

Fig. 1 shows only a portion of a telephone coin collector of the type disclosed in the above-mentioned Forsberg patent to which reference is made for further details as to its general construction and methods of operation. A coin deposited by a subscriber after passing through a coin chute 15 in upper housing 16 drops into the coin hopper 17, actuates a coin trigger 18 and is temporarily retained upon a pivoted coin trap 19. The present invention is mainly concerned with the construction and operational features of the polarized relay 20 the energizing circuit for which is prepared by the coin actuation of coin trigger 18, the relay in operating serving to restore coin trigger 18 to normal and release trap 19 to cause the deposited coin to be collected or refunded.

Referring more particularly to the relay as illustrated in Figs. 3, 4 and 5, brackets 21, 22 suitably mounted in the lower housing 23 support the coin relay 20 which has an E-shaped core of magnetic material comprising a center limb 24 and two side limbs 25, 26. The main winding 27 for the relay surrounds the center leg while two small auxiliary windings 28, 29 surround the two side legs 25, 26. Mounted on the upper end of center leg 24 is a U-shaped pole-piece 30 (Fig. 6) between the upturned ends 33, 34 of which is pivoted the armature 35 by means of the pivoting screws 38, 39. The pole faces 36, 37 of the two side cores 25, 26 may be bent at an angle of about 6 degrees to the horizontal, so as to be parallel to the armature 35 in its operated position. Direct approach of armature to pole face is employed, and the pole face areas are made substantially larger than have heretofore been used in coin relays.

One or more varistors or asymmetrical conducting devices 40 which may be of the copper oxide type are mounted on core arm 25 for connection in circuit with auxiliary winding 28 and similarly one or more varistors 41 are mounted on core arm 26 for connection in circuit with auxiliary winding 29. Also mounted from the side cores 25, 26 is a bracket 44 having two spaced horizontal tabs 45, 46 for supporting the tensioning and restoring springs for the armature. As shown more clearly in Figs. 10 and 11, one tensioning spring 47 has one end fastened to tab 46 while its free end 48 is biased to rest on the other tab 45. Spring 47 near its free end has a stud 49 which rests upon the armature when the armature and spring 47 are in normal positions. For tensioning armature 35 against movement in the opposite direction a tensioning spring 50 is provided, one end of which is fastened to tab 45 with its free end 51 resting on tab 46. Spring 50 also has near its free end a stud 52 which bears against the armature 35 when the armature and the spring are in their normal positions. Members 47 and 50 are lightly tensioned springs employed for the purpose of centering the armature in its neutral position while two additional springs 53, 54 are employed for restoring the armature from one of its operated positions to neutral position. Spring 53 is spaced above spring 47 with one end fastened to tab 46 and with its free end normally resting on stop 45 while spring 54 is spaced above spring 50 with one end fastened to tab 45 and its free end normally resting on stop 46. It will be apparent from Fig. 11 that when the armature is moved to the operated position shown in that figure, the armature will first lift tensioning spring 47 and with further armature movement the head of stud 49 will contact with the lower surface of the free end of spring 53 whereby both springs 47, 53 are moved from their normal positions so that when the operating current is removed spring 53 will supply the main armature restoring force until stud 49 is free of spring 53 whereupon springs 47 and 50 serve to center the armature in its neutral position. Similarly, if the armature 35 is moved to its other operated position from that shown in Fig. 11 such armature movement by means of stud 52 first deflects tensioning spring 50 and then deflects restoring spring 54. Preferably, in each case the restoring spring 53 or 54 is not picked up until after the armature has completed about one-half of its travel from neutral to its fully operated position.

Armature 35 carries an arm 62 for actuating the coin vane 58 to release the pivoted coin trap 19. This operating arm comprises a flat plate 59 fastened on top of armature 35 by screws 60, 61 and from this flat strip the arm extends outwardly beyond pole-piece arm 33 and then downwardly to a point adjacent coin vane 58 where arm 62 terminates in a horizontal piece 63 containing an elongated slot 64 for receiving a pin 65 carried by a short arm 66 pivoted at the point 67. It should be noted that the main portion of arm 62 between armature 35 and pin 65 comprises a flat strip of metal lying in a plane at right angles to the direction of its motion so as to provide a flexible connection between armature 35 and pin 65 for a purpose to be described later. Small arm 66 at its upper end has an elongated slot 68 for receiving a pin 69 attached to coin vane 58 at a point substantially above the pivoting axis for the coin vane. As shown particularly in Fig. 5 pin 69 projects through an arcuate slot 71 in side wall 70 of the coin hopper 17. It will be obvious from the above description that armature 35 will actuate coin vane 58 to release the trap 19 and discharge any coins thereon either into collect chute 72 or refund chute 73 in the same manner as described in the above-mentioned Forsberg patent.

In order to provide a pivoting support for coin trigger 18, bracket 44 has an extension 74 terminating in two spaced lugs 75, 76 apertured to support the pivoting pin 77 for the coin trigger. The counterweight 78 for the coin trigger normally rests on the upper portion of a stop 79 supported by the armature pivoting screw 38.

Bracket 44 by means of an upwardly extending portion 85 also supports a horizontally arranged electrical spring contact pile-up jointly controlled by coin trigger 18 and armature 35. This pile-up comprises two electrical spring contacts 82, 83 normally biased to open condition, and a biasing spring 84 which is biased towards spring contacts 82 and 83 but normally restrained from closing these contacts by reason of the fact that coin trigger 18 in its normal position has a shoulder 86 interposed in the path of the tip portion 87 of the biasing spring as shown in Fig. 3. However, as soon as coin trigger 18 is hit by a deposited coin the trigger in assuming its actuated position of Fig. 7 frees the biasing spring 84 from shoulder 86 and allows the biasing spring to move to the right as shown in Fig. 7 to close contacts 82, 83. Counterweight 78 is prevented at this time from restoring the coin trigger to normal since tip 87 of the biasing spring 84 now lies in the return path for shoulder 86 as shown in Fig. 7.

It will be obvious from Fig. 2 that the closure of contacts 82, 83 prepares an energizing circuit

for the coin relay to enable the deposited coin or coins to be collected or refunded.

In order that the closed contact springs 82, 83 may be reopened and the coin trigger 18 restored to normal, there is pivoted about the pin 77 an angular member 88 having two spaced horizontally extending legs 89, 90 resting on the top of armature 35 on opposite sides of the armature pivoting axis, and a vertical arm 91 which acts as a stop against which the springs 82, 83 are forced by the actuation of biasing spring 84 when released by coin trigger 18. However, as soon as armature 35 has been deflected in either direction by the application of energizing current to the relay windings, member 88 will be moved counter-clockwise from its position shown in Figs. 6 or 7 to the position of Fig. 9 whereby the upper arm 91 forces the spring pile-up to the left far enough to free trigger shoulder 86 from the restraining influence of the tip 87 of biasing spring 84, allowing coin trigger 18 to restore to normal while still maintaining contacts 82, 83 closed as long as the armature 35 remains in its operated position. When the energizing current for the relay windings is removed, armature 35 is restored to normal and arm 91 will likewise be moved clockwise to its normal position. Biasing spring 84 will follow this movement of arm 91 until trap 87 hits shoulder 88 as shown in Fig. 3 whereupon with the completion of the movement of arm 91 contact springs 82, 83 will be permitted to separate under their own tension.

Referring now to the wiring diagram of Fig. 2 for a telephone substation employing a coin collector of the type just described it will be apparent that when contacts 82, 83 are closed by the coin actuation of trigger 18, conductor 93 of the telephone line is connected to ground through the windings of the polarized relay. If the operating voltage for the relay applied at the central office over conductor 93 is of such a polarity that current passes freely through varistor 40 but not through varistor 41, then the current will flow in series through auxiliary winding 28 and main winding 27 to ground and the armature 35 will be operated counter-clockwise to perform the functions previously described. On the other hand, if the applied voltage is of the opposite polarity the current will pass freely through varistor 41 but not varistor 40 and the current will flow in series through an auxiliary winding 29 and main winding 27 to ground to cause the operation of the armature in a clockwise direction. It will, therefore, be seen that the relay is polarized by means of the oppositely poled varistors 40, 41 in circuit with the auxiliary windings 28, 29 whereby when the applied voltage is of one polarity current is permitted to flow through winding 28 but not winding 29 while when the voltage is of the opposite polarity current is permitted to flow through winding 29 and not winding 28.

As previously stated, the pull on armature 35 is primarily due to main coil 27 except at the neutral position where it produces equal flux and pull at the two gaps between the armature and the pole faces 36, 37. Whichever side coil 28 or 29 is receiving current then serves to unbalance the flux and produce a net pull in one direction, after which the deflection of the armature to its fully operated position is due mainly to main winding 27. The small initial pull on the armature due to current in either winding 28 or winding 29 is opposed by one of the tensioning springs 47 or 50 and these two springs serve to hold the armature in its neutral position for applied voltages below that at which operation is desired.

The arm 62 through which the armature 35 acts on the coin vane 58 is flexible and preferably of such stiffness that armature 35 can move through about one-half of its total travel before sufficient force is developed at the coin vane to overcome the maximum coin load. Hence, the load which arm 62 applies to armature 35 varies linearly from zero at neutral position to a maximum at whatever point sufficient force is developed at the lower end of arm 62 to trip coin trap 19. With such an arrangement the pull required to operate the coin trap and hence the operating current is independent of the coin load and is controlled only by the tension in springs 47, 50 which hold the armature in neutral position. At the half-way point in the armature travel one of the heavy return springs 53 or 54 is picked up which balances the pull for the remaining half of armature travel so that when the applied current is removed the armature returns to the half-way point under the action of the deflected spring 53 or 54. At this point the spring contacts 82, 83 open as previously described and the deflected tensioning spring 47 or 50 restores the armature to neutral position.

Such an arrangement provides a polarized relay with a close margin between operative and non-operative voltage. This close margin can be realized because the initial operation of the armature is independent of the coin load and because the pull deflected in the neutral position is proportional to the square of the current, and hence the operate and non-operate margin can be controlled substantially as closely as can be done for a simple unpolarized relay.

In order to have the desired pull characteristic in the above-described relay it was found desirable to employ a direct approach of armature to the pole faces, to make the pole face areas 36, 37 as large as possible, and to reduce the armature travel by the above-described coupling between coin vane 58 and the armature as compared with the amount of armature travel required if arm 62 were directly linked to coin vane pin 69. It has also been found desirable to make the center gap between the armature and the core portion 24 as small as possible and in the embodiment shown this is accomplished by employing a U-shaped pole-piece 30 mounted on top of center core 24 with a minimum air-gap between arms 33, 34 and the adjacent edges of the armature. In order to get armature 35 accurately centered in its neutral position, the relay construction is preferably such as to minimize any motion of the tensioning springs 47, 50 before they are lifted off their stops against which they are tensioned. In one particular embodiment of the invention it was found desirable to employ about 1000 turns for each of the windings 28 and 29 and about 14,000 turns for the main winding 27.

If desired, the plate 59 which bears the flexible arm 62 may be pivoted independently of the armature so that the armature will be free to move a few thousandths of an inch before it picks up plate 59 and the load. An advantage to be derived from such an arrangement is that it eliminates the mass of the armature and the friction at its pivots from the parts which must be accurately aligned to determine the armature position at which it is tensioned to meet operative and non-operative requirements.

What is claimed is:

1. A polarized electromagnet comprising an E-shaped core, an armature pivoted adjacent the free end of the center limb of said core for rotative movement in a direction depending upon the polarity of the voltage applied to said electromagnet, a main winding on the center limb of said core, an auxiliary winding on each of the side limbs of said core and connected in circuit with said main winding, means for preventing current from traversing one of said auxiliary windings when the applied voltage is of one polarity, and means for preventing current from traversing the second of said auxiliary windings when the applied voltage is of the opposite polarity.

2. A relay comprising an E-shaped core, an armature pivoted adjacent the free end of the center limb and biased to a neutral position forming substantially equal air-gaps with the ends of the side limbs, a main winding on said center limb, an auxiliary winding on each of said side limbs and connected in circuit with said main winding, means for preventing current from traversing one of said auxiliary windings when the applied voltage is of one polarity, and means for preventing current from traversing the second of said auxiliary windings when the applied voltage is of the opposite polarity.

3. A relay comprising an E-shaped core, an armature pivoted adjacent the free end of the center limb and biased to a neutral position forming substantially equal air-gaps with the ends of the side limbs, a main winding on said center limb, an auxiliary winding on each of said side limbs and connected in circuit with said main winding, each of said auxiliary windings comprising a total number of turns equal to less than 10 per cent of the number of turns of said main winding, means for preventing current from traversing one of said auxiliary windings when the applied voltage is of one polarity and means for preventing current from traversing the second of said auxiliary windings when the applied voltage is of the opposite polarity.

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