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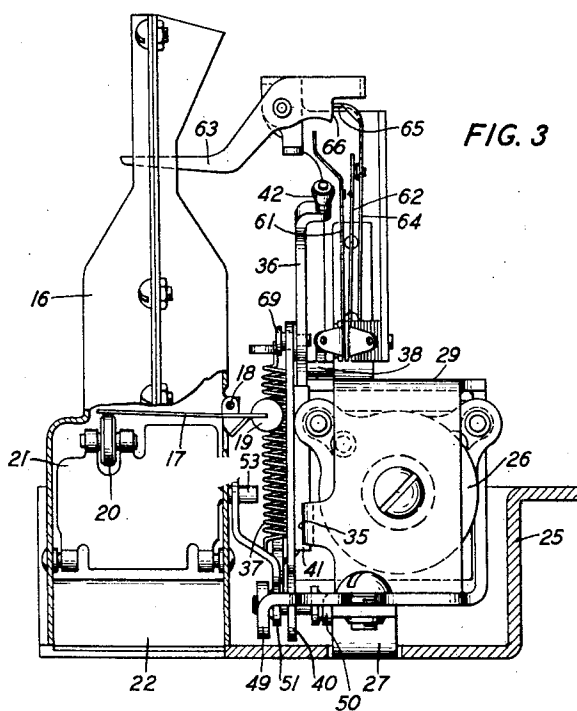
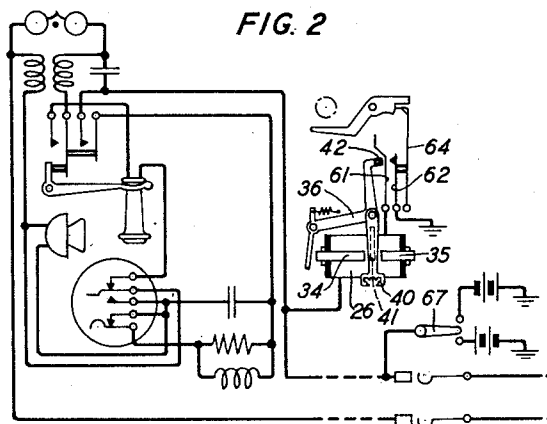
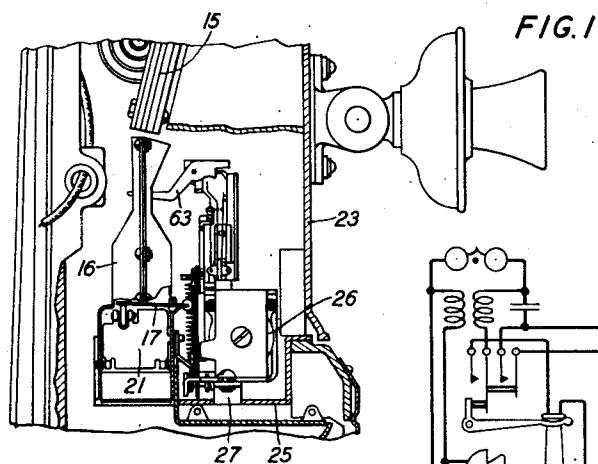
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2,218,609

ELECTROMAGNETIC APPARATUS

Filed March 14, 1939

4 Sheets-Sheet 1



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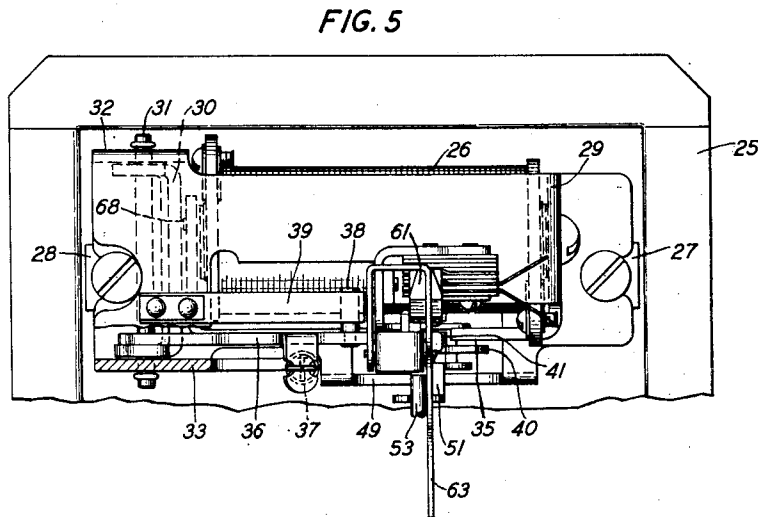
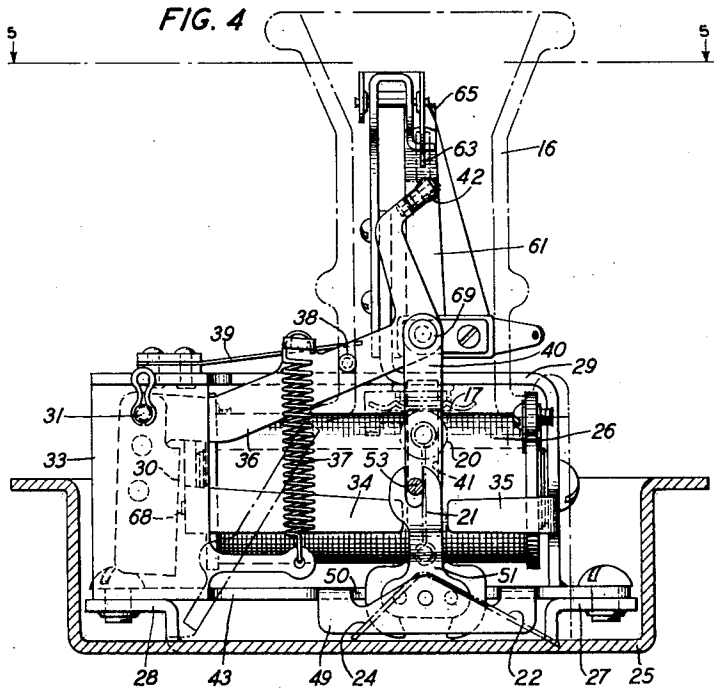
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ELECTROMAGNETIC APPARATUS

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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

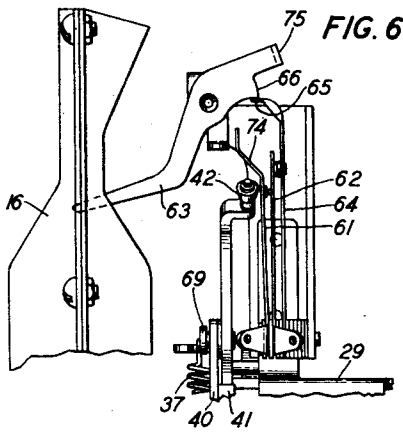


FIG. 6

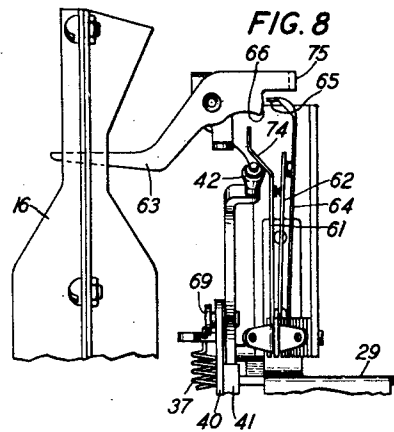


FIG. 8

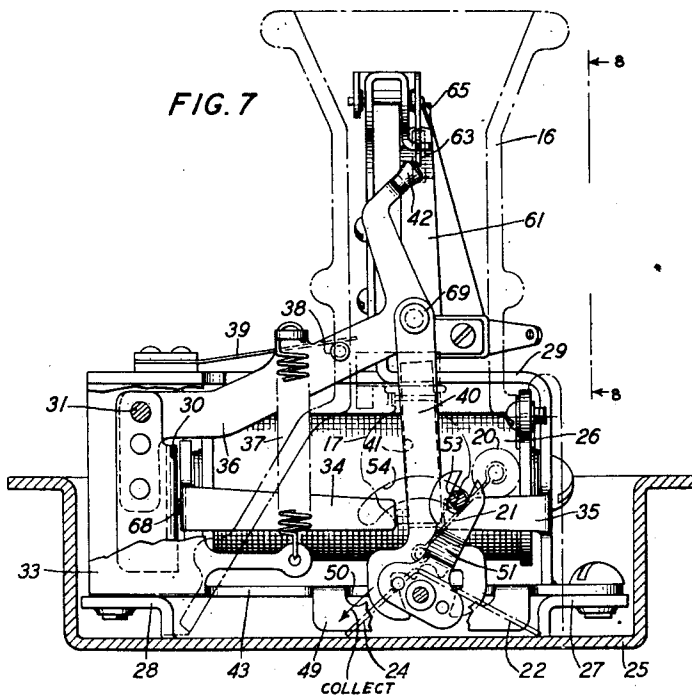


FIG. 7

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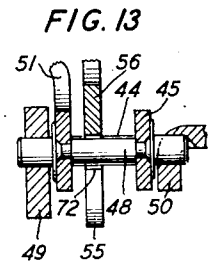
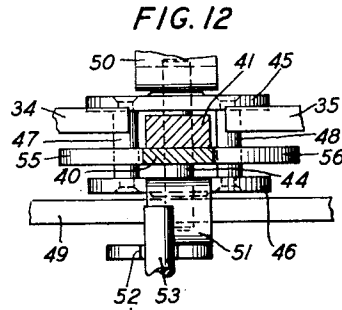
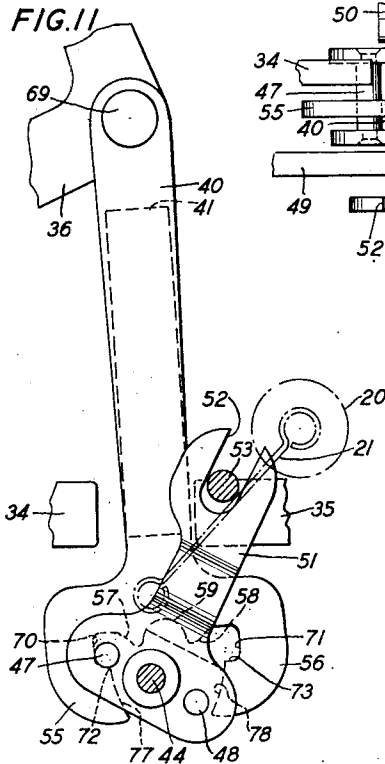
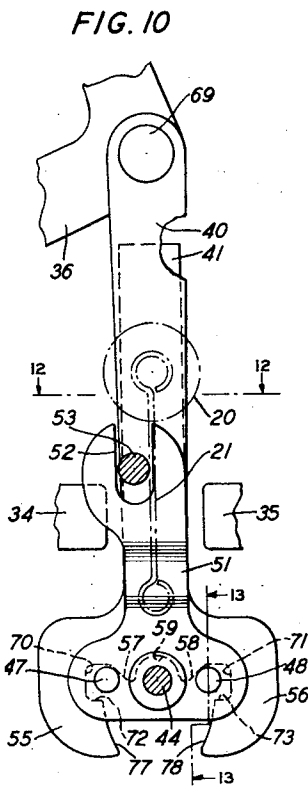
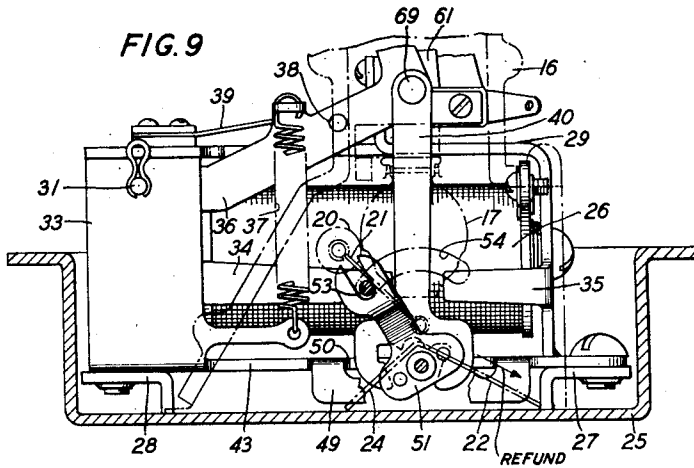
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ELECTROMAGNETIC APPARATUS

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4 Sheets-Sheet 4



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2,218,609

ELECTROMAGNETIC APPARATUS

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Application March 14, 1939, Serial No. 261,696

13 Claims. (Cl. 175—339)

This invention relates to electromagnets particularly of a type suitable for use in telephone coin collectors.

An object of the invention is to improve the efficiency of electromagnets and simplify their construction in securing a selective operation of their armatures depending upon the polarity of the voltage applied thereto.

The electromagnet of this invention is of particular value in the operation of telephone coin collectors wherein the subscriber tentatively deposits a coin which is placed under control of the central office and is subsequently collected or refunded, depending upon whether the desired telephone connection is obtained. Thus in the type of telephone coin collector disclosed in the O. F. Forsberg U. S. Patent 1,043,219, issued November 5, 1912, the coin deposited by the subscriber is temporarily held upon a coin trap which is supported by a pivoted vane under the control of an electromagnet. If the pivoted vane is moved by the electromagnet in one direction the deposited coin is collected, while if it is moved in the opposite direction the coin is refunded and the direction the vane is moved depends upon the polarity of the applied voltage. For producing such a selective actuation to control coin collection or coin refund, an electromagnet is required which is capable of efficient operation over a wide variation in energizing current and load.

This invention as applied to telephone coin collectors of the above type preferably comprises a single coil electromagnet. The armature for the electromagnet has a lateral extension to which is pivoted a depending member carrying a permanent magnet located in the field of the electromagnet so that the depending member is deflected laterally in a direction dependent upon the polarity of the voltage applied to the winding. This depending member will therefore be elevated whenever the armature is attracted and at the same time will be deflected laterally in a direction defining the polarity of the applied voltage. The lower end of the depending member may comprise a cam type latch for engaging suitable means for rotating the coin vane clockwise or counter-clockwise depending upon the direction the depending member is deflected.

Referring to the drawings:

Fig. 1 is a view partly in section of the central portion of a telephone coin collector;

Fig. 2 is a circuit schematic of a coin collector substation;

Fig. 3 is an end view partly in section of the

electromagnet of this invention associated with a coin hopper;

Fig. 4 is a front view of the apparatus of Fig. 3;

Fig. 5 is a top view of the apparatus of Fig. 4;

Fig. 6 is a side view of the electrical spring contacts which control the energizing circuit for the associated electromagnet;

Fig. 7 is similar to Fig. 4 except that the electromagnet is shown energized to cause a discharge of any deposited coin into a collect chute;

Fig. 8 is a side view of the electrical spring contacts and associated parts in positions reached by the energization of the electromagnet as in Fig. 7;

Fig. 9 illustrates the essential portion of the apparatus of Fig. 4 when the electromagnet has been energized to discharge any deposited coin into a refund chute;

Figs. 10 and 11 are enlarged views of the coupling mechanism between the armature of the electromagnet and the coin vane shown in normal and operated positions, respectively;

Fig. 12 is a sectional view along the line 12—12 of Fig. 10; and

Fig. 13 is a sectional view along the line 13—13 of Fig. 10.

The above drawings do not disclose a complete telephone coin collector but the general construction of one form of such a collector with which this invention may be employed may be ascertained by reference to the O. F. Forsberg U. S. Patent 1,043,219.

As disclosed in the Forsberg patent, a person wishing to use a telephone coin collector inserts a coin in a coin gauge and the deposited coin after traversing a coin chute 15 for testing its genuineness and striking a suitable coin signal drops into a coin hopper 16 and comes to rest upon a coin trap 17 which extends across the coin passageway. The trap 17 which is shown pivoted at the point 18 has a counterweight 19 and when it carries a coin load is supported by a roller 20 on a vertical coin vane 21 pivoted at its lower end. The coin passage below trap 17 is divided into two coin channels, a refund chute 22 leading to an opening where coins are accessible from outside the collector housing 23, and a collect chute 24 leading to a cash compartment within the housing. As explained in the Forsberg patent, if the vane 21 is moved to close the collect passageway 24 the dropping of trap 17 will allow the deposited coin to fall into refund chute 22 while if the vane 21 is moved to close the refund passageway 22 the dropping of

trap 17 will allow the deposited coin to fall into collect chute 24. The apparatus so far described is similar to that disclosed in the Forsberg patent.

- 5 The invention in the embodiment shown in the drawings is concerned with the provision of improved means whereby the operation of vane 21 may be remotely controlled to collect or refund a deposited coin depending upon whether or not
10 the desired telephone connection is secured.

Suitably mounted on lugs 27, 28 of tray 25 and adjacent the coin hopper 16 is an electromagnet comprising a single coil 26 surrounding a core of soft iron or other suitable material. A U-shaped strip 29 of magnetic material surrounding the top and the ends of the coil completes the main magnetic circuit except for the armature 30 which is pivoted about axis 31. Armature 30 is U-shaped in cross-section having a flat face adjacent the core and a flat portion parallel to and closely adjacent each of the plates 32, 33 of the return path 29. An auxiliary return path for the magnetic flux is provided by arm 34 fastened to the core at the armature end thereof and arm
25 35 extending from the U-shaped member 29 at the opposite end of the core. The adjacent ends of these two arms 34, 35 are separated by an air-gap for a purpose to be described later.

Suitably fastened to armature 30 is a laterally and upwardly extending arm 36 to an intermediate portion of which is fastened the armature biasing spring 37. Arm 36 also carries a stud 38 which on its upward travel due to armature attraction picks up an additional armature restoring spring 39. Freely pivoted on extension 36 is a depending arm 40 which carries a small permanent bar magnet 41 the lower end of which lies centrally in the air-gap between the ends of arms 34, 35. The extreme upper end of arm
40 36 has an insulating stud 42 for controlling the electrical spring contacts in a manner to be described later.

Suitably supported between spaced portions 49 and 50 of the bottom plate 43 of the coil supporting structure is a stationary rod 44 about which is rotatably mounted a framework comprising two cross-pieces 45, 46 which are centrally apertured to receive rod 44. These two cross-pieces are rigidly united by two spaced pins 47, 48 which lie
50 on opposite sides of rod 44 with the two pins and the rod normally lying in a substantially horizontal plane as shown in Fig. 10. The cross-bar 46 has an upwardly extending arm 51 which has a fork 52 at its upper end to receive the coin vane pin 53 which projects through the arcuate slot 54 in the adjacent coin hopper side wall.

Depending arm 40 terminates in a cam type latch comprising a pair of spaced jaws 55, 56 which embrace the pins 47, 48 with pin 47 normally lying against cam surface 57 and pin 48 lying against cam surface 58. Intermediate its cam surfaces 57, 58 the arm 40 has a hollowed-out portion 59 to avoid contact with the stationary rod 44. These pins 47, 48 act as a stop for the armature in its non-operated position since the downward pull of spring 37 on arm 36 causes a downward thrust on depending arm 40 to normally maintain cam surfaces 57, 58 against pins 47, 48, as shown in Fig. 10. The opposed cam surfaces 57 and 58 are so shaped that their contact with pins 47 and 48 when the electromagnet is deenergized causes arm 40 and its permanent magnet 41 to be centrally located in the air-gap between arms 34 and 35.

75 As shown in Figs. 2 and 3, the winding 26 of

the electromagnet cannot be energized until electrical spring contacts 61 and 62 have been closed to connect one terminal of the winding to ground. However, these contacts may be closed by the deposit of a coin in the collector. Any deposited coin before coming to rest on coin trap 17 strikes a coin trigger 63 and causes the coin trigger to move from its normal position of Fig. 3 to its coin actuated position of Fig. 6. A biasing spring 64 is normally prevented from closing these contacts because its upper end 65 lies against coin trigger shoulder 66 as shown in Fig. 3. However, the coin actuation of trigger 63 lifts shoulder 66 out of the path of spring end 65 as in Fig. 6 thereby allowing biasing spring 64 to move freely to the left to close the contacts. Thereafter and at the proper time a suitable switching means 67 at the central office (Fig. 2) may be actuated to connect either positive or negative battery to winding 26 depending upon whether coin refund or coin collection is desired.

As long as the electromagnet is deenergized, the various movable parts occupy their normal positions of Fig. 4 but as soon as battery is applied to the electromagnet the armature is attracted from its position of Fig. 4 to its position as in Fig. 7 where it lies against stop 68. At the same time permanent magnet 41 which lies in the stray magnetic field between pole extensions 34 and 35 will be attracted towards arm 34 or arm 35 depending upon the polarity of the applied voltage. If the applied voltage is of one polarity, arm 40 is moved about its pivot 69 to the right as seen in Fig. 11 tending to bring vertical edge 70 of jaw 55 against pin 47; or if the applied voltage is of the opposite polarity, arm 40 is moved laterally towards pole extension 34 tending to bring vertical edge 71 of jaw 56 against pin 48. At the same time that arm 40 is being moved laterally due to the reaction between permanent magnet 41 and the stray magnetic field, the said arm 40 will also be moved upwardly by the attraction of armature 30. However, the small lateral movement required of arm 40 is substantially completed before there has been an appreciable upward movement of arm 40 and if we assume that the lateral movement has been such as to attract edge 70 towards pin 47 the subsequent lifting of arm 40 will bring the horizontal surface 72 into engagement with pin 47 thereby moving pin 47 upwardly and pin 48 downwardly since with pin 47 embraced by portions 70, 72 of jaw 55 the opposing jaw 56 lies outside the downward path of pin 48. The completed movement of the pins 47 and 48 is shown in Fig. 11 for an applied voltage of one polarity and shows that the frame structure comprising pins 47 and 48 has been moved clockwise through an angle of about 25 degrees.

On the other hand if the applied voltage is such that the permanent magnet is attracted towards pole-piece 34 tending to bring vertical edge 71 of jaw 56 into engagement with pin 48 the resulting upward movement of arm 40 by armature attraction will cause the horizontal shoulder 723 to engage pin 48 and throw pin 48 upwardly since the other jaw 55 will not lie in the path of pin 47; and upon the completion of this counter-clockwise movement pins 47, 48 will lie in positions just the reverse of that shown in Fig. 11. As previously stated, spring 37 for the unoperated position of the armature holds the opposed cam surfaces 57, 58 against pins 47, 48 as indicated in Fig. 10. Forces due to the reaction of the by-passed flux and the permanent magnet 75

41 do not, therefore, produce lateral motion of the magnet arm 40 until due to the main armature motion the cam 55, 56 has been disengaged from the two pins.

5 It, therefore, follows that the structure which comprises cross-bars 45, 46 with interconnecting pins 47, 48 will be moved clockwise or counter-clockwise about its axis 44 depending upon the polarity of the applied voltage; and since arm 51 constitutes a part of this rotatable frame structure it follows that for an applied voltage of one polarity, coin vane 21 will be moved counter-clockwise to its coin refunding position of Fig. 9 and for an applied voltage of the opposite polarity coin vane 21 will be moved clockwise to its coin collecting position of Fig. 7.

It will be apparent from the showing in Fig. 10 that if the arm 40 should be moved upwardly by armature attraction without any lateral movement, cam surfaces 72 and 73 would strike pins 47 and 48 simultaneously, whereupon the upward movement would cease without producing any rotational movement of the vane controlling arm 51. But the arrangement of the parts is such that only a slight lateral movement of arm 40 in one direction or the other is needed to have only one of these cam surfaces contact with its associated pin, thereby producing the desired rotational movement. As previously pointed out both the horizontal and vertical forces actuating on cam 55, 56 actuate simultaneously and both components of attraction enter into the resulting cam stroke. However, it is not necessary to exhaust the horizontal component of the cam before establishing a vertical driving contact. In the preferred embodiment, a very small horizontal motion of the cam type latch 55, 56 is sufficient to start the proper selection of pin 47 or 48. In the very rare event that the horizontal motion is not completed before surface 72 or 73 strikes pin 47 or 48, then the opposite surface 77 or 78 combined with the strong vertical pull from the armature completes the horizontal selection.

The cam type latch 55, 56 furnishes the important control point in the design of the relay. Its design permits the use of one restoring spring 37 which restores the armature and the trap vane for either collect or refund. The latch is also so designed that the initial movement of the armature can be made independent of the coin load and thus controlled by the restoring spring 37 alone. To some extent the contours of the cam surfaces of the latch member 55, 56 can be used to control the amount of pull exerted by the armature during the entire stroke so that the optimum forces can be obtained at the desired points of the stroke. While the pins 47, 48 are shown integral with arm 51 and the cam surfaces are shown cut in the lower end of arm 40, it is obvious that these parts may be reversed with the pins attached to link 40 and the cam surface cut in a plate attached to arm 51.

Regardless of the polarity of the applied voltage the resulting upward movement of armature extension 36 raises the insulating stud 42 carried thereby and the upward movement of this stud acting against the angular portion 74 of spring 61 causes the spring pile-up 61, 62, 64 to be moved to the right far enough to free the coin trigger of spring projection 65 thereby allowing the coin trigger to restore to normal under the action of its counterweight 75, as shown in Fig. 8. In Fig. 8, it is assumed that the electromagnet is still energized with stud 42 maintaining the spring pile-up in such a position that spring projection

65 is out of engagement with trigger shoulder 66. As soon as the electromagnet has been deenergized the downward movement of arm 36 allows the spring pile-up to move to the left until projection 65 engages shoulder 66 whereupon the electrical contacts are in their normal open position.

In view of the above description it is believed that there will be no difficulty in following the various operating steps shown in the various figures. In Figs. 3, 4 and 5 all parts are in their normal positions with the electromagnet deenergized and the coin trigger non-operated. In Fig. 6 the coin trigger has been dropped by coin deposit to close the electrical contacts but the electromagnet has not yet been energized. In Figs. 7 and 8 the electromagnet has been energized by voltage of such polarity as to cause the coin trap to discharge its coin load into collect chute 24, while in Fig. 9 the electromagnet has been energized by a voltage of the opposite polarity to cause the coin trap to discharge its coin load into refund chute 22.

As previously stated the armature 30 is biased to its normal position by coiled spring 37 but after the armature has moved through the initial portion of its path, stud 38 on arm 36 picks up spring 39 which provides an additional restoring force for the armature when the source of energizing current is disconnected from winding 26. It is also obvious that the coin vane load is not coupled to the armature until after the armature has moved a short distance from its normal position. Both of these features contribute in reducing the load carried by the armature in its initial movement and hence aid in meeting the close margin between the operate and non-operate requirements of a coin collector relay. In one embodiment of the invention the electromagnet operated with a minimum applied current of .045 ampere which value was independent of the coin load, it would not operate with an applied current of .041 ampere, and would release with an applied current of .031 ampere. Spring 39 provides the necessary adjustment to meet the release value just given.

It should also be noted that the main magnetic circuit of the electromagnet of this invention is not polarized by a permanent magnet but is a simple electromagnet towards which the armature 30 is always attracted regardless of the direction of the operating current. Leakage flux from the main magnetic circuit is used to react upon an auxiliary permanent magnet of extremely small size, which through a cam type latch permits the armature to actuate the coin trap vane in one direction or the other depending upon the direction of current in the main magnetic circuit winding.

What is claimed is:

1. In combination, an electromagnet comprising a core, an energizing winding on said core, a movable member comprising a permanent magnet, means controlled by said electromagnet for moving said permanent magnet about one axis in a direction independent of the polarity of the voltage applied to said winding, means for moving said magnet about a different axis in a direction dependent upon the polarity of the applied voltage and means selectively controlled by the resultant movement of said member.

2. In combination an electromagnet comprising a core, an energizing winding on said core, a movable member comprising a permanent magnet, means controlled by said electromagnet for

moving said permanent magnet about one axis in a direction independent of the polarity of the voltage applied to said winding, means for moving said magnet about a different axis in a direction dependent upon the polarity of the applied voltage, a rotatable member, and means responsive to the resultant movement of said first member to rotate said rotatable member in a direction dependent upon the polarity of the voltage applied to said winding.

3. In combination, an electromagnet comprising a core, an energizing winding on said core, a movable member comprising a permanent bar magnet mounted adjacent said electromagnet, means located in the field of said electromagnet for moving said permanent magnet about an axis in a direction independent of the polarity of the voltage applied to said winding, other means located in the field of said electromagnet for moving said permanent magnet about a different axis in a direction dependent upon the polarity of the applied voltage, and means selectively actuated by said member in accordance with the polarity of the voltage applied to said winding.

4. In combination, an electromagnet comprising a core, an energizing winding on said core, a member pivotally mounted for rotative movement about a fixed axis, an arm pivoted to said member and comprising a permanent magnet, means controlled by said electromagnet for moving said member about said axis in a direction independent of the polarity of the voltage applied to said winding, other means for deflecting said arm in a direction dependent upon the polarity of the voltage applied to said winding, and means selectively actuated by said arm in accordance with the polarity of the voltage applied to said winding.

5. In combination, an electromagnet comprising an energizing winding, a non-permanently magnetized armature mounted for movement about one axis, an arm pivotally mounted on said armature about an axis parallel to said first axis, a permanent magnet mounted on said arm and located in the field of said electromagnet whereby said arm is deflected in a direction dependent upon the direction of current flow through said winding, and means selectively actuated by said arm.

6. In combination, an electromagnet comprising a core, an energizing winding on said core, a non-permanently magnetized armature for said electromagnet pivotally mounted for rotative movement about a certain axis, said armature having an extension extending substantially parallel to said core, an elongated member pivotally mounted at one end to said extension and comprising a permanent magnet located in the field of said electromagnet, and means selectively actuated by said member.

7. In combination, an electromagnet having a core, an energizing winding for said core, a non-permanently magnetized armature mounted for movement about one axis adjacent said core, an arm pivotally mounted on said armature and comprising a permanent magnet located in the field of said electromagnet whereby said arm is deflected in a direction dependent upon the polarity of the voltage applied to said winding and is moved in another direction by the attraction of said armature, a rotatable member, and means responsive to the resultant movement of said arm for rotating said rotatable member in a direction dependent upon the polarity of the voltage applied to said winding.

8. In combination, an electromagnet having a non-permanently magnetized armature mounted for movement about a fixed axis, said armature having a laterally extending arm which is moved upwardly when said armature is attracted by said electromagnet, a downwardly extending member pivoted to said arm and carrying a permanent magnet located in the field of said electromagnet whereby said member is deflected laterally in accordance with the direction of current flow through said electromagnet, and means selectively actuated by said member.

9. In combination, an electromagnet having a non-permanently magnetized armature pivoted about a substantially horizontal axis, said armature having a laterally extending portion, a downwardly extending arm pivoted at its upper end to said portion and comprising a permanent magnet located in the field of said electromagnet whereby said arm is deflected about its pivot when said electromagnet is energized, and said arm is moved longitudinally when said armature is attracted by said electromagnet, and means selectively actuated by said arm.

10. In a telephone coin collector, an electromagnet having an energizing winding and a non-permanently magnetized armature pivoted about a substantially horizontal axis, said armature having a laterally extending portion which is moved upwardly when said armature is attracted by said electromagnet, a downwardly extending arm pivoted to said portion and carrying a permanent magnet located in the field of said electromagnet whereby said arm is deflected laterally in accordance with the polarity of the voltage applied to said winding, a rotatable member, and coupling means between said member and said arm to cause rotation of said member in a direction dependent upon the polarity of the voltage applied to said winding.

11. In a telephone coin collector, an electromagnet having an energizing winding and a non-permanently magnetized armature pivoted about a substantially horizontal axis, said armature having a laterally extending portion which is moved upwardly when said armature is attracted by said electromagnet, a downwardly extending arm pivoted at its upper end to said portion and carrying a permanent magnet located in the field of said electromagnet whereby said arm is deflected laterally in accordance with the polarity of the voltage applied to said winding, a bar mounted for rotation about a fixed axis, and spaced pins on said bar, said arm having spaced fingers for engaging one of said pins when the applied voltage is of one polarity and for engaging the other of said pins when the applied voltage is of the opposite polarity to rotate said bar in a direction dependent upon the polarity of the applied voltage.

12. In combination, an electromagnet having an energizing winding, a non-permanently magnetized armature pivoted for rotative movement about a fixed axis, said armature having a substantially horizontally disposed extension, a depending arm pivoted at its upper end to said extension and comprising a permanent magnet located in the field of said electromagnet whereby said arm is raised when voltage is applied to said winding and at the same time is deflected about its pivot in a direction determined by the polarity of the applied voltage, a member mounted for rotation about a fixed axis, and coupling means between said arm and said member for rotating said member in a clockwise direction

when the applied voltage is of one polarity and for rotating said member counter-clockwise when the applied voltage is of the opposite polarity.

13. In combination, an electromagnet having
5 a non-permanently magnetized armature pivotally mounted about a substantially horizontal axis, said armature having a laterally extending portion, a downwardly extending arm pivoted at its upper end to said portion and comprising a
10 permanent magnet located in the field of said electromagnet, a rotatable pin bar carrying two

spaced pins located on opposite sides of the axis about which said bar is rotatable, and a cam type latch on the lower end of said arm for engaging one of said pins to cause a clockwise rotation of said bar when the voltage applied to
5 said electromagnet is of one polarity and for engaging the other of said pins to cause a counter-clockwise rotation of said bar when the applied voltage is of the opposite polarity.

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