

Oct. 24, 1933.

B. LAZICH

1,932,020

ELECTRICAL RELAY

Filed April 13, 1931

4 Sheets-Sheet 1

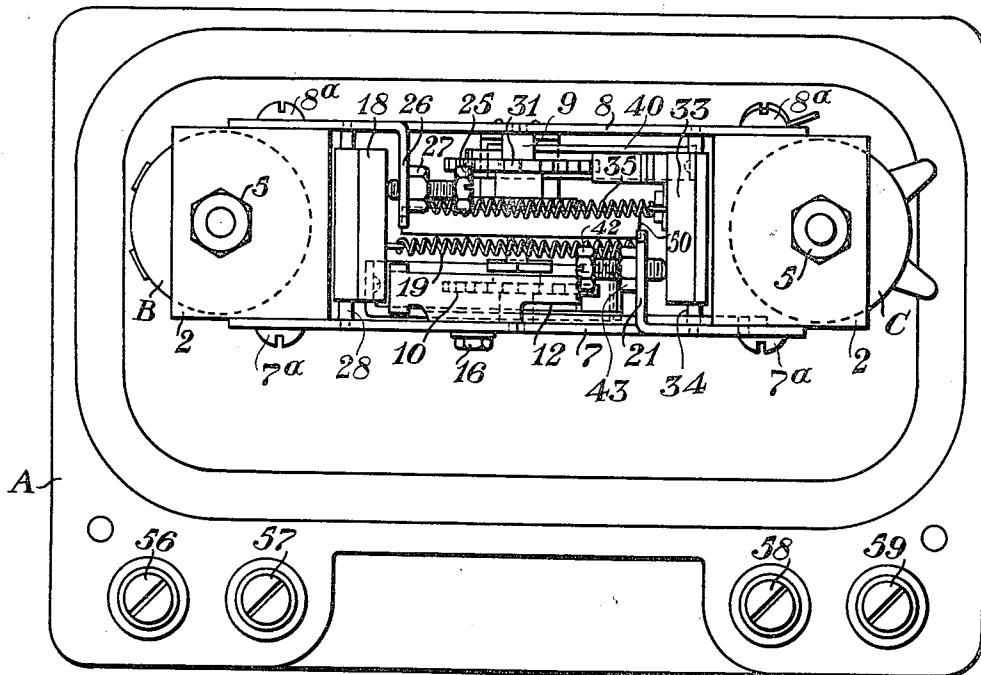
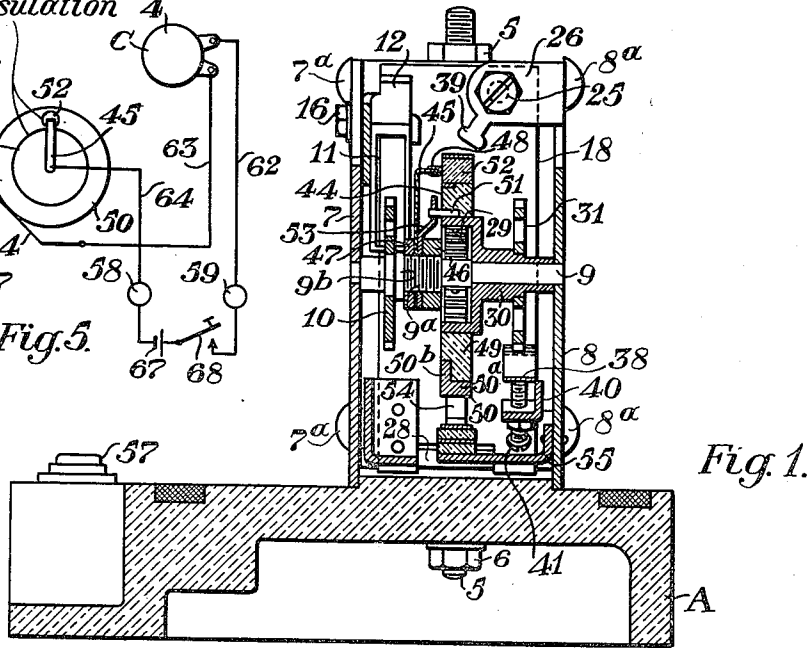
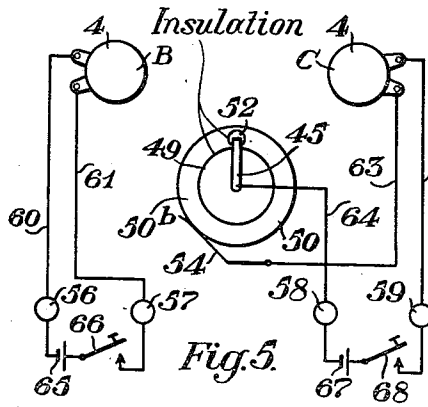


Fig. 2.

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4 Sheets-Sheet 2

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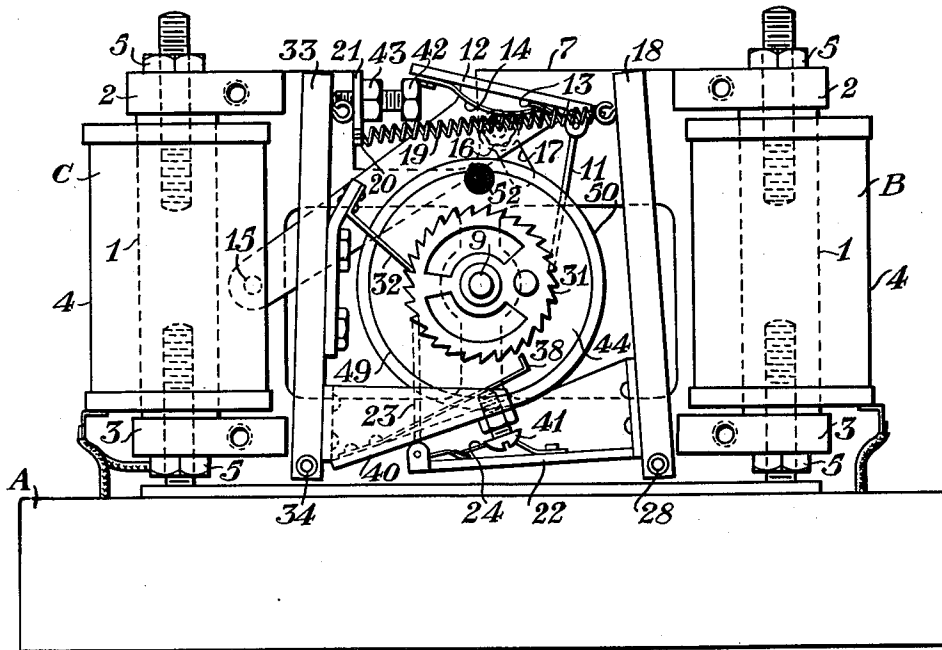


Fig.3.

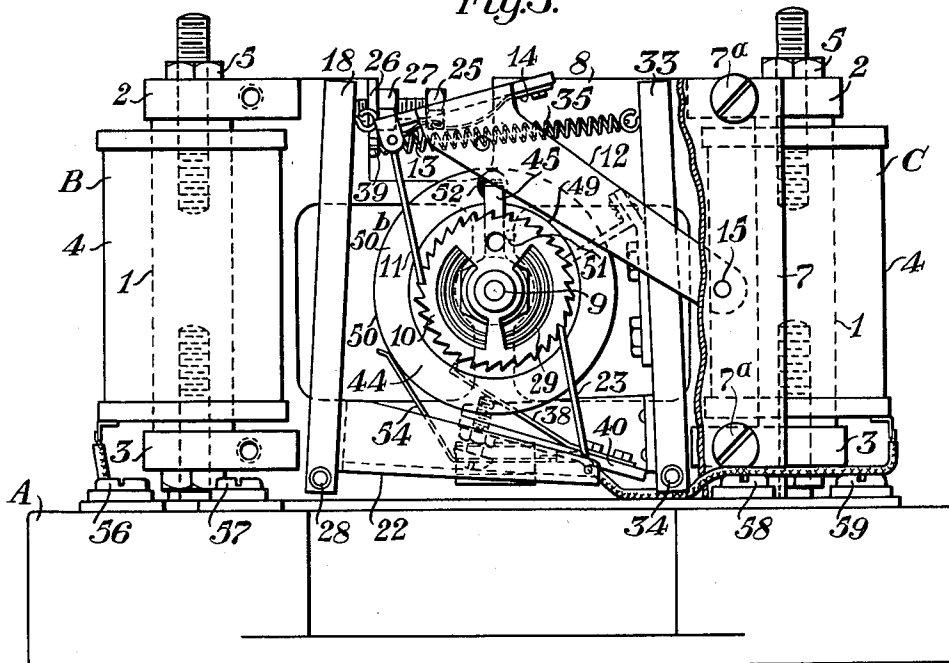


Fig. 4.

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4 Sheets-Sheet 3

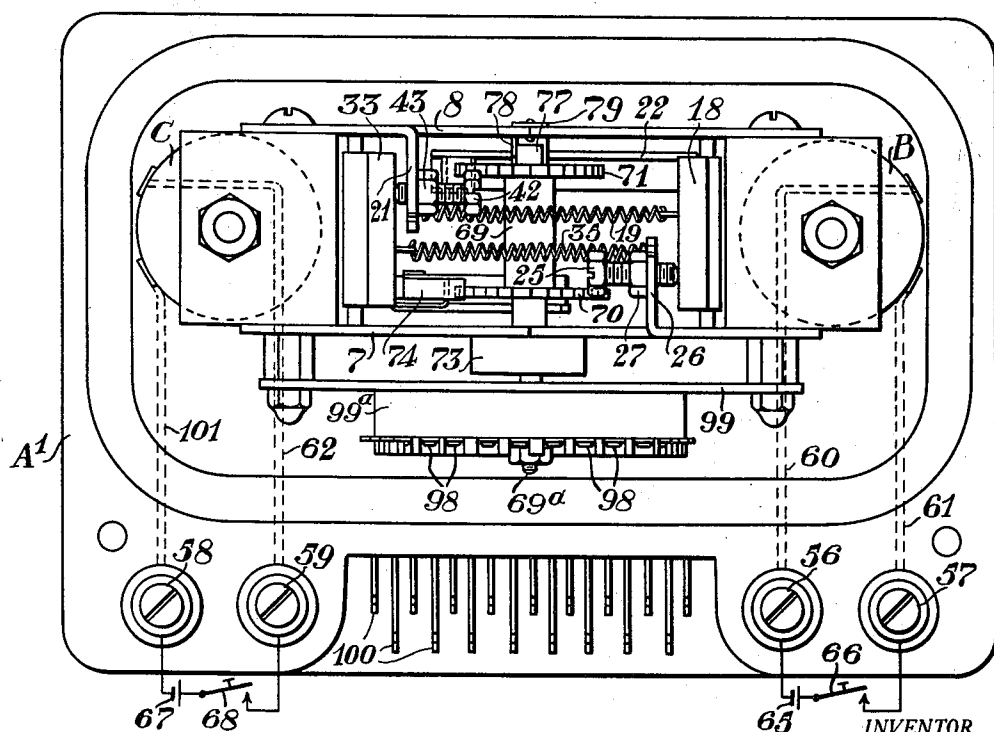
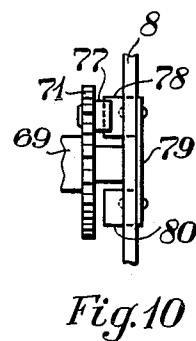
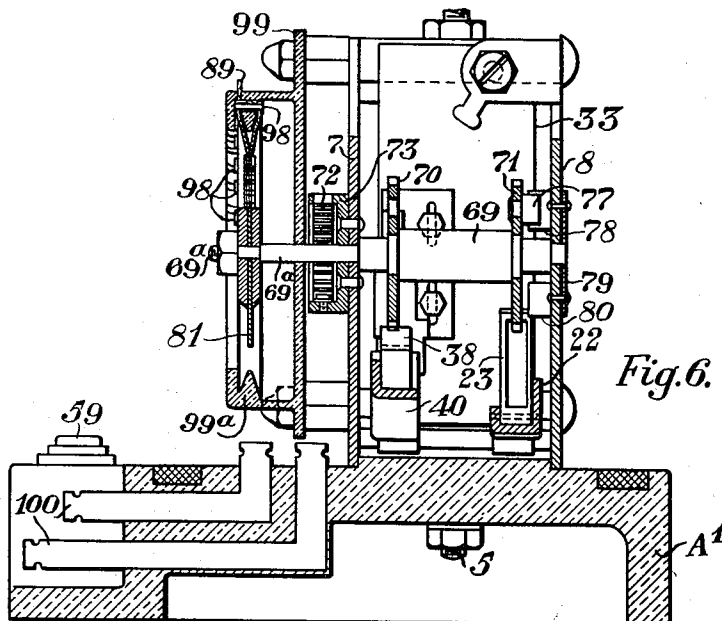


Fig. 7.

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ELECTRICAL RELAY

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4 Sheets-Sheet 4

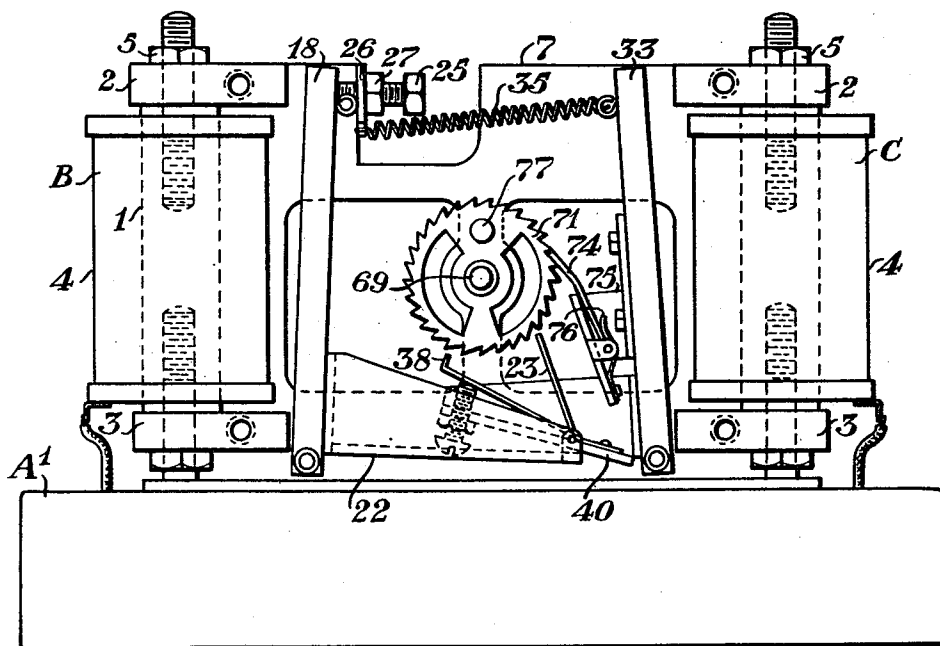


Fig. 8.

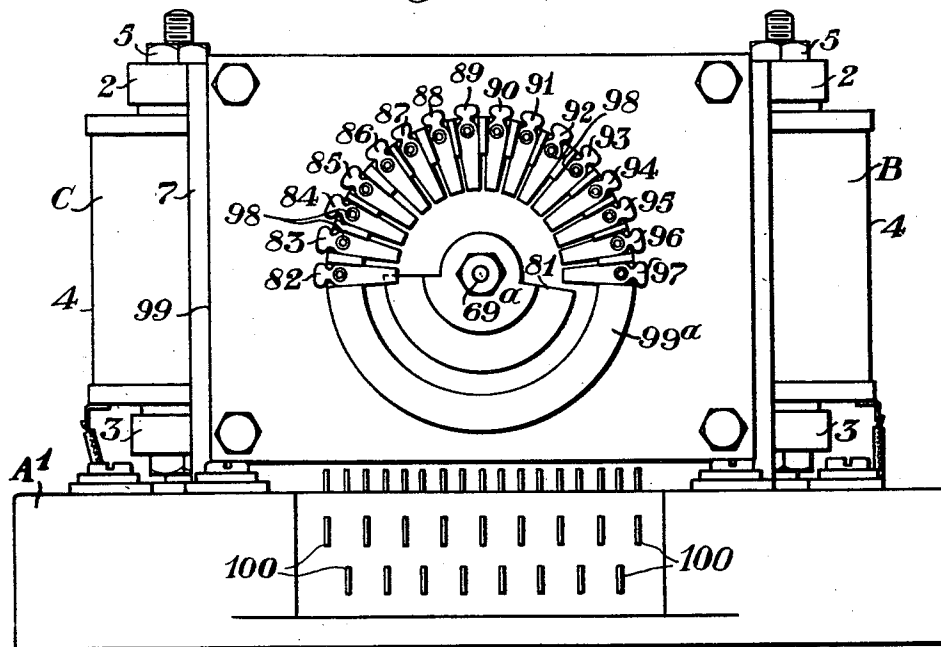


Fig. 9.

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UNITED STATES PATENT OFFICE

1,932,020

ELECTRICAL RELAY

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Application April 13, 1931. Serial No. 529,634

8 Claims. (Cl. 200-105)

My invention relates to electrical relays, and particularly to that class of electrical relays known as counting relays in which cooperating contact members are operated from one relative position to another relative position in response to a predetermined number of energizations of one electromagnet and are restored to said one relative position in response to a corresponding number of energizations of another electromagnet.

I will describe two forms of counting relays embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a vertical sectional view illustrating one form of counting relay embodying my invention. Fig. 2 is a top plan view of the relay shown in Fig. 1. Figs. 3 and 4 are right-hand and left-hand views, respectively, of the relay shown in Fig. 1, certain of the parts being broken away or removed to more clearly illustrate the construction of the operating mechanism. Fig. 5 is a diagrammatic view illustrating one circuit arrangement for the relay shown in Fig. 1. Fig. 6 is a vertical sectional view illustrating a modified form of the counting relay illustrated in Fig. 1 and also embodying my invention. Fig. 7 is a top plan view of the relay shown in Fig. 6. Fig. 8 is a view of the relay shown in Fig. 6 as it appears when viewed from the right in Fig. 6, certain of the parts being removed to better illustrate the construction of the operating mechanism. Fig. 9 is a view of the relay shown in Fig. 6 as it appears when viewed from the left in Fig. 6, and illustrating the contact mechanism of the relay. Fig. 10 is a detail view of a portion of the relay shown in Fig. 6.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Figs. 1 to 4, inclusive, the reference character A designates a base plate of suitable insulating material, such as hard rubber or a phenol condensate product, which base plate supports the operating mechanism of the relay. Mounted on the base plate A in parallel spaced relation are two electromagnets B and C, each comprising a magnetizable core 1 provided with enlarged pole pieces 2 and 3, and carrying an energizing winding 4. As here shown, the pole pieces are rectangular in shape and are fastened to the core 1 by means of studs 5 which extend through clearance holes in the pole pieces and are screwed into threaded holes in the cores. The upper studs 5 extend above the top of the magnets a sufficient distance so that they can be employed to hold a protective cover in place. The lower

studs 5 of the magnets extend downwardly through the base plate A, and are provided on the underside of the base plate with nuts 6 which fasten the magnets to the base plate, as best seen in Fig. 1. A pair of laterally spaced vertically extending non-magnetizable plates 7 and 8 are secured by means of screws 7^a and 8^a, respectively, to the pole pieces 2 and 3 of each magnet on opposite sides of the magnets, and together constitute the supporting framework for the operating mechanism of the relay.

Journalled in the plates 7 and 8 is a horizontal shaft 9. This shaft is intended to be rotated in a step by step fashion, and for this purpose, the shaft is provided adjacent its left-hand end, as viewed in Fig. 1, with a ratchet wheel 10 which is operated by an armature 18 controlled by electromagnet B. The armature 18 is pivotally supported at its lower end on a rod 28 carried by the plates 7 and 8, and is biased toward the right, as viewed in Figs. 2 and 4, by means of a spring 19 which is fastened at one end to the armature. The other end of the spring 19 is fastened to an ear 20 provided on the lower side of a lug 21 which is formed by bending a portion of the side plate 8 at right angles to the side plate as best seen in Figs. 2 and 3. The armature 18 carries a rigid operating arm 22, which, in turn, carries a propelling pawl 23. The propelling pawl 23 is pivoted in the tip of the operating arm and is biased, by means of a spring 24 carried by the operating arm (see Fig. 3), to a position in which the tip of the pawl engages an adjacent tooth of the ratchet wheel 10 as shown in Fig. 4.

Also cooperating with the ratchet wheel 10 is a retaining pawl 11 which prevents rotation of the ratchet wheel in one direction (the clockwise direction as viewed in Fig. 4). The retaining pawl 11 is pivotally supported at its upper end in a bracket 12, and is provided with an arm 13 against which a spring 14 carried by the bracket 12 bears. The function of the spring 14 is to direct the lower end of the retaining pawl into engagement with the successive teeth on the ratchet wheel. The bracket 12 is pivotally attached to the side plate 7 at 15, and is arranged to be locked in an adjusted vertical position by means of a screw 16 which passes through an arcuate slot 17 in the plate 7, and is threaded into the bracket 12. It will be seen that by loosening the screw 16, the bracket 12 may be rotated through a limited arc about the pivot 15, thereby providing a convenient means for adjusting the position in which the retaining pawl 11 will engage the teeth of the ratchet wheel 10.

When electromagnet B becomes energized, armature 18 moves toward the left as viewed in Fig. 4, thereby raising the operating arm 22 and the propelling pawl 23, and hence stepping the ratchet wheel 10 one tooth in a counterclockwise direction as viewed in this figure. This rotation of the ratchet wheel permits the retaining pawl 11 to drop back of the next successive tooth on the ratchet wheel so that the ratchet wheel is subsequently held in its stepped position. When electromagnet B next becomes deenergized, spring 19 draws the armature 18 toward the right as viewed in Fig. 4, thereby restoring the operating arm 22 to the position shown, and hence causing the propelling pawl 23 to drop back of another tooth of the ratchet wheel. The propelling pawl is then ready to again step the ratchet wheel the next time electromagnet B becomes energized. It will be apparent, therefore, that the shaft 9 will be rotated in a counter-clockwise direction, as viewed in Fig. 4, through a distance corresponding to one tooth of the ratchet wheel 10 each time electromagnet B becomes energized.

The stroke of the armature 18 and, hence, of the propelling pawl 23, may be adjusted to the proper length for stepping the ratchet wheel in the desired manner by means of an adjusting screw 25 which acts as a stop to limit the movement of the armature away from the electromagnet B. The adjusting screw 25 is screwed through a lug 26 which is similar to the lug 21 previously described, this lug being formed integral with the side plate 8. A jam nut 27 is screwed onto the adjusting screw 25 to maintain the screw in its adjusted position.

As best seen in Fig. 1, a cylindrical casing 30 is rotatably mounted on the shaft 9, and this casing houses a coil spring 29 which is attached at its inner end to the shaft 9 and at its outer end to the casing. The spring 29 is so arranged that it always tends to rotate the casing about the shaft 9 in the clockwise direction as viewed in Fig. 3. Rigidly fastened to the casing 30 is a second ratchet wheel 31, the teeth of which face in the opposite direction from the teeth of the ratchet wheel 10. The ratchet wheel 31 cooperates with a releasing pawl 32 which is rigidly fastened to an armature 33 controlled by electromagnet C. The armature 33 is similar to the armature 18 controlled by electromagnet B, and is pivotally supported at its lower end on a rod 34 carried by the side plates 7 and 8, in the same manner as the armature 18 is pivotally supported on the rod 28. A spring 35 is fastened at one end to the armature 33, and at the other end to an ear 39 formed on the lug 26, and this spring biases the armature toward the right as viewed in Fig. 3 to a position in which the releasing pawl 32 engages the teeth of the ratchet wheel 31 and prevents rotation of the casing 30. The ratchet wheel 31 also cooperates with a holding pawl 38 which is attached to an operating arm 40 secured to the armature 33. The holding pawl 38 is preferably constructed of resilient material such as phosphor bronze, and is so arranged that when the armature 33 occupies the position to which it is biased by the spring 35, the pawl is out of engagement with the ratchet wheel 31. An adjusting screw 41 carried by the operating arm 40 bears against the underside of the pawl 38 near its free end, and holds the pawl in the desired operative relation with respect to the ratchet wheel.

When electromagnet C becomes energized, armature 33 moves toward the left as viewed in Fig. 3, thereby withdrawing the retaining pawl

32 from engagement with the ratchet wheel 31, and moving the holding pawl 38 into a position in which it will engage the ratchet wheel after the ratchet wheel has been rotated approximately one tooth in the clockwise direction by the action of the spring 29. When the electromagnet C next becomes deenergized, spring 35 draws armature 33 to the right as seen in Fig. 3, thereby withdrawing the pawl 38 from engagement with the ratchet wheel 31 and moving the pawl 32 back into engagement with the ratchet wheel, the pawls being so arranged that substantially no rotation of the ratchet wheel is permitted during this latter movement of the armature. It will be apparent, therefore, that each time electromagnet C becomes energized and deenergized, the casing 30 will be rotated about the shaft 9 by the spring 29 an amount represented by one tooth of the ratchet wheel 31, except under certain conditions to be described hereinafter.

The stroke of the armature 33 may be adjusted by means of an adjusting screw 42 carried by the lug 21 in the same manner as the stroke of the armature 18 is adjusted by the adjusting screw 25. The adjusting screw 42 is locked in its adjusted position by a jam nut 43.

The casing 30 also carries a contact member 44 (see Fig. 1) which, in the form here shown, comprises a ring 50 of suitable conducting material secured to the outer edge of an insulating disc 49 which is fixed to the casing 30. As best seen in Fig. 1, the conducting ring 50 is of L-shaped cross section having a horizontal portion 50^a and a vertical portion 50^b. The vertical portion 50^b cooperates with a contact member 45, here shown as a contact arm of suitable resilient conducting material such as phosphor bronze, to close a contact 45-50. The contact arm 45 is clamped between a washer 47 which abuts against a shoulder 9^b formed on the shaft 9, and a nut 46 which is screwed onto a threaded portion 9^a of the shaft 9. The free end of the contact arm 45 is bent at right angles to the body of the arm and is provided with a low resistance conducting tip 48 which at times engages the conducting ring 50 at the outer face of the vertical portion 50^b.

A stop arm 53 is also clamped between the nut 46 and the washer 47, and this stop arm cooperates with a stop pin 51 carried by the contact member 44 to limit the amount of rotation of the casing 30 about the shaft 9 to approximately one revolution. It should be pointed out that the spring 29 constantly biases the casing 30 to the position in which the stop pin 51 engages the left-hand side of the stop arm 53 as viewed in Fig. 4, this position of the casing with respect to the shaft being hereinafter referred to as the normal position. When the casing occupies its normal position, the contact arm 45 is insulated from the conducting ring 50 by means of an insulating button 52 which extends through the conducting ring 50, as best seen in Fig. 1.

The contact member 44 also cooperates with a second contact member here shown as a resilient contact finger 54. The contact finger 54 is mounted on, but insulated from a bracket 55 which is attached to the side plate 8, as shown in Fig. 1, and is arranged to constantly engage the outer curved edge of the horizontal portion 50^a of the conducting ring 50 of the contact member 44.

External electrical connections to the relay are facilitated by providing the base plate A with four binding posts 56, 57, 58 and 59, as shown

in Figs. 1, 2 and 4. Referring now also to the wiring diagram for the relay illustrated in Fig. 5, it will be seen that as here shown, the terminals of winding 4 of electromagnet B are connected with the binding posts 56 and 57 by means of two conductors 60 and 61, respectively, and these binding posts, in turn are connected with a battery 67 over a contact 66. It will be apparent, therefore, that when contact 66 is closed, electromagnet B will become energized. One terminal of winding 4 of electromagnet C is likewise connected with binding post 59 by means of a conductor 62, and the other terminal of this winding is connected with binding post 58 through a conductor 63, contact finger 54, conducting ring 50, contact arm 45, the framework of the relay, and a conductor 64. The binding posts 58 and 59 as here shown are connected with a battery 67 over a contact 68. It will be seen, therefore, from an inspection of Fig. 5, that if contact 68 is closed when arm 45 is engaging the conducting ring 50, electromagnet C will become energized, but that, if contact 68 is closed when the contact arm 45 is engaging the insulating button 52, electromagnet C will remain deenergized. The contacts 66 and 68 may be controlled in any suitable manner forming no part of my present invention, and therefore not shown in the drawings.

The operation of the relay as a whole is as follows: If contact 66 is operated to alternately energize and deenergize electromagnet B, shaft 9 will be rotated one step each time electromagnet B becomes energized in the manner previously described. As soon as the shaft has been rotated one step, the arm 45 will be moved off of the insulating button 52 and into engagement with the conducting ring 50, so that electromagnet C can then be energized by closing contact 68. If this is done, the casing 30 will be rotated one step by the spring 29 in the same direction as the shaft 9 was previously rotated, and the contact member 44 will therefore be moved to the position in which the contact arm 45 again engages the insulating button 52. As a result, electromagnet C cannot again become energized, until after electromagnet B is next energized. If, however, contact 68 remains open while the shaft 9 is being stepped so that electromagnet C remains deenergized, the casing 30 will be prevented from rotating, and the rotation of the shaft 9 under these conditions will therefore cause the contact arm 45 to advance around the conducting ring 50 one step at a time, and will also wind the spring 29. The shaft 9 will continue to be rotated, and the contact arm will continue to move around the conducting ring in response to the alternate energization and deenergization of electromagnet B, until the shaft 9 has been rotated through approximately one complete revolution, at which time the stop arm 53 will engage the right-hand side of the stop pin 51, as viewed in Fig. 4, thus preventing further rotation of the shaft since the casing 30 is held in a fixed position under these conditions by the pawl 32 and ratchet wheel 31. It should be pointed out that when the shaft and casing occupy the relative positions in which the stop arm 53 is engaging the right-hand side of the stop pin 51, as viewed in Fig. 4, the contact arm 45 still makes electrical contact with the conducting ring 50 of the contact wheel 44.

If, at any time when the contact arm 45 is engaging the conducting ring 50, switch 68 is operated to alternately energize and deenergize

electromagnet C, the casing 30 will be moved toward its normal position by the spring 29 one step each time electromagnet C becomes energized and deenergized as previously described. When the casing has been stepped by the spring 29 the same number of times as the shaft 9 was previously stepped in response to the alternate energization and deenergization of electromagnet B, the contact arm 45 will move off of the insulating ring 50 of the contact wheel 44, and onto the insulating button 52, thus preventing further energization of electromagnet C. The parts will then be restored to the normal positions in which they are illustrated in the drawings.

It will be seen, therefore, that I have provided a relay in which two cooperating contact members are moved from one relative position to another relative position in response to a predetermined number of operations of one electromagnet, and are restored to said one relative position in response to the same number of operations of another electromagnet.

Relays of this type are particularly suitable for, although in no way limited to, use in connection with certain forms of street car control systems, wherein it is desired to provide a convenient means for determining the number of cars which have entered a particular stretch of track during a measured time interval. When used for this purpose, the contact 66 would be replaced by a car actuated contact so that this contact would be operated, and hence the shaft 9 would be stepped, each time a car entered the stretch. It will be apparent, therefore, that with the relay arranged in this manner, the number of times contact 68 must be operated at the end of a measured period of time to restore the parts of the relay to their normal positions would be an indication of the number of cars that had entered the stretch during that period of time, within the limits of the apparatus.

It should be pointed out that the number of times shaft 9 has to be stepped to move it from the position in which the arm 45 engages the insulating button 52 to the position in which the stop arm 53 engages the right-hand side of stop pin 51 as viewed in Fig. 4, may be varied by varying the number of teeth on the ratchet wheel 10, and, similarly, the number of times the casing 30 has to be stepped by the spring 29 to restore the casing 30 to its normal position from the relative position which it occupies when the stop arm 53 engages the right-hand side of stop pin 51 as viewed in Fig. 4, may be varied by varying the number of teeth on the ratchet wheel 31. The number of teeth on the ratchet wheels 10 and 31 will usually be the same, although my invention is not limited to this particular arrangement.

Referring now to the modified form of relay shown in Figs. 6 to 9, inclusive, as here shown, the plates 7 and 8 support a rotatable shaft 69 which is constantly urged in a clockwise direction as viewed in Fig. 8 by means of a spiral spring 72, the inner end of which is fastened to an extension 69^a of the shaft 69, and the outer end of which is fastened to a spring housing 73 mounted on the side plate 7. Rigidly fastened to the shaft 69 are two ratchet wheels 70 and 71, the teeth of which face in the same direction. The ratchet wheel 71 is operated by the armature 18 through the medium of the operating arm 22 and propelling pawl 23 previously described in connection with the relay shown in Figs. 1 to 4, inclusive, the

parts being so arranged that the ratchet wheel, and hence the shaft 69, will be rotated one step in a counter-clockwise direction, as viewed in Fig. 8, each time armature 18 moves to the left due to the energization of electromagnet B. It will be noted that, as here shown, the parts are so adjusted that when the armature 18 occupies its retracted position to which it is biased by the spring 19, the pawl 23 is out of engagement with the ratchet wheel 71 so that, under certain conditions which will become apparent as the description proceeds, the spring 72 can rotate the shaft 69 in the opposite direction from that in which it is impelled by the propelling pawl 23 and ratchet wheel 71. The shaft 69 is normally maintained in the position to which it has been rotated by the propelling pawl 23 and ratchet wheel 71 by means of a retaining pawl 74. The retaining pawl 74 is pivotally supported at its lower end in a bracket 75 attached to armature 33, and is biased by means of a spring 76 to a position in which it will engage an adjacent tooth of the ratchet wheel 70 when armature 33 occupies its left-hand or retracted position as viewed in Fig. 8. When armature 33 moves to the right as viewed in Fig. 8 due to the energization of electromagnet C, the pawl 74 is withdrawn from engagement with the ratchet wheel 70, and the holding pawl 38 previously described in connection with the relay shown in Figs. 1 to 4, inclusive, then moves into engagement with the ratchet wheel 70. The parts are so proportioned that when the pawl 74 is moved out of engagement with the ratchet wheel and the pawl 38 is moved into engagement with the ratchet wheel in the manner just described, the ratchet wheel, and hence the shaft 69, will be rotated by the spring 72, in the opposite direction from that in which it is impelled by the propelling pawl 23 and ratchet wheel 71, through a distance which corresponds to the length of one tooth of the ratchet wheel 70. When the shaft 69 occupies the position shown, a stop 77 attached to the ratchet wheel 71 engages a lug 78 formed on a bracket 79 attached to the side plate 8 (see Fig. 10), and prevents further rotation of the shaft by the spring 72 in the clockwise direction, as viewed in Fig. 8, and when the shaft has been rotated away from the positions shown through a predetermined distance in a counterclockwise direction, the stop 77 then engages a lug 80 formed on the bracket 79 and prevents further rotation of the shaft in this direction. As shown in the drawings, the lugs 78 and 80 are so arranged that the shaft 69 may be rotated through a total angle of approximately 180° but it will be readily understood that this arrangement may be varied as conditions require.

A contact member, here shown as a semi-circular disc 81 of suitable conducting material, such as phosphor bronze, is attached to the outer end of the extension 69^a of the shaft 69, and this disc is arranged to cooperate with a plurality of pairs of contact fingers. As here shown, there are sixteen such pairs of contact fingers, designated by the reference characters 82 to 97, inclusive. The contact fingers of each pair are attached, as by eyelets 98, to the opposite sides of a ring 99^a (see Fig. 6) of insulating material formed on a panel 99 attached to the side plate 7 and are so arranged that they extend radially inward toward the extension 69^a of the shaft 69, in a position to engage the opposite sides of the semi-circle disc 81 when the disc has been rotated to the proper position. The parts are so adjusted that when the shaft 69 occupies the position in which the

stop 77 engages the lug 78, the disc 81 will be engaged by the pair of fingers 82 only, and the pairs of fingers are spaced apart a distance which is equal to the distance through which the semi-circle disc 81 is stepped by one energization and deenergization of electromagnet B. It follows, therefore, that each time the shaft 69 is consecutively stepped in the clockwise direction as viewed in Fig. 9, it will engage an additional pair of contact fingers.

External connections with the contact fingers may be made by means of L-shaped conducting bars 100 which are molded in the base plate A¹ of the relay, and each of which conducting bars is adapted to be connected at its inner end with the fingers of a corresponding pair of fingers. The wires for connecting the bars with the fingers are omitted from the drawings for the sake of clearness.

As shown in Fig. 7, the terminals of winding 4 of electromagnet B of the relay shown in Figs. 6 to 9, inclusive, are connected directly with the terminal posts 56 and 57 by means of the conductors 60 and 61, and the posts 56 and 57, in turn, are connected with the battery 65 of a contact 66. The terminals of winding 4 of electromagnet C are likewise connected with the binding posts 58 and 59 by means of conductors 101 and 62, and the binding posts 58 and 59 are connected with the battery 67 over contact 68.

In explaining the operation of the relay shown in Figs. 6 to 9, inclusive, I will assume that with the parts in their normal positions in which they are shown in the drawings and with contact 68 remaining open so that electromagnet C remains deenergized, contact 66 is operated to alternately energize and deenergize electromagnet B. Each time electromagnet B becomes energized, the shaft 69 will be stepped one step in a clockwise direction as viewed in Fig. 9 thereby moving the disc 81 successively into engagement with the pairs of contact fingers 83, 84, 85 and so forth. The shaft 69 will continue to be stepped under these conditions in response to the alternate energization and deenergization of electromagnet B until it has been rotated to the position in which the stop 77 engages the lug 80 at which time further rotation of the shaft is prevented. When the shaft occupies this latter position, the disc 81 will engage the contact fingers of each pair of fingers 82 to 97.

If, when the shaft 69 occupies any position except the position in which the stop 77 engages the lug 78, and, the contact 66 remaining open, contact 68 is operated to alternately energize and deenergize electromagnet C, the shaft 69 will be returned by spring 72 toward the position in which the stop 77 engages the lug 78, one step each time electromagnet C becomes energized and deenergized. When the electromagnet C has been energized and deenergized the proper number of times the disc 81 will be restored to the position in which it is illustrated in the drawings so that the disc will then be engaged by only the fingers of the pair of fingers 82.

Although I have herein shown and described only two forms of electrical relays embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a rotatable shaft, a casing journaled on said shaft, means for biasing said

casing to one relative position on said shaft, two electromagnets, means controlled by one electromagnet for rotating said shaft one step at a time, means controlled by the other electromagnet for at times preventing rotation of said casing and for at other times releasing said casing to permit rotation of said casing one step at a time by said biasing means, a contact member attached to said casing and comprising an insulating disc provided at its outer edge with a conducting ring, a contact arm attached to said shaft for sliding engagement with said conducting ring, and an insulating button extending through said conducting ring in such manner that said contact arm will engage said button when and only when said casing occupies said one position.

2. In combination, a rotatable shaft, a casing journaled on said shaft, means for biasing said casing to one relative position on said shaft, two electromagnets, means controlled by one electromagnet for rotating said shaft one step at a time, means controlled by the other electromagnet for at times preventing rotation of said casing and for at other times releasing said casing to permit rotation of said casing one step at a time by said biasing means, a contact wheel attached to said casing and comprising an insulating disc provided at its outer edge with a conducting ring, a contact arm attached to said shaft for sliding engagement with one side of said conducting ring, an insulating button extending through the side of said conducting ring in such manner that said contact arm will engage said button when and only when said casing occupies said one position, and a fixed contact finger engaging the periphery of said conducting ring for sliding contact therewith.

3. In combination, a rotatable shaft, a casing journaled on said shaft, a spring connected with said casing and said shaft for biasing said casing and said shaft to a predetermined relative position, a first ratchet wheel secured to said shaft and a second ratchet wheel secured to said casing, two electromagnets, means controlled by one electromagnet for advancing said first ratchet wheel one step each time said one electromagnet is energized, means controlled by the other electromagnet for normally preventing rotation of said second ratchet wheel but for releasing said second ratchet wheel to permit advancement of said second ratchet wheel one step by said spring each time said second electromagnet is energized, and a contact responsive to the relative position of said shaft and said casing.

4. In combination, a rotatable shaft, a casing journaled on said shaft, a spring connected with said casing and said shaft for biasing said casing and said shaft to a predetermined relative position, a first ratchet wheel secured to said shaft and a second ratchet wheel secured to said casing, two electromagnets, means controlled by one electromagnet for advancing said first ratchet wheel one step each time said one electromagnet is energized, means controlled by the other electromagnet for normally preventing rotation of said second ratchet wheel but for releasing said second ratchet wheel to permit advancement of said second ratchet wheel one step by said spring each time said second electromagnet is energized, a contact member attached to said casing and comprising an insulating disc provided at its outer edge with a conducting ring, a contact arm attached to said shaft for sliding engagement with one side of said conducting ring, and an insulating button extending through the side

of said conducting ring in such manner that said contact arm will engage said button when and only when said casing occupies said one position.

5. In combination, a rotatable shaft, a casing mounted to rotate on said shaft, a spring secured to said shaft and to said casing for biasing said shaft and said casing to a predetermined relative position, a first ratchet wheel fixed to said shaft, a second ratchet wheel fixed to said casing, a first armature biased to a first position, a first electromagnet for at times moving said first armature from its first position to a second position, a second armature biased to a first position, a second electromagnet for moving said second armature from its first position to a second position, a first retaining pawl biased into engagement with said first ratchet wheel, a stepping pawl controlled by said first armature and arranged to advance said first ratchet wheel one tooth each time said first armature is moved to its second position, a holding pawl controlled by said second armature and arranged to engage said second ratchet wheel when said second armature occupies its second position but not when said second armature occupies its first position, and a releasing pawl controlled by said second armature and arranged to prevent rotation of said second ratchet wheel when said second armature occupies its first position but to release said second ratchet wheel to permit rotation of said second ratchet wheel one tooth by said spring each time said armature is moved to its second position, and cooperating contact members controlled by said shaft and said housing.

6. In combination, a rotatable shaft, a casing mounted to rotate on said shaft, a spring secured to said shaft and to said casing for biasing said shaft and said casing to a predetermined relative position, a first ratchet wheel fixed to said shaft, a second ratchet wheel fixed to said casing, a first armature biased to a first position, a first electromagnet for at times moving said first armature from its first position to a second position, a second armature biased to a first position, a second electromagnet for moving said second armature from its first position to a second position, a first retaining pawl biased into engagement with said first ratchet wheel, a stepping pawl controlled by said first armature and arranged to advance said first ratchet wheel one tooth each time said first armature is moved to its second position, a holding pawl controlled by said second armature and arranged to engage said second ratchet wheel when said second armature occupies its second position but not when said second armature occupies its first position, and a releasing pawl controlled by said second armature and arranged to prevent rotation of said second ratchet wheel when said second armature occupies its first position but to release said second ratchet wheel to permit rotation of said second ratchet wheel one tooth by said spring each time said armature is moved to its second position, a contact member attached to said casing and comprising an insulating disc provided at its outer edge with a conducting ring, a contact arm attached to said shaft for sliding engagement with one side of said conducting ring, an insulating button extending through the side of said conducting ring in such manner that said contact arm will engage said button when and only when said casing occupies said one position, and a fixed contact finger engaging the periphery

of said conducting ring for sliding contact therewith.

7. In combination, a contact, two electromagnets, means controlled by one electromagnet and effective when said one electromagnet has been energized one time for closing said contact, and means controlled by the other electromagnet for subsequently maintaining said contact closed during additional energizations of said one electromagnet until said other electromagnet has been energized the same number of times as said one electromagnet was previously energized.

8. In combination, two cooperating contact

members arranged to be moved into engagement with each other in response to a predetermined amount of movement of one contact member in one direction and to be moved out of engagement with each other in response to a corresponding amount of movement of the other contact member in the same direction, a first electromagnet for moving said one contact member one step at a time in said one direction, and means controlled by a second electromagnet for moving the other contact member one step at a time in said one direction.

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