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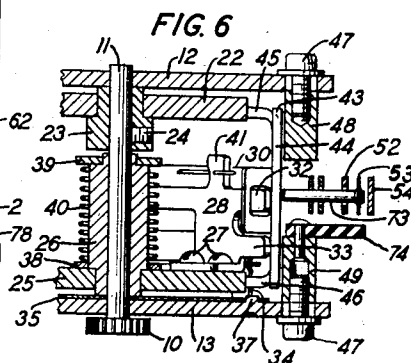
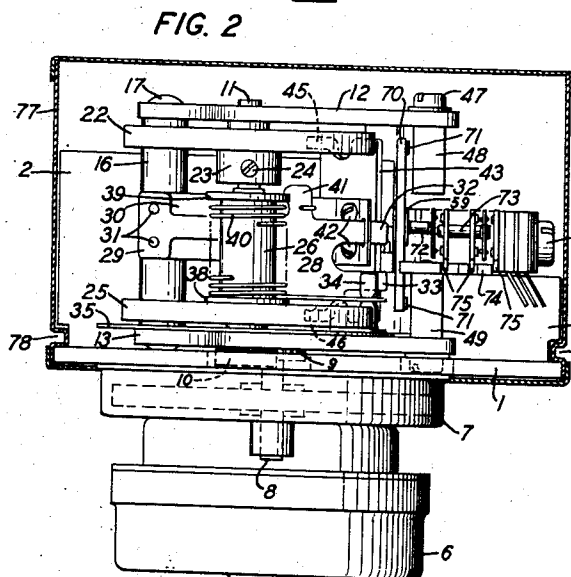
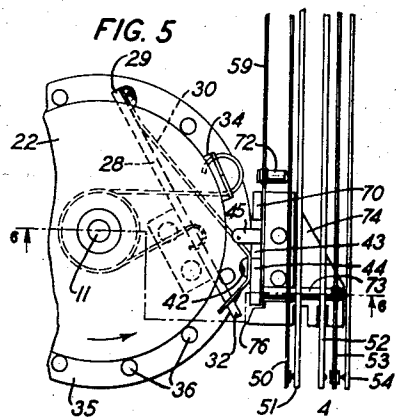
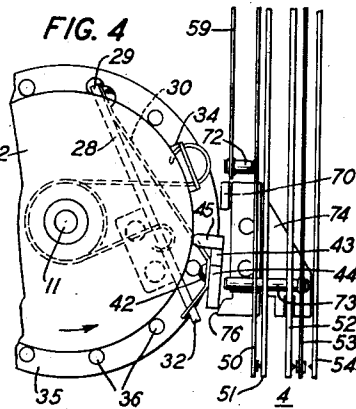
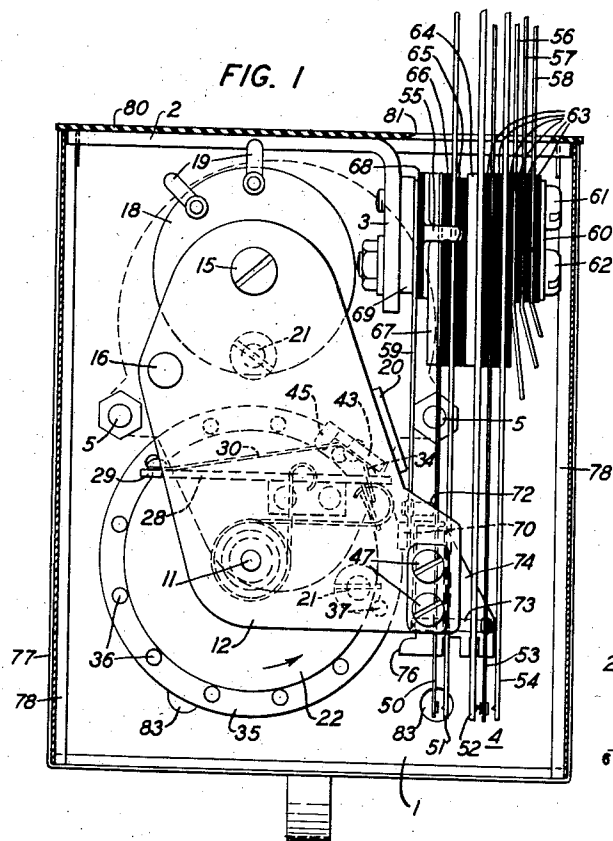
T. AAMODT

2,268,235

TIME DELAY RELAY

Filed Dec. 26, 1940

2 Sheets-Sheet 1



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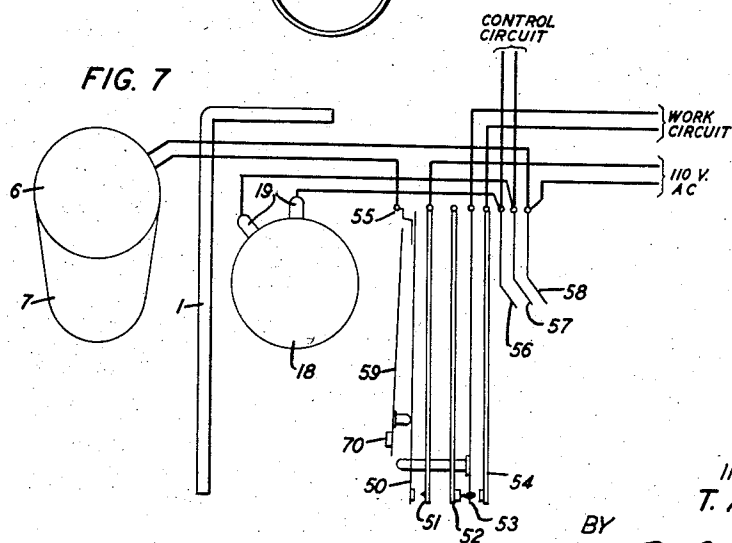
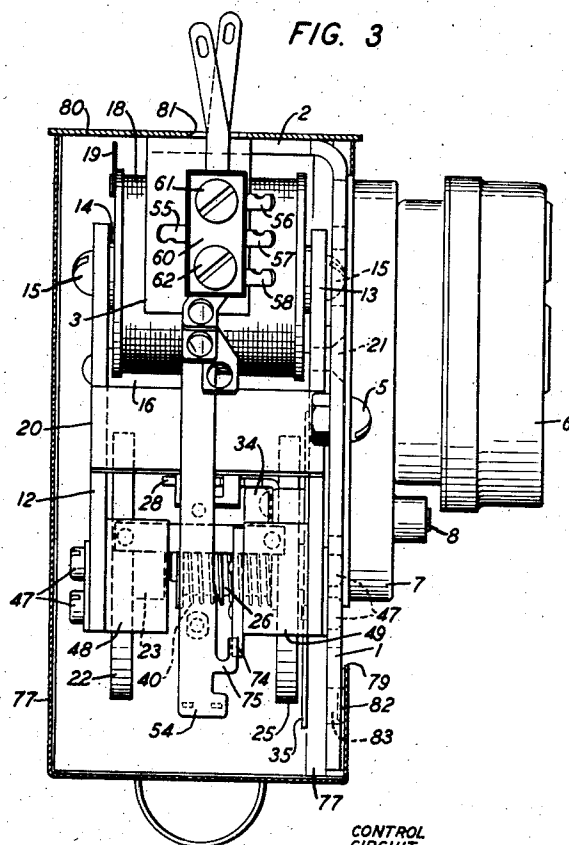
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2,268,235

TIME DELAY RELAY

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Application December 26, 1940, Serial No. 371,631

7 Claims. (Cl. 200—97)

This invention relates to a relay, and more particularly, to a relay which closes its work circuit a predetermined interval after its energizing circuit is closed.

It is a well-known expedient to render a relay slow to operate by providing a short-circuited winding on its core whereby the relay armature is delayed in its attracted movement thereby delaying the closure of the work circuit over the contact springs operated by the armature. For the measurement of short delay intervals of a fraction of a second which do not require accurate limitation, this type of relay structure has been found to be satisfactory. When, however, longer delay intervals are to be measured and more accurate timing of intervals is required this type of relay is not adequate. Other types of delay relays have heretofore been devised which permit longer delay intervals to be attained with a measure of accuracy but they have been complex in structure and therefore expensive to manufacture and have required comparatively large operating currents.

It is therefore the object of the present invention to provide a delay which is simple and compact in structure, which will operate accurately under changes in temperature, humidity and under fluctuations in operating voltage, which is easily adjustable with respect to the delay interval desired and which, because of its simplicity, is inexpensive to manufacture and to maintain in efficient operating condition.

In accordance with the invention, the aforesaid object is attained by providing a relay structure of the general type disclosed in my application, Serial No. 304,486, filed November 15, 1939, but of greatly improved construction. The improved relay comprises an electromagnet having two fixed pole-pieces and an operating coil therefor, a first pole-piece positioned adjacent to one of such pole-pieces and rotatable at a constant speed by a small synchronous alternating current motor, a second rotatable pole-piece positioned adjacent to the other fixed pole-piece and restorable to an adjustable back-stop by a spring, a spring pile-up, an armature attractable to the fixed pole-pieces by the energization of the operating coil to operate certain springs of the pile-up to close the circuit of the motor for rotating the first rotatable pole-piece, and a second armature carried by the second rotatable pole-piece and attractable to the two rotatable pole-pieces upon the energization of the operating coil whereby it is carried by the rotation of the first rotatable pole-piece to a point adja-

cent to the fixed pole-pieces and is thereupon attracted thereto and out of engagement with the rotatable pole-pieces to operate other springs of the pile-up to close a work circuit. The work circuit is then maintained closed so long as the operating coil remains energized. When, however, the operating coil becomes deenergized the armatures are both released thereby opening the previously closed work circuit and permitting the restoration of the rotatable pole-piece to which one of the armatures is secured to its normal position determined by the adjustable back-stop.

By selecting the reduction ratio of the motor gearing through which the motor drives the rotatable pole-pieces and by adjusting the position of the back-stop, the delay interval between the time the magnet coil is energized and the time the work circuit is closed may be altered between very wide limits, it being possible, for example, to obtain a maximum delay of several minutes and a minimum delay of a few minutes with one choice of gearing, and a maximum delay of a few seconds and a minimum delay of a fraction of a second with a second choice of gearing.

The invention having been described in a general manner, reference may now be had for a more comprehensive understanding thereof to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of a relay embodying the invention with the upper portion of the dust cover broken away to better disclose the relay structure;

Fig. 2 is a forward end view of the relay disclosed in Fig. 1 with the forward end of the dust cover broken away;

Fig. 3 is a side elevational view of the relay disclosed in Fig. 1 with the side of the dust cover broken away;

Fig. 4 is a detail view disclosing the positions of the relay armatures and the springs of the spring pile-up following the closure of the motor circuit by the attraction of one of such armatures to the fixed pole-pieces and just prior to the attraction of the second armature carried by one of the rotatable pole-pieces;

Fig. 5 is a detail view similar to Fig. 4 but showing the position of the armature and springs of the spring pile-up following the attraction of both armatures to the fixed pole-pieces;

Fig. 6 is a cross-sectional view taken along section line 6—6 of Fig. 5; and

Fig. 7 is a circuit diagram disclosing the circuit of the relay.

The relay is provided with a base plate 1 fabricated from a sheet of brass having its rear end bent at right angles to form a bracket portion 2 by means of which the relay may be secured to the relay mounting plate of a relay or apparatus rack and having a portion of the bracket portion 2 partially severed therefrom and bent forwardly at right angles to form a support 3 for the spring pile-up 4. Secured to the lower face of the plate 1 by bolts 5 is a motor assembly which comprises a synchronous alternating current motor which may, for example, be of the type employed for driving electric clocks, mounted within the cylindrical housing 6 and a speed reduction gearing indicated by dotted lines positioned within the housing 7 whereby the motor drives the shaft 8. Positioned on the upper end of shaft 8 is a gear 9 which meshes with gear 10 which, in turn, is secured to the lower end of a shaft 11 of the rotating pole-piece assembly as will be later described. Thus through the reduction gearing in the housing 7 and through the gears 9 and 10 the motor is enabled to drive the shaft 11 at a slow speed.

Mounted upon the upper face of the base plate 1 is the electromagnet assembly constituting the essential elements of the relay. This assembly comprises two parallelly disposed plates 12 and 13 of magnetic iron, joined at their inner ends by the core 14 of the magnet coil which is secured to such plates by screws 15, and also maintained in their parallel spaced relationship by the brass post 16 the reduced ends of which are engaged in holes of such plates and riveted over as indicated at 17 in Fig. 2, and by the nickel silver plate 20 welded at its opposite ends to the edges of the assembly plates 12 and 13. The core 14 is surrounded by an operating coil 18 to one spool-head of which the coil terminal lugs 19 are riveted or otherwise secured. The plate 13 is secured to the mounting plate 1 by screws 21, the heads of which are seated in countersunk holes in the under face of the plate 1 and the shanks of which are threaded into holes in the plate 13. To provide clearance for the head of screw 15 which secures the plate 13 to the lower end of the core 14, the plate 1 is provided with a suitable hole indicated by dotted lines in Fig. 3.

The assembly plates 12 and 13 are also provided with aligned holes in which the shaft 11 of the rotatable pole-piece assembly has a running fit. This pole-piece assembly comprises an upper pole-piece disc 22 of magnetic iron, staked to the upper end of a brass hub 23 which, in turn, is secured to shaft 11 by the set screw 24. The upper face of disc 22 is positioned to lie closely adjacent to the under face of plate 12. The rotatable pole-piece assembly also comprises a lower pole-piece disc 25 of magnetic iron staked to the lower end of a brass hub 26 which has a free running fit on the shaft 11. The lower face of disc 25 is positioned to lie closely adjacent to the upper face of assembly plate 13. The length of the two hubs 23 and 26 are such that they substantially extend between the inner surfaces of the assembly plates 12 and 13 and thereby hold the shaft 11 and gear 10 in the vertical position disclosed in Fig. 6. As before stated, the gear 10 meshes with the gear 9 carried by the shaft 8 of the reduction gearing when the magnet assembly is secured to the mounting plate 1 by the screws 21, the lower assembly plate 13

and the mounting plate 1 being provided with openings therein (not shown) to afford ample clearances for the free rotation of these gears.

Secured to the upper face of the disc 25 by the screws 27 is an armature supporting bracket 28. The bracket lies in a plane perpendicular to the surface of the disc with its opposite ends extending beyond the periphery of the disc as best disclosed in Figs. 4 and 5. The left end of the bracket, as disclosed in Fig. 2, is provided with a T-head 29 to which one end of an armature supporting leaf spring 30 is secured as by rivets 31. The other end of the bracket is provided with two arms 32 and 33 one of which, 32, extends freely through a hole in the inturned free end of the armature supporting spring 30, and which thus serves to limit the movement of the free end of the spring 30. The other arm 33 serves to engage against the edge of the adjustable back-stop arm 34 which is upturned from the edge of the adjustable back-stop disc 35. The disc 35 is rotatably positioned on the shaft 11 between the lower pole-piece disc 25 and the lower assembly plate 13 and is preferably stamped from non-magnetic material, such as sheet brass, and provided with a series of holes 36 adjacent to its periphery which cooperates with a locking embossment 37 formed on the upper surface of the lower assembly plate 13.

Surrounding the hub 26 and lying adjacent to the upper face of the lower disc 25 is a phosphor bronze spacing washer 38 and staked to the upper end of this hub is a second phosphor bronze retaining washer 39. Surrounding the hub 26 and retained in position by the washer 39 is a coil spring 40, one end of which is looped around the stop arm 34 and held in place thereon by notches formed in the edges of said arm, and the other end of which is looped around the upwardly extending arm 41 of the bracket 28. This spring is normally so tensioned as to hold the arm of the armature supporting bracket against the edge of the back-stop arm 34 of the back-stop disc 35.

Secured to the leaf spring 30 near its free end by the screws 42 is an armature 43. This armature has a bar portion 44 and two inturned polar extensions 45 and 46 which are engageable against the peripheral surfaces of the rotatable pole-piece discs 22 and 25, respectively.

Secured to the assembly plates 12 and 13 by screws 47 are two inwardly extending pole blocks 48 and 49. These blocks are in alignment as disclosed in Figs. 2 and 6 so that the bar portion 44 of the armature 43 may cooperate with the inner pole-faces thereof.

The spring pile-up 4, comprising the pair of springs 50 and 51, the set of three transfer springs 52, 53 and 54, the soldering terminal lugs 55, 56, 57 and 58, and the armature supporting spring 59 is supported on the bracket arm 3 of the base plate 1 and clamped thereto by the clamping plate 60, the clamping screw 61 and the clamping bolt 62. The screw 61 and bolt 62 are surrounded by insulating sleeves in the usual manner whereby they are insulated from the springs and terminal lugs through the holes in which they extend. The terminal lugs 56, 57 and 58 and the springs 52, 53 and 54 are insulated from each other and the outer terminal lug 58 is insulated from the clamping plate 60 by interposed strips 63 of insulating material. The springs 51 and 52 are spaced and insulated from each other by an interposed metal spring strip 64 and a strip 65 of insulating material, and the

50 springs 51 and 52 are insulated from each other by the interposed strip 66 of insulating material. The spring 50 and terminal lug 55 are in conductive engagement through the interposed metal spacing strip 67 and the terminal lug 55 is insulated from the armature supporting spring 59 by the interposed strip 68 of insulating material. To position the armature supporting spring 59 with respect to the pole-faces of the pole-blocks 48 and 49, a metal spacing strip 69 is interposed between the spring 59 and the bracket 3.

Secured to the free end of the armature supporting spring in any suitable manner, as by spot-welding, and extending transversely to the axis of the spring is an armature 70 positioned to cooperate with the pole-faces of the pole-blocks 48 and 49. The inner face of the armature 70 may have discs 71 of non-magnetic material welded or otherwise secured thereto to prevent such armature from sticking to the pole-blocks 48 and 49 upon its attraction thereto. The armature 43 is also provided with similar discs for the same purpose. Also ring staked at one end to the armature supporting spring 59 adjacent to the armature 70 is a stud 72 of insulating material, the outer end of which is normally engaged against the contact spring 50 and which is effective upon the attraction of the armature 70 to the pole-piece blocks 48 and 49 to engage the contacts of spring 50 with the contacts of spring 51 as illustrated in Figs. 4 and 5.

A stud of insulating material is also ring staked at one end to the contact spring 53 adjacent to the contact end thereof and extends inwardly through aligned holes in springs 50, 51 and 52 with its inner end positioned to be engaged by the outer face of the armature 43 when such armature has been moved by the rotation of the rotatable pole-piece discs 22 and 25 into the position illustrated in Fig. 4. Thereafter when the armature 43 becomes attracted to the pole-blocks 48 and 49, the armature 43 presses the stud 73 endwise to cause the disengagement of the contacts of springs 52 and 53 and the engagement of the contacts of springs 53 and 54.

To insure that the contact ends of the fixed contact springs 51, 52 and 54 shall be correctly positioned to provide the proper contact gaps between them and the movable contact springs 50 and 53, a strip 74 of insulating material is riveted as best disclosed in Figs. 2 and 6 to the inner end of the pole-block 49 in a position underlying the contact ends of the springs. This strip is provided with notches in which the downwardly extending tangs 75 of the fixed springs are engaged. The strip 74 is also provided with a stop member 76 which serves to prevent the armature 43 from being prematurely attracted to the pole-blocks 48 and 49 and to determine the end of the delay interval as the instant when the following edge of the armature 43 leaves the inner edge of the member 76.

To protect the relay from the accumulation of dust and from accidental engagement, the relay may be enclosed in a dust cover 77 having its side walls longitudinally indented as indicated at 78 in Fig. 2 to form grooves for guiding the cover on the edges of the base plate 1, when such cover is pushed rearwardly over the relay. The lower wall of the cover which lies adjacent to the lower face of the base plate 1 is suitably cut away at 79 to provide clearance for the reduction gear casing 7. The cover is retained in position by the engagement of embossments 82 formed in the bottom wall thereof in holes 83

in the base plate 1 as best disclosed in Fig. 3. The enclosure of the relay is completed by a strip 80 of insulating material which is positioned between the mounting bracket 2 and the mounting plate of the rack to which the relay is secured and against which the rim of the cover 77 engages when the cover is in position. The strip 80 is provided with an opening 81 through which the soldering terminals of the spring pile-up extend.

The relay upon its installation may be wired as illustrated in Fig. 7, the terminals of the motor 6 being connected to the soldering terminal lugs 55 and 58 by conductors extending through a hole in the base plate 1 provided therefor, the terminal lugs 19 of coil 18 being connected to soldering terminal lugs 56 and 57, the terminal lug 58 and the soldering terminal of relay spring 51 being connected to the bus-bar terminals of a commercial source of alternating current and the soldering terminals of relay springs 53 and 54 being connected to the work circuit which the relay is assigned to control. With the relay thus wired the motor 6 continues in operation following the closure of contact springs 50 and 51 upon the operation of armature 70 in response to the energization of coil 18 until such coil becomes deenergized. If, however, it is desired to stop the motor following the closure of the work circuit by the engagement of contact spring 53 with spring 54 the bus-bar terminal of the alternating current source shown connected to spring 51, could be connected to spring 53 and springs 51 and 52 then interconnected whereby upon the energization of coil 18 the circuit of the motor 6 would be closed over the normally closed contacts of springs 52 and 53 upon the closure of the contacts of springs 51 and 52 and would be opened upon the disengagement of the contacts of springs 52 and 53 at the time the work circuit becomes closed.

To prepare the relay for operation the stop disc 35 is sprung sufficiently to become disengaged from the embossment 37 which is normally engaged in one of the holes 36 near the periphery of such disc and the disc is then rotated around the shaft 11 to the position required to determine the length of the desired delay interval. It will be noted that the greater the clockwise movement of the back-stop arm 34 of the back-stop disc as viewed in Fig. 1, the greater will be the length of the delay interval since the armature 43 carried by the disc 25 will be moved in a clockwise direction by the tensioning of the spring 40 due to such movement of the stop arm 34 until the arm 33 of the armature supporting bracket 28 engages the rear edge of the stop arm 34 and will thus require a longer interval to rotate in a counter-clockwise direction upon the operation of the motor 6 to reach a position in which it can close the work circuit. On the contrary, the greater the counter-clockwise movement of the back-stop arm 34 which through its engagement with the arm 33 of the armature supporting bracket also causes the counter-clockwise movement of the armature 43, the less will be the length of the delay interval since the armature will require a shorter counter-clockwise movement upon the operation of the motor 6 to reach a position in which it can close the work circuit. As illustrated in Fig. 1, back-stop arm 34 has been positioned to give substantially the maximum delay interval. When the back-stop arm has been set to the desired position the edge of the disc 35 is released to engage the embossment

37 in a hole 36 therein to maintain the back-stop arm in the adjusted position.

When thereafter the circuit through coil 18 is closed a first magnetic circuit is established through the core 14, plate 12, pole-block 48 across the air-gap between such pole-block and one end of the armature 70 through such armature, across the air-gap between such armature and the pole-block 49, thence through the pole-block 49 and plate 13 back to the other end of the core 14. The armature 70 thereupon becomes attracted to the pole-blocks 48 and 49 and through the stud 72 carried by the supporting spring 59 causes the movement of spring 50 to engage its contacts with the contacts of spring 51 as illustrated in Fig. 4 thereby connecting the motor 6 to the source of alternating current. The motor 6 thereupon drives the rotatable pole-piece disc 22 through the reduction gearing within the casing 7 and through the gears 9 and 10 at a slow speed in a counter-clockwise direction as indicated by the arrow in Fig. 1.

Upon the energization of coil 78 a second magnetic circuit is also established through the core 14, plate 12, across the air-gap between the plate 12 and the rotatable pole-piece disc 22 through the polar extension 45 of armature 43, through such armature, the polar extension 46 of such armature, the rotatable pole-piece disc 25 and across the air-gap between such disc and the plate 13 back to the other end of the core 14. The flux flowing in this circuit causes the attraction of the polar extensions 45 and 46 of the armature 43 to the peripheries of the discs 22 and 25 whereby the rotary movement of the disc 22 under the control of the motor 6 is imparted to the armature 43 and through the armature to the disc 25. As the disc 25 thus rotates in a counter-clockwise direction it moves the arm 33 of the armature supporting bracket secured thereto away from the back-stop arm 34 and thus tensions the spring 40. When the armature 43 has been moved to the position illustrated in Fig. 4 the attractive force exerted by the pole-blocks 48 and 49 will pull the armature lightly against the surface of the member 76 but not sufficiently to retard the rotational movement thereof. As soon, however, as the armature has moved to the position disclosed in Fig. 5 at which time the following edge of the armature will have just moved beyond the far edge of the member 76, the following edge of the armature will be attracted toward the pole-blocks 48 and 49 thereby operating stud 73 to move spring 53 to disengage its contacts from the contacts of spring 52 and to engage its contacts with the contacts of spring 54 to thereby close the work circuit. Immediately thereafter the magnetic force exerted by the pole-blocks 48 and 49 on the leading edge of the armature overcomes the magnetic force holding the polar extensions 45 and 46 of the armature against the peripheries of discs 22 and 25 and the leading edge of the armature therefore assumes the position illustrated in Fig. 5 in which the polar extensions 45 and 46 are disengaged from the discs 22 and 25. Disc 22 is now free to rotate under the driving force of the motor 6 with no tendency to stall the motor. The member 76 thus serves as a very accurate means for determining the end of the desired delay interval.

A delay interval measured from the time of closure of the circuit of coil 18 to the closure of the work circuit by the attraction of armature 43 to the pole-blocks 48 and 49 has thus been

measured. The motor 6 continues to operate and to rotate the pole-piece disc 22 so long as the coil 18 remains energized unless, as previously described, the alternative wiring is employed whereby the motor circuit is opened upon the disengagement of springs 52 and 53. When the circuit through coil 18 is opened the armatures 43 and 70 are retracted by their respective supporting springs 30 and 59 from the pole-blocks 48 and 49, the armature 70 permitting the contacts of springs 50 and 51 to disengage thereby opening the circuit of motor 6 and the retraction of armature 43 permitting the coil spring 40 to return the rotatable pole-piece disc 25 in a clockwise direction until the arm 33 of the armature supporting bracket 28 secured thereto again engages the edge of the back-stop arm 34.

By the adjustment of the back-stop arm 34 and/or the selection of a reduction gear ratio the delay interval may be varied from a fraction of a second, for example, four-tenths of a second, to a maximum of several seconds or minutes, or even hours.

What is claimed is:

1. In a time delay relay, an electromagnet having an energizing coil, a pair of fixed pole-pieces associated therewith, a pair of rotatable pole-pieces associated with said fixed pole-pieces, an adjustable back-stop, an armature whose normal position is determined by said back-stop attractable to said rotatable pole-pieces by the energization of said coil whereby said armature is carried by said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted into engagement with said fixed pole-pieces and contact springs operable by said armature when it is attracted into engagement with said fixed pole-pieces to close a work circuit.

2. In a time delay relay, an electromagnet having an energizing coil, a pair of fixed pole-pieces associated therewith, a pair of rotatable pole-pieces associated with said fixed pole-pieces, a motor for rotating said rotatable pole-pieces, an adjustable back-stop, an armature whose normal position is determined by said back-stop attractable to said rotatable pole-pieces by the energization of said coil, a second armature attractable to said fixed pole-pieces by the energization of said coil, contact springs operable upon the attraction of said second armature to close the circuit of said motor whereby said first armature is carried by the movement of said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted into engagement therewith and contact springs operable by said first armature when it is attracted into engagement with said fixed pole-pieces to close a work circuit.

3. In a time delay relay, an electromagnet having an energizing coil, a pair of fixed pole-pieces associated therewith, a pair of rotatable pole-pieces associated with said fixed pole-pieces, a stop arm secured to one of said rotatable pole-pieces, a rotatably adjustable back-stop arm against which said stop arm normally engages, a motor for rotating said rotatable pole-pieces, an armature attractable to said rotatable pole-pieces by the energization of said coil, a second armature attractable to said fixed pole-pieces by the energization of said coil, contact springs operable upon the attraction of said second armature to close the circuit of said motor whereby said first armature is carried by the movement of said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted

into engagement therewith and contact springs operable by said first armature when it is attracted into engagement with said fixed pole-pieces to close a work circuit.

4. In a time delay relay, an electromagnet having an energizing coil, a pair of fixed pole-pieces associated therewith, a pair of rotatable pole-pieces associated with said fixed pole-pieces, a stop arm secured to one of said rotatable pole-pieces, a rotatably adjustable back-stop disc having a back-stop arm against which said stop arm normally engages, said disc having a circular row of holes adjacent its periphery for engagement with a fixed locking lug, a motor for rotating said rotatable pole-pieces, an armature attractable to said rotatable pole-pieces by the energization of said coil, a second armature attractable to said fixed pole-pieces by the energization of said coil, contact springs operable upon the attraction of said second armature to close the circuit of said motor whereby said first armature is carried by the movement of said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted into engagement therewith, and contact springs operable by said first armature when it is attracted into engagement with said fixed pole-pieces to close a work circuit.

5. In a time delay relay, a base plate having a bracket portion, an electromagnet assembly secured to said plate comprising an energizing coil, a pair of fixed pole-pieces, a pair of rotatable pole-pieces associated with said fixed pole-pieces, an adjustable back-stop, an armature whose normal position is determined by said back-stop attractable to said rotatable pole-pieces by the energization of said coil, and a second armature attractable to said fixed pole-pieces by the energization of said coil, a motor mounted on said plate for rotating said rotatable pole-pieces, and a spring pile-up secured to said bracket having a pair of contact springs engageable by the attraction of said second armature to close the circuit of said motor whereby said first armature is carried by the movement of said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted into engagement therewith, and said spring pile-up having a pair of contact springs engageable by the attraction of said first armature to said fixed pole-pieces to close a work circuit.

6. In a time delay relay, an electromagnet hav-

ing a core, an energizing coil thereon, a pair of parallelly disposed pole-piece plates secured to the opposite ends of said core, a shaft journaled in said plates, a first rotatable pole-piece disc secured to said shaft and positioned adjacent to one of said pole-piece plates, a second rotatable pole-piece disc rotatable on said shaft and positioned adjacent to the other of said pole-piece plates, an armature supporting bracket secured to said latter disc, an armature resiliently supported by said bracket with its polar ends disposed adjacent to the peripheries of said discs, and attractable to said discs upon the energization of said coil, an adjustable back-stop arm, a coiled spring surrounding said shaft with its ends secured respectively to said bracket and to said arm and tensionable to move an extension of said bracket into engagement with said back-stop arm, pole-blocks secured to said pole-piece plates and extending in alignment toward each other, a motor for rotating said shaft whereby upon the attraction of said armature to said discs said armature is carried by the movement of said first disc to a position adjacent to said pole-blocks whereupon it is attracted into engagement therewith, and contact springs engageable upon the attraction of said armature to said pole-blocks for closing a work circuit, said second disc and said armature being restored to their normal positions by said coiled spring upon the deenergization of said energizing coil.

7. In a time delay relay, an electromagnet having an energizing coil, a pair of fixed pole-pieces associated therewith, a pair of rotatable pole-pieces associated with said fixed pole-pieces, an adjustable back-stop, an armature whose normal position is determined by said back-stop attractable to said rotatable pole-pieces by the energization of said coil whereby said armature is carried by said rotatable pole-pieces to a position adjacent to said fixed pole-pieces whereupon it is attracted toward said fixed pole-pieces, a stop member for preventing the complete attraction of said armature to said fixed pole-pieces until said armature has been advanced to a predetermined rotational position, and contact springs operable by said armature when it is attracted into engagement with said fixed pole-pieces to close a work circuit.

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