No. 714,904. Patented Dec. 2, 1902.

J. S. HODGES.

ELECTROMAGNETIC DEVICE.

(Application filed Apr. 14, 1902.)

(No Model.) 2 Sheets—Sheet 1.

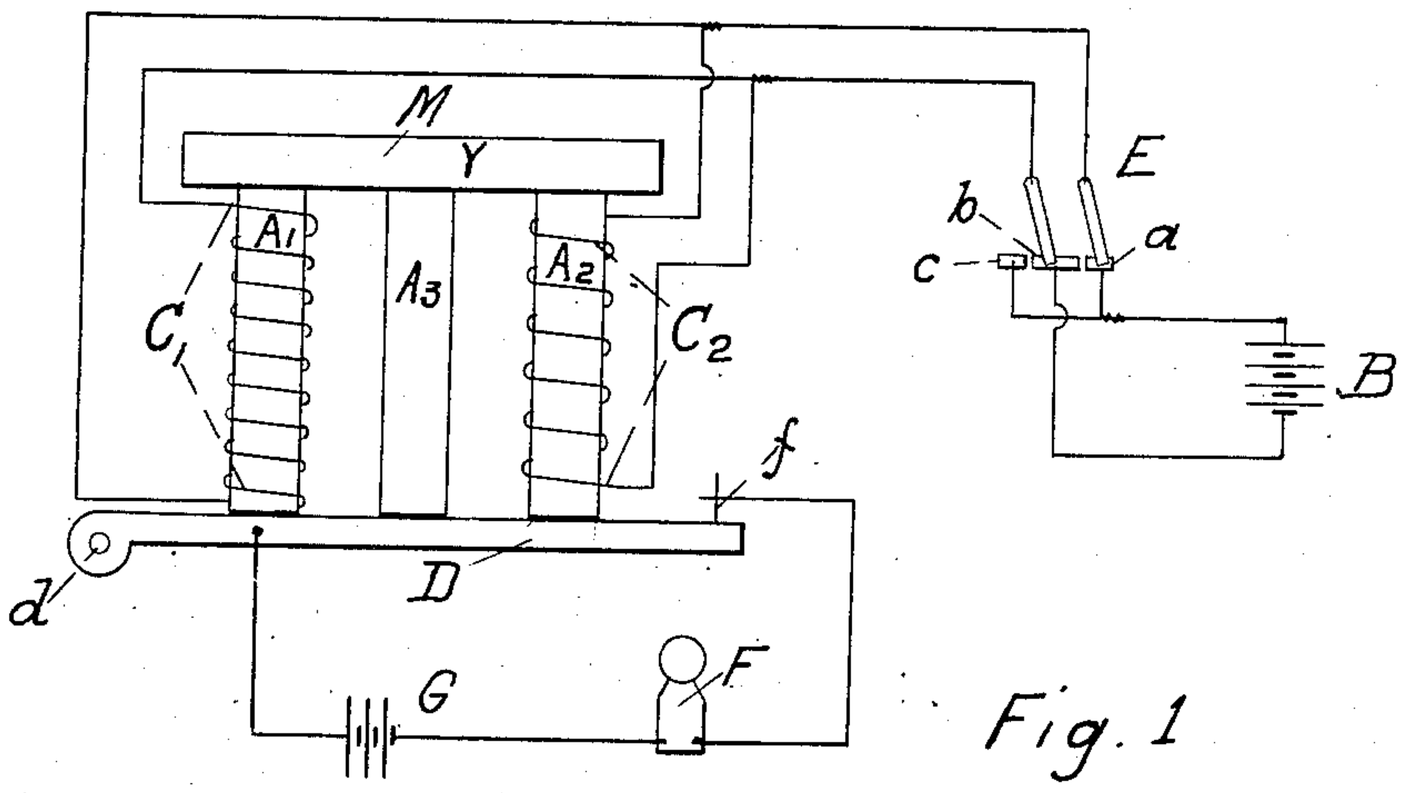

Fig. 1

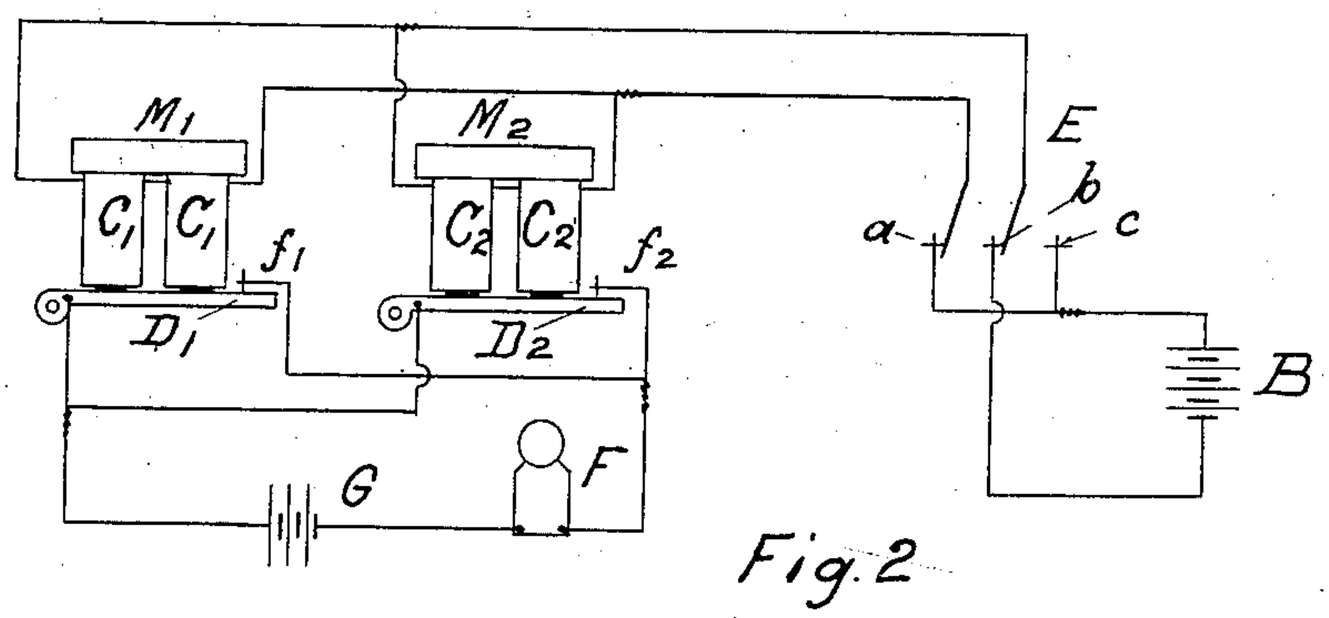

Fig. 2

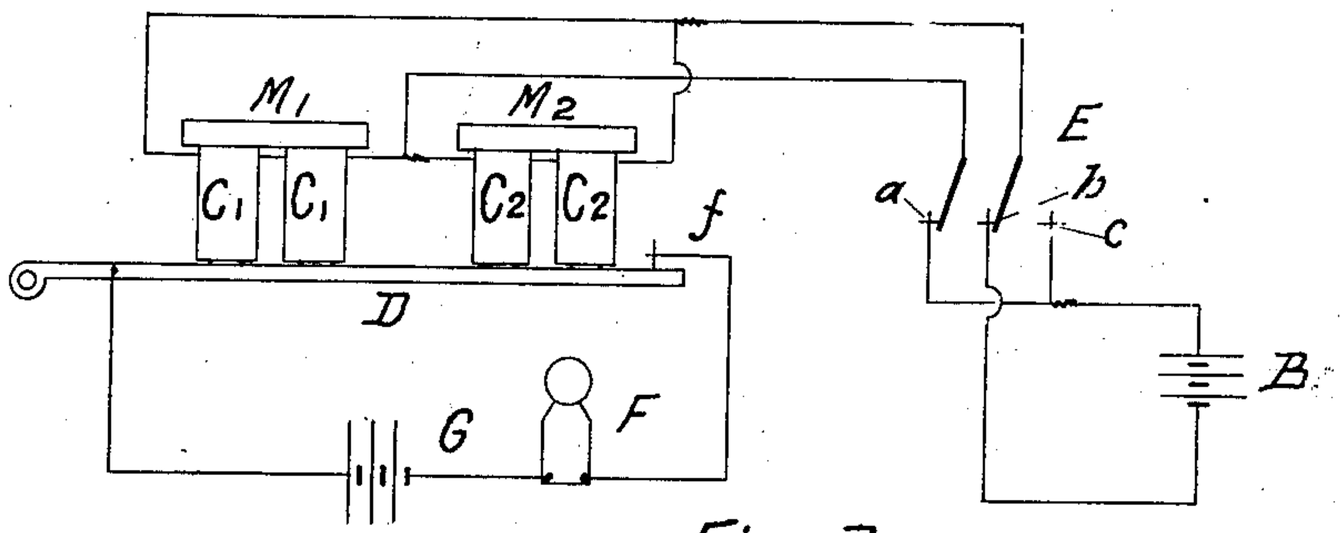

Fig. 3

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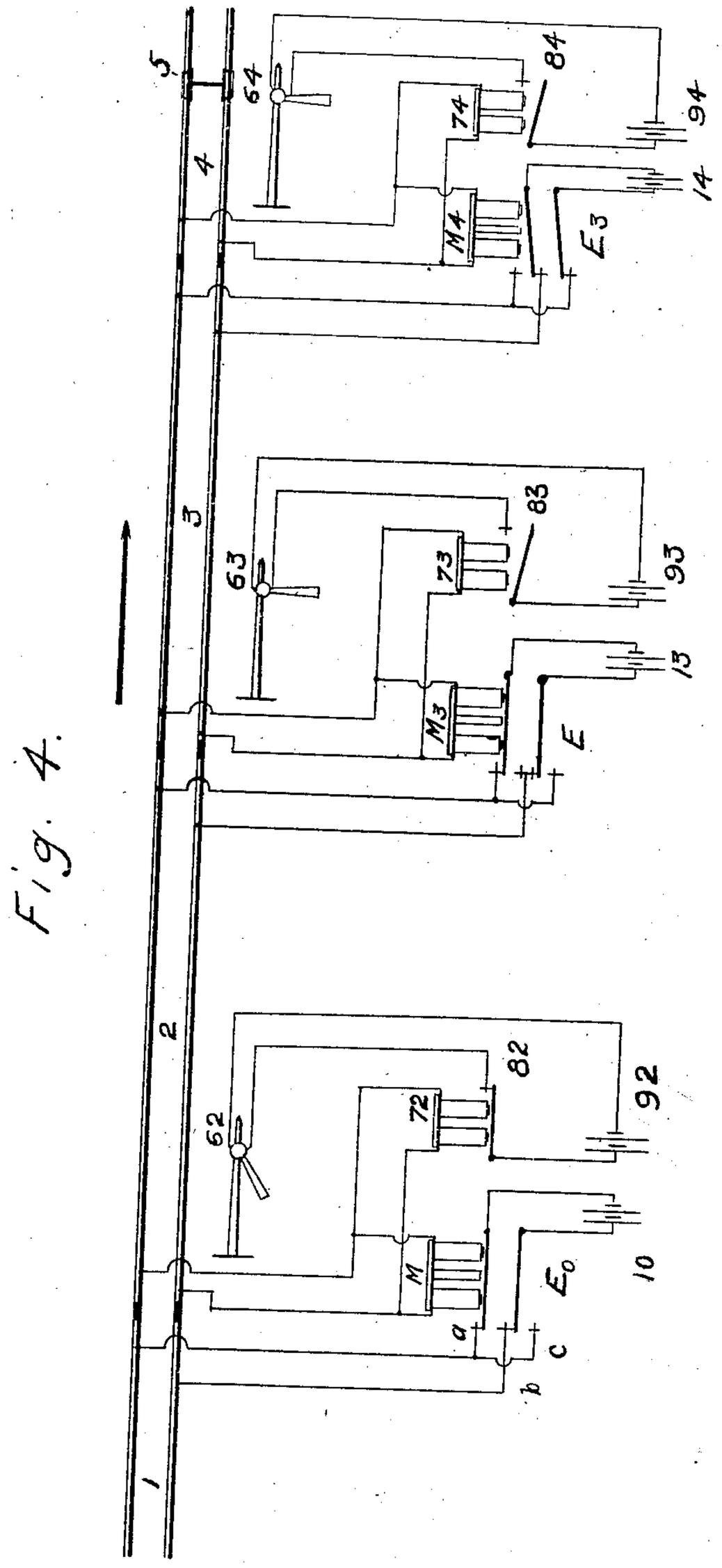
Fig. 4.



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ELECTROMAGNETIC DEVICE.

SPECIFICATION forming part of Letters Patent No. 714,904, dated December 2, 1902.

Application filed April 14, 1902. Serial No. 102,845. (No model.)

To all whom it may concern:

Be it known that I, JAMES SHALER HODGES, a citizen of the United States, residing at Troy, in the county of Rensselaer and the State of New York, have invented a new and useful Improvement in Electromagnetic Devices, of which the following is a specification.

My invention relates to that class of electromagnetic devices which are intended to perform the same function upon the passage of an operating-current in either direction and which should continue to perform the same function during the time of reversal of the current, and has for its object maintaining the continuity of electromagnetic action during said time of reversal of current.

Of the above devices the so-called "slow-acting" relay is a type, and I have selected it as adapted to show the principle underlying my invention, but I do not confine the scope of application solely to this or any other special type. As heretofore constructed, slow-acting relays consist of an electromagnet with single magnetic circuit wound with one or more coils, and which when energized attract a movable armature, thereby controlling other apparatus. During reversal of the exciting-current the release of the armature is delayed by mechanical or other means until the magnet has been deënergized and again excited. There must, however, necessarily be an instant when no attraction is exerted by the poles on the armature—*i. e.*, there is a cessation of the action of the electromagnetic device. By embodying the principle of my invention in such a relay there will at all times during the reversal of the exciting-current be an attraction between the armature and the electromagnet, as will be evident from the drawings and the following description.

In Figure 1 I have shown the form of electromagnet M which I prefer to use, consisting of a single yoke Y, armature D, and cores A' A^2 A^3. On cores A' and A^2 are wound exciting-coils C' C^2, connected through the pole-changer or current-reverser E to battery B. Figs. 2 and 3 show other forms which the device may take, and in Fig. 4 the form shown in Fig 1 is shown applied to a signaling circuit for railways.

Considering Fig. 1, the armature D is free to move on the pivot *d* and when attracted will close a local circuit through contact-point *f*, bell F, and battery G. The pole-changer E will when thrown over reverse the polarity of the circuit, including coils C' and C^2, and consequently the direction of the exciting-currents. It is evident that the electromagnet M has three magnetic circuits each comprising the yoke Y, armature D, and one pair of cores A' A^2 or A^2 and A^3 or A^3 and A', and that one or more of these magnetic circuits will be energized if there be any current flowing in either of the coils C' or C^2, and that unless the currents in both coils are zero a pull will be exerted on the armature D. The coils C' and C^2 are so proportioned that the "time-constant" of C' is greater than that of C^2—that is, with the same conditions operating to reverse the currents that in C' will require a longer time to change than that in C^2.

The operation will be as follows: Starting with the pole-changer E in the position shown, current is passing through both coils C' and C^2, and the armature D is held up. The pole-changer when thrown over onto the other contacts first short-circuits the coils C' and C^2 by bridging the contact-points *a* and *c* and then reverses the polarity of the battery. The currents in C' and C^2 will not reverse instantly, but that in C^2 will change at the greater rate, and consequently will pass through zero before that in C' and will have reversed when that in C' is passing through zero. By this means there will always be current in one or other of the two coils, and consequently an attraction between armature D and electromagnet M.

Figs. 2 and 3 show two of the many forms in which the principle may be utilized. Fig. 2 shows two electromagnets M' and M^2, with separate armatures D' and D^2, arranged to close a local circuit through the contact-points f' or f^2 when either or both armatures are attracted. In Fig. 3 are shown two electromagnets M' M^2, acting on the same armature D' and through its means closing a local circuit. The other letters in all three figures refer to parts which perform the same functions in each arrangement. In these latter cases the magnetic circuits are only two, and

these separate; but if the constants of the coils C′ and C² be so adjusted and the coils so connected that at least one of the said magnetic circuits is energized at every instant during reversal of the total current the action of the device as a whole depends upon the principle of my invention.

In Fig. 1, I have shown the pole-changer E with the contacts *a*, *b*, and *c* arranged so that the circuit of the electromagnet M is not opened, but is short-circuited momentarily as the pole-changer operates. This is not, however, essential to successful operation, as the arrangement shown in Figs. 2 and 3 will produce the desired results, and it is immaterial how the change in polarity is accomplished.

The local circuit through *f* F G D shown may of course be replaced by any mechanism, electrical or otherwise, controlled by the armature. Any method known to the art may be employed to adjust the time-constants of the coils—for example, altering the resistance or the self-induction of the coils, inserting a condenser, or by the use of external resistances, secondary coils, &c., or coils may be wound on all three cores or more cores employed, with coils or without, and various other arrangements—without departing from the principle of my invention.

In Fig. 4 a device of the above description is shown in connection with an automatic block-signaling system with overlap. 1 2 3 4 are four blocks of a track of which blocks 2, 3, and 4 are protected by the signals 62 63 64. The track-circuit 2 includes a battery 13, a pole-changer E, a polarized relay 72, and a neutral device M, constructed in accordance with my invention. When polarized relay 72 is energized by current in proper direction, which will be when device M³ is energized, a local circuit is closed through contact-point 82, battery 92, and signal 62 thereby put "clear." The neutral device M through its armature operates the pole-changer, thereby controlling the direction of current from battery 10 in circuit 1, at the further end of which are the same connections as shown for block 2. So in block 3 we have included in track-circuit battery 14, pole-changer E³, polarized relay 73, neutral device M³, the last controlling pole changer E, and thereby the direction of current in track-circuit 2 and the action of polarized relay 72. At 5 is shown a pair of wheels short-circuiting track-circuit 4 and deënergizing polarized relay 74 and neutral device M⁴, the former putting signal 64 to "danger" and the latter reversing current in track-circuit 3 and opening polarized relay 73, so putting signal 63 to "danger." The operation of the system may readily be followed from the drawings, and it will be seen that blocks 2, 3, and 4 serve as overlaps for blocks 1, 2, and 3, respectively. The operation of the device M and the value of my invention will be seen when considering that as a train passes out of block 4 the neutral device M⁴ is energized and the polarity of track-circuit 3 reverses, thereby through polarized relay clearing signal 63. The same operation reverses the direction of current in neutral device M³, and should its armature drop for an instant track-circuit 2 would be reversed, signal 62 would go to "danger," and a similar failure on the part of device M would send a false danger indication back another block. If, however, M³ M, &c., are constructed on the principle of my invention, their action will be continuous throughout the reversal of current, and the indications of signals controlled by them will not be affected by a sudden change in polarity.

I do not confine the scope of application of the invention to the above system, as it is evident that its utility is equally great in connection with any system of signaling where two indications are to be given over one circuit, whether track or signal circuit. For instance, in a system protected by home and distant signals the pole-changer may be operated by the advance home and the polarized relay control the distant signal while the neutral device controls the home. A little consideration will also show its application to normal danger or normal clear systems, while the polarized relay may be replaced by any device responsive solely to current in one direction only in the track or signaling circuit.

Electromagnetic devices with delayed action have been produced and are in use, but none of them depend for their action on causing the magnetization of the various parts of the device so to change that there is no time during the change from positive to negative excitation when every part is demagnetized.

What I therefore claim, and desire to secure by Letters Patent, is—

1. An electromagnetic device adapted to produce a unidirectional effect while the exciting current varies from a positive to a negative maximum, and comprising electric circuits of different time-constants and a plurality of magnetic circuits, such magnetic circuits being controlled by such electric circuits.

2. An electromagnetic device having electric circuits of different time-constants and a plurality of magnetic circuits, such magnetic circuits being controlled by such electric circuits, in combination with means for reversing the polarity of such device.

3. An electromagnetic device comprising a plurality of electric circuits and a plurality of magnetic circuits, each magnetic circuit interlinked with one or more of the electric circuits, such circuits having different time-constants so that all of the magnetic circuits are not demagnetized at the same instant while the total operating-current varies from a positive to a negative maximum.

4. An electromagnetic device comprising a plurality of electric circuits and a plurality of magnetic circuits, each magnetic circuit interlinked with one or more of the electric circuits,

such circuits having different time-constants so that all of the magnetic circuits are not demagnetized at the same instant while the total operating-current varies from a positive to a negative maximum, in combination with means for reversing the polarity of such device.

5. An electromagnetic device comprising a plurality of electric circuits having different time-constants, and a plurality of magnetic circuits, each magnetic circuit interlinked with one or more of the electric circuits, in combination with means for reversing the polarity of the device.

6. An electromagnetic device having exciting-coils of different time-constants and magnetic parts constructed to form a plurality of magnetic circuits under the control of such coils, in combination with means for reversing the direction of current flowing through such coils.

7. An electromagnet consisting of three cores or limbs of magnetic material in magnetic contact with one another at one end, and at the other each presenting a free end, and exciting-coils wound on two of said limbs or cores; said coils having different electromagnetic time-constants.

8. In combination, an electromagnet consisting of three cores or limbs of magnetic material in magnetic contact with one another at one end, and at the other each presenting a free end, and exciting-coils wound on two limbs; and a single armature so disposed as to be attracted when current flows in either or both said exciting-coils.

9. An electromagnetic device comprising three cores of magnetic material in magnetic contact with one another at one end and at the other end each presenting a free end, and exciting-coils of different time-constants wound on two of said cores, in combination with a pole-changer constructed to reverse the direction of current flowing through such coils.

10. An electromagnetic device comprising exciting-coils having different time-constants and magnetic parts constructed to form a plurality of magnetic circuits under the control of such exciting-coils, a source of electric energy, and a pole-changer controlling the flow of current from the source of electric energy to the exciting-coils and constructed to effect the reversing movement without opening the circuit of the source of electric energy by short-circuiting the exciting-coils during the reversing movement.

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Witnesses.
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