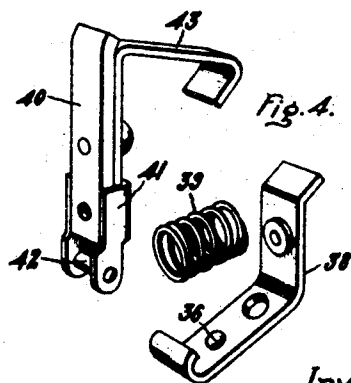
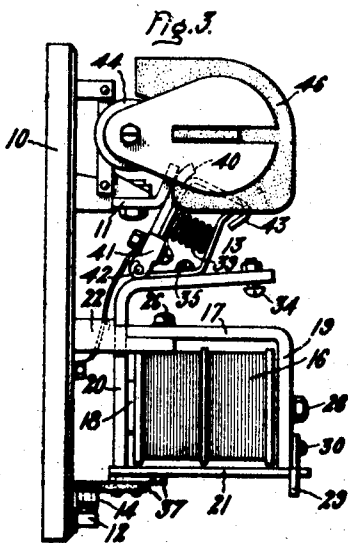
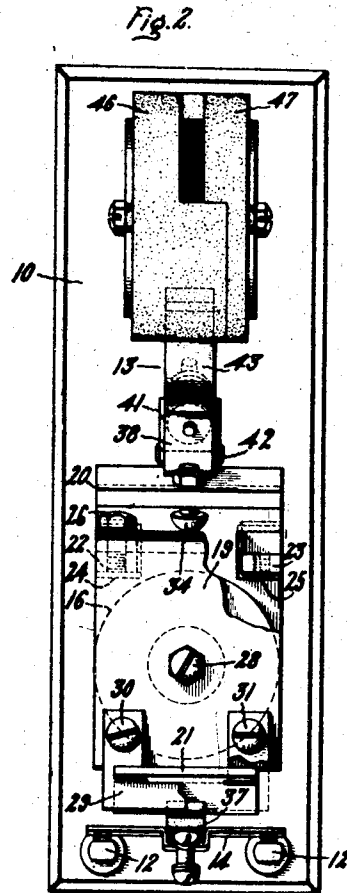
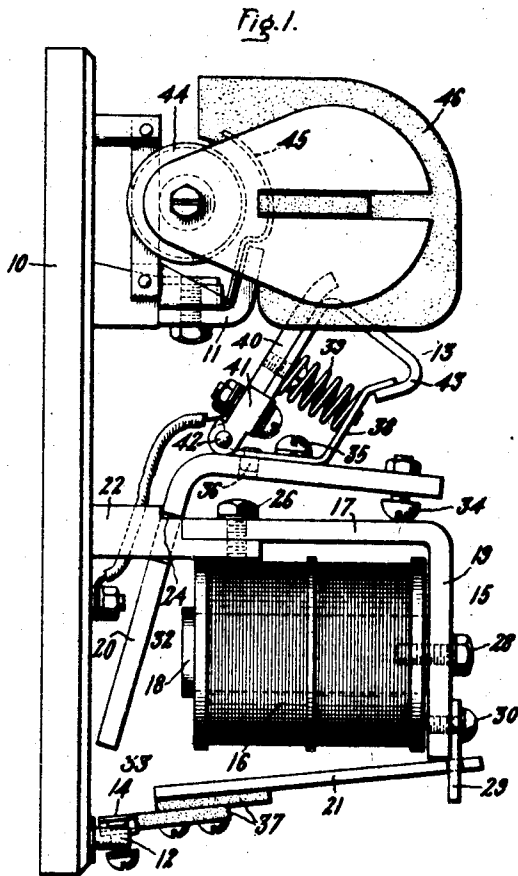


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E. R. CARICHOFF  
ELECTROMAGNETIC DEVICE

Filed Feb. 9, 1924



Inventor:  
Eugene R. Carichoff.  
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## UNITED STATES PATENT OFFICE.

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## ELECTROMAGNETIC DEVICE.

Application filed February 9, 1924. Serial No. 691,797.

My invention relates to electromagnetic devices, and particularly to electromagnetic switches and the like, and has for its principal object an improved arrangement and construction of parts whereby such devices are rendered more simple and reliable and may be inexpensively manufactured, easily assembled, and readily maintained in operative condition.

In electromagnetic devices, such as electric switches, wherein two or more independently movable members are magnetically operated or controlled by a single electromagnet, it is often desirable to have the operation of the members proceed in a definite sequence, and a further object of the invention is, therefore, to provide an improved arrangement whereby a definite sequence of operation of the members is effected.

Other objects of the invention will become evident and a better understanding thereof will be had upon a consideration of the following description in connection with the accompanying drawing which illustrates the invention embodied in a plural electromagnetic switch mechanism for the purpose of explaining the principles thereof, and in which Fig. 1 shows a side view of an electromagnetic switch having two successively operable switch elements or members; Fig. 2 shows a front view of the switch with certain parts broken away to better illustrate the details of construction; Fig. 3 shows the relative positions of the several operating parts after energization of the switch operating electromagnet; and Fig. 4 is a more detailed perspective view of the yielding contact mechanism with which one of the switch elements is provided.

The various features of novelty which I believe to be characteristic of my invention are pointed out with particularity in the appended claims.

In the preferred form of the electromagnetic switch embodying my invention illustrated in Figs. 1, 2 and 3 of the drawing, the several component switch elements are designed and arranged to be independently mounted on the supporting base 10, thus allowing the separate assembly of the individual parts into component elements during the process of manufacture and facilitating their final assembly into a complete electromagnetic switch. Referring particularly to

Fig. 1, the stationary switch elements 11 and 12 are independently supported on base 10 and cooperate with two movable switch elements 13 and 14 respectively to constitute two independently operable electric switches which are respectively biased by gravity to the open and the closed position as shown. An operating electromagnet 15, comprising an energizing winding 16 and a stationary magnetic structure 17 which includes the core 18 and the L shaped magnetic return member 19, is provided for successively attracting the two movable magnetic members or armatures 20 and 21 upon which are mounted the movable switch elements 13 and 14 respectively, and thereby operating the movable switch element 13 into contacting engagement with the corresponding stationary switch element 11 and element 14 out of contacting engagement with 12 upon the energization of the winding 16 as will more fully appear in connection with the description of the operation of my invention. A particular use for an arrangement as thus described is that of closing a main power circuit through the main contacts 11 and 12 and employing the switch member 14 to introduce a resistance in the coil circuit of the operating magnet when the main contacts are closed.

It will be observed that the several individual parts of the operating electromagnet 15 are so designed and arranged as to be supported in operative relation by the two spaced supports 22 and 23 each of which has one end fixed in the supporting base 10. The armature 20 is bent intermediate its ends into an L shape as shown in the drawing and is provided near the bend with oppositely disposed openings 24 and 25 for loosely engaging an intermediate portion of the supports 22 and 23 respectively so as to be rotatably supported thereby with a bias towards the base 10 due to the overhanging bent leg. This feature of construction simplifies both the manufacture and assembly of the movable armature 20 since the usual cylindrical bearing pin is entirely eliminated. Upon the free ends of the supports 22 and 23 which extend through the openings 24 and 25 in the armature 20, the end of one leg of the L-shaped magnetic return member 19 is secured by the screw 26 and another screw not shown and the core 18 upon which the energizing winding 16 is dis-

posed is joined to an intermediate portion of the other leg of member 19 by the screw 28 and extends parallel with the one leg of member 19 to provide a pair of projecting poles in spaced apart alignment and disposed in opposing spaced relation with the base 10 with the armature 20 operating in the space between the base and the pair of projecting poles as shown.

It will be obvious that by this arrangement and construction the electromagnet 15 may be individually assembled as a unit which is easily secured in operative magnetic relation with the armature 20. Likewise the operating electromagnet 15 may be as easily removed without interfering with or disturbing the other operating parts of the switch. The supports 22 and 23 with the L-shaped member 17 form a two part magnetic frame, the parts of which are removably secured to each other and hold the armature 20 between them.

Although the above features of arrangement and construction are of much practical importance in an electromagnetic device having a single armature, they also readily permit the provision of the second movable magnetic member, or armature 21 which is arranged to be magnetically attracted by the electromagnet 15 subsequent to the attraction of the armature 20. This arrangement is obtained by rotatably supporting the armature 21 at the free end of the magnetic return member 19 by means of the strap 29 and the screws 30 and 31 so that its path of movement intersects the path of movement of armature 20.

In this way, two multiple paths for the operating flux of the electromagnet 15 are provided, one extending through the core 18, the variable air gap 32 between the exposed pole of core 18 and the armature 20, the upper portion of armature 20, the pole between the supports 22 and 23 at the end of magnetic member 19, and the major portion of magnetic return member 19, and the other extending through the core 18, the same variable air gap 32, the lower portion of armature 20, and then across the variable air gap 33 which normally separates the armature 20 from the armature 21, and through the latter armature and the lower portion of return member 19. In order to regulate the normal length of the air gap 32 so as to vary the value of the energizing current required in the winding 16 to operate the armature 20, the adjustable screw 34 is located near the end of the bent leg of armature 20 and constitutes an adjustable stop between the bent leg of armature 20 and the member 19.

As previously pointed out, the movable switch elements 13 and 14 are carried respectively by the armatures 20 and 21, the switch element 13 being secured upon the bent leg of armature 20 by the screw 35 and the pin 36

and the switch element 14 being mounted as shown upon the insulation pieces 37, with which the armature 21 is provided.

As shown more in detail in Fig. 4 the movable switch element 13 comprises the supporting strip 38, the spring 39 and the contact 40. This form of contact mechanism is fully described and broadly claimed in my copending application, Serial No. 755,063, filed December 10, 1924, which is a division of the present application. It will be observed that the supporting strip 38 has, as shown, the left end curved to form an open cylindrical bearing and the right end bent up to form a hooked stop. The contact 40 is provided with a channel member 41 into which is inserted the cross pin 42 and the bent arm 43. These parts are so designed that the cross pin 42 may be readily inserted in the open cylindrical bearing of the supporting strip 38, the arm 43 engaged with the outer side of the bent up stop, and the compression spring 39 interposed between the inner side of the stop and an intermediate portion of the contact 40 so as to maintain the cross pin 42 and the arm 43 in yielding engagement with the supporting strip 38.

If desired either or both of the stationary switch elements 11 and 12 may be provided with any of the usual types of arc suppressing arrangements to permit interrupting high power electric circuits. As shown, the stationary contact 11 is provided with a blow out coil 44, an arcing horn 45 and the interlocking insulating members 46 and 47 which form an arc chute of restricted passage. Arm 43 also serves as an arcing horn on the moving contact member 13.

As thus constructed and arranged and with the parts in their respective positions shown, the operation of the switching mechanism embodying my invention is as follows: Upon the energization of the winding 16 the movable armature 20 receives the major portion of the operating flux of electromagnet 15 due to the lower reluctance of the path through this armature. Armature 20 is thereby attracted towards the core 18 so as to bridge the spaced apart poles at the left hand ends of the magnetic return member 19 and the core 18, and due to the loose engagement of the openings 24 and 25 with the supports 22 and 23 the armature 20 is permitted to rotate into abutting engagement with the core 18 and the upper end of the magnetic return member 19, thereby closing one of the multiple flux paths through the electromagnet 15 and also operating the movable switch element 13 into contact with the stationary element 11. Upon the operation of movable armature 20 towards the core 18 the variable air gap 33 which normally separates the armatures 20 and 21 is greatly reduced and this causes an increasing portion of the operating flux of the electromagnet 15 to pass

from the moving end of armature 20 to the armature 21 so as to attract the latter into abutting engagement with the lower end of armature 20 and magnetic member 19 immediately after the operation of the armature 20. The resulting movement of armature 21 both closes the variable air gap 33 between armatures 20 and 21 and also the second flux path through the electromagnet 15 as well as moves the switch element 14 from its normal contacting engagement with stationary switch element 12. The disposal of the rotating armatures 20 and 21 so as to move in this particular spaced relation with the magnetic structure of the electromagnet 15 insures that the armature 20 is always operated prior to the attraction of the armature 21. The practical utility and advantage of this arrangement will be obvious to those skilled in the art of electromagnetic switches.

Upon the attraction of armature 20 and the consequent rotation of the movable switch element 13 into contact with the stationary element 11, as shown in Fig. 3 a closing force is exerted upon the contact 40 which causes the spring 39 to yield and permit the contact 40 to adjust itself in any direction necessary to establish uniform contact with the stationary switch element 13 without restraint by the supporting strip 35. This feature is of great practical importance when my improved electromagnetically actuated switch mechanism is applied to the control of heavy duty electric circuits.

It will evident that all the operating parts of my improved switching mechanism may be readily dismantled for inspection or repair. Upon unfastening the screw 26, the operating electromagnet 15 together with the movable switch elements 13 and 14 may be easily removed from the base 10 and further disassembled in an obvious manner if desired.

In accordance with the provisions of the patent statutes I have illustrated the preferred embodiment of my invention in order to explain the principles thereof but I would have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an electromagnetic device, a magnetic structure comprising a fixed support and a magnetic return member removably secured to the free end of the support, an electromagnet having one end of the core thereof secured to said return member with the free end of the core disposed adjacent the said support, and an armature hingedly mounted with respect to the said support for operation between the support and the free end of said core in response to the energization of said electromagnet.

2. In an electromagnetic device, the combination with a pair of spaced apart supporting members, each having one end fixed, of a movable armature extending between said supports intermediate the ends thereof, and an electromagnet having a magnetic return member secured at one end to the free ends of said supports adjacent said armature with the electromagnet secured to the other end of the magnetic return member in operative magnetic relation with said armature.

3. In an electromagnetic device, the combination with a pair of spaced apart supporting members each having one end fixed, of a magnetic member movably supported thereby for movement between the said spaced apart supporting members intermediate the ends thereof, an electromagnet having a magnetic return member secured at one end to the free ends of said supports with the electromagnet supported thereby in magnetic attractive relation with said movably supported magnetic member, and a second magnetic member movably supported at the other end of said magnetic return member in magnetic attractive relation with the said first movable magnetic member.

4. An electromagnetic device comprising a pair of spaced apart supporting members, each having one end fixed, a substantially L-shaped magnetic frame member having one end of one leg thereof secured to the free ends of said supports and interconnecting the same, an armature pivotally supported on said supports adjacent the said interconnecting end of the magnetic frame for movement between the supporting members, and an electromagnet having a core secured to the other leg of the said frame with the free end of the core in magnetic attractive relation to said armature.

5. An electromagnetic device comprising a base, a supporting member for the device disposed at an angle to the base and having one end thereof secured to the base, a substantially L-shaped magnetic frame member, means for removably securing one end of the first leg of said frame member to the free end of said supporting member, at least one of said members provided with an aperture for the reception of an armature between the members, an electromagnet having a core secured to the second leg of said frame and disposed substantially parallel with the said first leg with the free end of the core of the electromagnet adjacent to said base, and a substantially L shaped armature member pivotally mounted in the said aperture with one leg thereof adjacent the free end of said core for movement toward and away therefrom responsively to the energization of the electromagnet, the other leg of said armature member disposed substantially parallel to the said first leg of said frame to provide means for biasing the said one end of the armature

member away from the free end of said core.

6. In an electromagnetically actuated switch mechanism, the combination with a supporting base, of an electromagnet having a core, an L-shaped magnetic frame having one end of said core secured to one leg thereof and the other leg disposed parallel with the core, a movable armature provided with oppositely disposed openings in an intermediate portion thereof and with a switch contact at one end thereof, a pair of spaced supports having corresponding ends fixed on said base and the other ends loosely passing through the said openings in said armature and provided with means for removably securing said magnetic member and said electromagnet in operative relation with the other end of said armature, and contact mechanism disposed on said base in co-operating relation with the said switch contact carried by said armature.

7. An electromagnetically operated device comprising an electromagnet, and two magnetic rotatable members arranged to be magnetically operated thereby in intersecting paths with air gaps of different lengths therein such that an increasing portion of the operating flux of said electromagnet passes from the first of said members upon operation thereof to the second member to operate the latter after the operation of the former.

8. An electromagnetically operated device comprising an electromagnet, and a pair of rotatable armatures mounted for movement in intersecting paths and arranged to be operated into abutting engagement with each other under the magnetic influence of said electromagnet whereby the operating flux of one armature is transmitted through a movable portion of the other armature to insure the successive operation thereof.

9. An electromagnetic device comprising a winding, a magnetic structure therefor, and two independently rotatable magnetic members having intersecting paths of movement and being normally disposed with air gaps of different lengths between the members and, a common pole of said magnetic structure to be magnetically attracted thereby successively to complete multiple magnetic flux paths through the said pole upon the energization of said winding.

10. An electromagnetic device comprising, a winding, a magnetic structure therefor providing two flux paths and including a movable armature partly in each of said paths and a second movable armature entirely in one of said paths, said second armature having a path of movement intersecting the path of movement of the first armature to receive operating flux from the first armature, thereby insuring the successive operation of said first and second armatures upon the energization of said winding.

11. An electromagnetic device comprising, an electromagnet, and two independently rotatable magnetic members having their axes of rotation spaced apart and arranged to be magnetically attracted in intersecting paths into abutting engagement upon energization of the electromagnet, the said rotatable members being normally disposed in their respective paths of movement to provide a variable air gap in a flux path of the said electromagnet which is decreased upon the attraction of one of said members and closed upon the abutting engagement of the member.

12. An electromagnetic device comprising a substantially F shaped magnetic structure having an energizing winding disposed on the intermediate arm thereof, and a pair of armatures, each pivotally mounted at the end of a different one of the remaining arms of the magnetic structure and normally disposed in different spaced relation with said intermediate arm to be successively attracted upon the energization of said winding to complete multiple magnetic flux paths there-through.

13. An electromagnetic device comprising, a substantially F shaped magnetic structure having an energizing winding disposed on the intermediate arm thereof, and a pair of armatures, each pivotally mounted at the end of a different one of the remaining arms of the magnetic structure and successively movable under the magnetic attraction of said structure, the first into abutting engagement with said intermediate arm and the second into abutting engagement with the said first armature.

14. An electromagnetic device comprising an L-shaped magnetic frame, a magnet core having one end joined to an intermediate portion of one leg of said frame and extending in parallel alignment with the other leg, a pair of armatures, one rotatably supported at each end of said frame and oppositely disposed from a leg thereof, and an energizing winding on said core for successively attracting one armature into abutting engagement with said core and the other armature into abutting engagement with said one armature.

15. An electromagnetic device comprising a supporting member, a substantially L-shaped magnetic frame member having one end of one leg thereof removably secured to the said support, at least one of said members provided with an aperture at the said secured ends of the members for the reception of an armature between the members, an electromagnet having a core secured to the other leg of the said frame with the free end of the core adjacent to said support, an armature mounted in the said aperture adjacent to and biased from the free end of the said core for movement to and from the

free end of the core responsively to the energization of the electromagnet, and a second armature hingedly connected to the said other leg of the frame to complete a multiple path for the flux of said electromagnet after the said first armature has been attracted to the free end of said core.

16. In an electromagnetic device, the combination of a supporting base, an operating electromagnet having a magnetic structure providing a pair of spaced apart poles, and means comprising spaced apart members extending between the base and the magnetic structure of the electromagnet for mounting the electromagnet with the said pair of poles in opposing spaced relation with the base, and a substantially L-shaped armature pivotally mounted intermediate its ends with one leg extending between said spaced apart members into the space between the said pair of poles and the base in abutting engagement with one of said poles and in attractive relation with the other of said poles.

17. An electromagnetic device comprising a base, a pair of spaced apart supports each secured at one end to the base and extending therefrom, a substantially L-shaped magnetic frame member having the end of one leg thereof secured to the free ends of said supports with the other leg of the frame member extending substantially parallel with the base, an electromagnet having a core secured to said other leg of said frame and extending substantially parallel with said first leg of said frame toward said base, and a substantially L shaped armature member pivotally mounted intermediate its ends with one leg of the armature extending between said supports adjacent the end of said first leg of the frame member into magnetic attractive relation with the free end of the core of said electromagnet.

18. In an electromagnetic switch, the combination of a supporting base, a switch contact mounted thereon, an electromagnet having a magnetic structure providing a pair of spaced apart poles, means for mounting the electromagnet with the said pair of poles in opposing spaced relation with the base, an armature pivotally mounted in abutting engagement with one of said poles and extending in the space between the said pair of poles and the base in attractive relation with

the other of said poles, and a switch contact mounted on said armature in cooperating circuit controlling relation with said contact mounted on the base.

19. In an electromagnetically operated switch, the combination of a supporting base, a switch contact mounted thereon, an operating electromagnet having a magnetic structure providing a pair of spaced apart poles, means for mounting the electromagnet with the said pair of poles in opposing relation with the base, a substantially L-shaped armature pivotally mounted intermediate its ends with one leg extending in the space between the said pair of poles and the base in abutting engagement with one of said poles and in attractive relation with the other of said poles, and a contact mounted on the other leg of said armature in cooperating circuit controlling relation with the said contact mounted on the base.

20. A normally open electromagnetic switch comprising a vertical base, a switch contact element mounted thereon, a pair of spaced apart supports each secured at one end to the base and extending horizontally therefrom below said contact, a substantially L-shaped magnetic frame member having one leg secured to the free ends of said supports in substantially horizontal alignment therewith with the other leg extending below the supports, an electromagnet having a core secured to the said other leg of said frame member with the free end of the core extending towards said base, and a substantially L-shaped armature pivotally mounted intermediate its ends adjacent said one end of said frame member with one leg thereof extending between said supports in abutting engagement with said one end of said frame member and in magnetic attractive relation with the free end of said core and with the other leg extending above said frame member for biasing the said first leg of the armature away from the free end of said core, and a second switch element mounted upon the said other leg of said armature to be operated into circuit closing engagement with said first contact upon the attraction of the armature.

In witness whereof, I have hereunto set my hand this 6th day of February 1924.

EUGENE R. CARICHOFF.

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**CERTIFICATE OF CORRECTION.**

**Patent No. 1,664,104.**

**Granted March 27, 1928, to**

**EUGENE R. CARICHOFF.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 36, before the word "evident" insert the word "be"; page 4, line 79, claim 11, for the word "member" read "members"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of May, A. D. 1928.

(Seal)

**M. J. Moore,**  
**Acting Commissioner of Patents.**