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RELAY STRUCTURE

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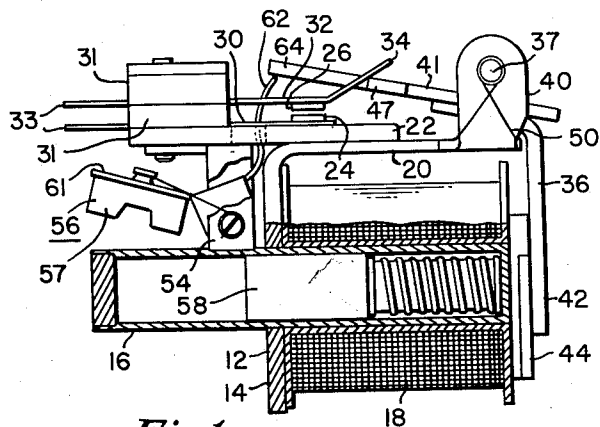


Fig. 1.

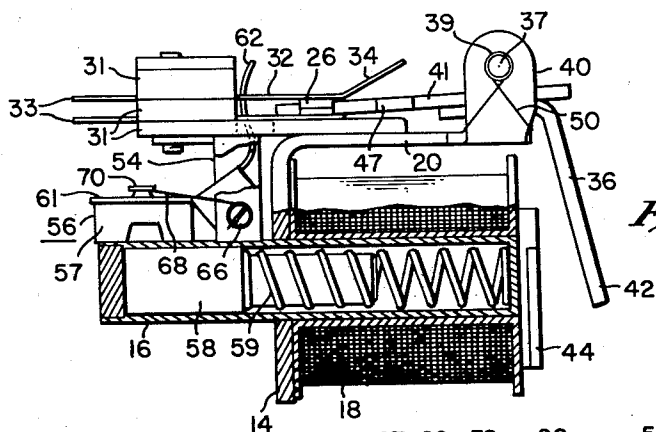


Fig. 2.

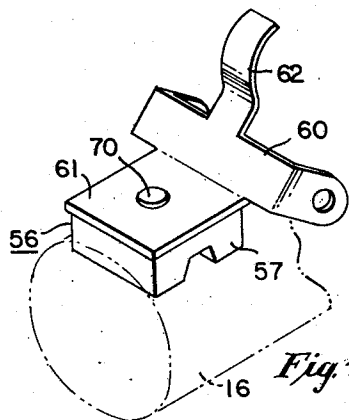


Fig. 4.

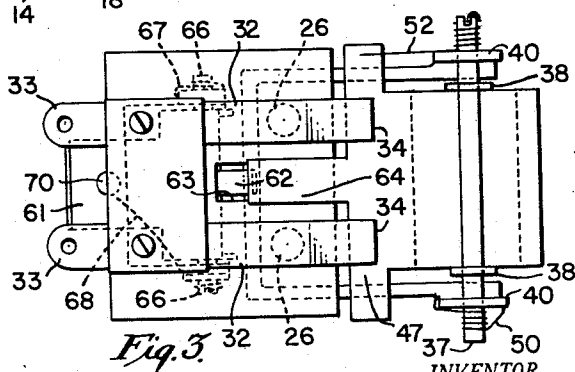


Fig. 3.

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RELAY STRUCTURE

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This invention relates to electromagnetic devices and more particularly to electromagnetic devices in which a time delay occurs between actuation of the electromag-
netic device and the return of the device to the condition existing prior to its actuation. It is an object of this in-
vention to provide improved structures of the foregoing type.

In certain electromagnetic structures, the electromag-
net is energized for actuating an armature to perform a certain function. When the electromagnet is deenergized it may be desired to maintain the armature in the position corresponding to energization of the electro-
magnet for a period of time before returning to the po-
sition corresponding to that of the deenergized electro-
magnet. The time delay in which the condition of the armature remains at that occurring during the energiza-
tion of the electromagnet provides sufficient time during which another function may be performed, by other de-
vices, before the armature returns to the condition ex-
isting prior to energization of the electromagnet.

Specifically, the invention may be utilized in an electro-
magnetic relay structure having an armature which is ac-
tuated upon the energization of the electromagnet coil to open contacts that are normally biased closed. Upon subsequent deenergization of the coil, it may be desired to restrain movement of the armature for automatically maintaining the contacts open to allow another function to be performed (by other devices) before the armature returns to the position corresponding to the deenergized position of the relay and the closed contacts position.

One embodiment of the invention is incorporated in an electromagnetic relay structure. The electromagnet comprises a coil and magnetically permeable frame members in the magnetic field of the coil. The permeable frame members are normally separated from one another by a gap which is automatically closed by a movable magnetically permeable core on energization of the coil to produce an electromagnet having adjacent poles of opposite polarity for attracting an armature.

The core is enclosed in a tube containing a liquid. The coil is mounted about a portion of the tube for moving the core in response to the magnetic field but the movement of the core is retarded, to the desired amount, by the liquid, before closing the gap, providing a time delay device, as is well known in the art.

An armature is pivotally mounted on the frame and is rotated upon energization of the electromagnetic coil for separating a movable contact from a stationary contact, the movable contact being normally biased to the closed position. The armature is spring biased and upon deenergization of the coil, were it not for the present invention, it would promptly return to its initial position allowing the contacts to close immediately. The present invention prevents this from happening and maintains the contacts open for a predetermined period of time during which another device may perform its function.

A movable magnetic device cooperates with the permeable core to prevent the armature from promptly returning to its deenergized position upon the deenergization of the coil. The magnetic device is spring biased away from the core and toward the position in which it will restrain the armature from returning to its deenergized position.

When the coil has been deenergized for a period of

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time, the core is in the position in which the attraction between magnetic device and core is sufficient to overcome the spring bias on the magnetic device and the magnetic device is out of engagement with the armature. Upon energization of the coil the core is moved into gap closing position away from the magnetic device, reducing the force of magnetic attraction therebetween below the bias force of the spring. The spring bias rotates the magnetic device into the position where it may engage the armature. Subsequent to this movement of the magnetic device the gap is closed by the core sufficiently for the armature to be actuated. When the armature is actuated it opens the contacts and engages a finger of the magnetic device.

The finger engages the armature and holds the latter in the open position of the contacts, after the coil is deenergized, for a period of time corresponding to the time required for the core to return sufficiently toward the end of the tube where the attracting force between the movable magnetic device and the core is larger than the spring bias on the magnetic device. Upon attainment of this attracting force between the movable magnetic member and the core, the magnetic device is rotated so that the finger disengages the armature, the spring bias on the armature returning the armature to its deenergized position and allowing the spring biased movable contact to engage the stationary contact.

The foregoing and other objects of my invention, the principles of my invention, and the best mode in which I have contemplated applying such principles will more fully appear from the following description and accompanying drawings in illustration thereof.

In the drawings,

FIG. 1 is a side elevational view, partly in section and partly cut away, illustrating the invention incorporated in an electromagnetic relay showing the open position of the contacts;

FIG. 2 is a view similar to FIG. 1 but showing the closed position of the contacts;

FIG. 3 is a top view of the structure in the position of the contacts illustrated in FIG. 1; and

FIG. 4 is a perspective view of the movable magnetic member showing the tube with which it is associated in dot-dash lines.

Referring to the drawings in detail, FIG. 1 illustrates an electromagnetic relay structure including a magnetically permeable L-shaped frame 12 through the vertical leg 14 of which extends a tube 16 of non-magnetic material which contains a time delay element. About the portion of the tube to the right of the leg 14 is mounted an electromagnetic solenoid coil 18. Mounted upon the horizontal leg 20 of the frame 12 is an insulator 22. Upon the insulator 22 are two spaced pairs of stationary contacts 24 and movable contacts 26. The contacts 24 and 26 are secured to conducting strips 30 and 32, respectively, which are held in spaced relation by insulators 31 and extend to the left thereof to form terminals 33 by which they are connected to the desired circuits. The movable contact strips 32 have portions 34 extending to the right of the contacts 26 by which the latter are moved. The movable contact strips 32 provide a spring bias to the movable contacts for maintaining them normally in the closed position.

An L-shaped armature 36 is pivotally secured to the frame 12 by a pin 37 which extends through bearing ears 38 and through openings 39 formed in upstanding ears 40 formed integrally with and at the right-hand portion of the horizontal leg 20. The armature 36 includes a horizontal leg 41 rigidly secured to a vertical leg 42, the bearing ears 38 being rigidly secured to the horizontal leg 41. The vertical leg 42 of the armature 36 bridges the gap between the right-hand portion of the leg 20 and

the pole piece 44 (secured to the right-hand end of tube 16) upon energization of the electromagnetic coil 18. The horizontal leg 41 extends to the left and has a portion 47 disposed below portions 34 of movable strips 32.

The pin 37 is maintained stationary by a spring 59 which is tightly wrapped about an end of the pin extending beyond the lower ear 40, FIG. 3, and which has its ends crossed and held apart by the width of the ear, as illustrated in FIGS. 1 and 2. Another spring 52, FIG. 3, biases the armature to its most counterclockwise position, allowing the contacts to be normally closed. The spring 52 is wrapped about the upper ear 40, FIG. 3, and has one end placed in a slot in the pin 37 and the other end placed upon the upper surface of the horizontal leg 41.

Within the tube 16 is a magnetically permeable movable core 58 (preferably of soft iron) which, upon energization of the coil 18, moves to the right into direct contact with the right-hand end of the tube substantially closing the gap between the core and the pole piece 44. This movement takes place against the retarding action of the liquid within the tube and a spring 59. The compression spring 59 is wrapped about a portion of the core and disposed between the right-hand end wall of the tube 18 and a shoulder of the core.

Mounted to the portion of the insulator 22 extending to the left of the vertical leg 14 and disposed above the portion of the tube 16 extending to the left of the vertical leg 14 is a U-shaped support 54 for a movable permanent magnet device 56 including a U-shaped permanent magnet 57.

The permanent magnet 57 is secured to an inverted generally U-shaped holder 60, the longitudinal axis of the U-shaped magnet 57 being perpendicular to the longitudinal axis of the tube 16. In FIGS. 1 and 2 one of the legs of the U-shaped support 54 has been cut away to show a part of the U-shaped holder 60. The holder 60 extends to the left to form a flat plate 61 to which the permanent magnet 57 is secured. On the right-hand side, as illustrated in FIG. 4, the holder 60 is provided with a curved arm or finger 62 extending through an opening 63 in the insulator 22. The finger 62 is aligned with a projection 64 (of the horizontal leg 41) which is disposed between the two pairs of contacts 24 and 26.

The holder 60 is pivotally mounted between the legs of the support 54 by a pin 66. The upper end of the pin 66, as viewed in FIG. 3, is restrained by a spring 67 which tightly engages the pin 66 and has crossed end portions apart by the width of one of the legs of the support 54. The lower end of the pin 66, as viewed in FIG. 3, is provided with a spring 68 that has one end in a slot formed in the pin 66, and the other end wrapped about a projection 70 on the plate 61 for biasing the holder 60 clockwise and away from the core 58 (relative to the core 58 when it is in the position illustrated in FIG. 2), clockwise movement of the holder being limited by the abutment of the finger 62 with the vertical leg 14 of the frame 12.

When the coil 18 has not been energized for a period of time, the contacts 24 and 26 are closed, the core 58 is in its most leftward position, FIG. 2, and the magnet 57 is attracted by the core 58 and is in its most counterclockwise position resting upon the tube 16, the finger 62 being away from the projection 64. At this time, the projection 64 of the armature 36 is in contact with the insulator 22, the armature 36 being in its most counterclockwise limiting position.

Upon the energization of the coil 18, the core 58 moves to the right but is retarded by the spring and liquid. When the core 58 moves sufficiently to the right so that the counter-clockwise force of attraction about the pin 66 upon the permanent magnet 57 developed between magnet 57 and core 58 is reduced below the clockwise spring force upon the holder 60, the holder 60 and magnet 57 are moved clockwise by the spring 68. Since the finger 62 is part of the holder 60 it is moved clockwise,

also, until the finger 62 abuts the leg 14, the finger 62 having an upper portion which overhangs the projection 64 when in this position. Thereafter, the core 58 closes the gap, the armature 36 being attracted by the coil and moved clockwise. The finger 62 and the projection 64 are proportioned so that as the armature is moved clockwise the projection 64 will ride upon the finger 62 and come to rest upon the end portion of the finger 62 when leg 42 (of the armature) abuts the pole piece 44. Simultaneously, the clockwise rotation of the armature causes the portions 47 to contact the underside of portions 34 of the movable strips 32 raising and opening the contacts.

It will be noted that as the armature is rotated into engagement with pole piece 44, the spring bias on the holder 60 will cause the finger 62 to slip under the projection 64 as the latter is raised. As illustrated, the upper portion of the finger 62 is curved toward the right, so that whenever the finger 62 is rotated clockwise by the spring 68 prior to the actuation of the armature 36, the finger 62 will have a curved portion in abutment with the left-hand end of portion 64 and slightly above the portion 64 to facilitate the riding up on finger 62 of the end of portion 64.

Upon deenergization of the coil 18, the finger 62 prevents the armature from being rotated counter-clockwise by the spring 52. By preventing this rotation the contacts 24 and 26 are maintained separated for an extended period of time. In other words, a time delay is introduced between deenergization of the coil and the return of the contacts to the closed position subsisting before the relay was energized. The finger 62 prevents movement of the armature until the core has moved sufficiently to the left to create a force of magnetic attraction between the magnet 57 and the core 58 which is larger than the spring bias (in the opposite direction) upon the holder 60. When this occurs, the holder 60 and finger 62 rotate counter-clockwise and the finger 62 releases the armature which, in turn, rotates counter-clockwise releasing the movable strips with the projection 64 coming to rest upon insulation 22 and the magnet 57 resting upon the tube 16. When the movable strips are released the contacts 24 and 26 again reclose.

With the foregoing construction a time delay of less than one second to several seconds can be provided between the deenergization of the coil and the reclosing of the contacts. This provides a time delay during which a desired function may be performed by devices not illustrated in the circuits to which the relay is connected, before the relay contacts are energized, energizing these circuits.

It will be seen, that although the invention has been illustrated in connection with a relay, the invention is equally applicable to other types of electromagnetic structures, such as circuit breakers, where a time delay after actuation of the circuit breaker may be desired.

Having described this invention, I claim:

1. An electromagnetic structure comprising an armature, an electromagnet in operative association with said armature, said electromagnet including a coil and a magnetizable frame in the magnetic field of said coil, a magnetizable core, said magnetizable core and said armature being both actuated by said coil, means for delaying movement of said core, and magnetic means responsive to the movement of said core for delaying movement of said armature upon deenergization of said coil.

2. An electromagnetic structure comprising an armature, an electromagnet in operative association with said armature, said electromagnet including a coil and a magnetizable frame in the magnetic field of said coil, a magnetizable core, said magnetizable core and said armature being both actuatable by said coil, and magnetizable means movable in response to the position of said core for controlling movement of said armature.

3. An electromagnetic structure comprising an armature, an electromagnet in operative association with said

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armature, said electromagnet including a coil and a magnetizable frame in the magnetic field of said coil, said armature being actuatable by said coil, first time delay means actuatable by said coil for producing a time delay between energization of said coil and actuation of said armature, and second time delay means controlled by said first time delay means for restraining movement of said armature.

4. An electromagnetic relay structure comprising a solenoid coil, a frame supporting said solenoid coil, an armature actuated by said coil from a first position to a second position, said coil including a magnetizable core movable from a first position to a second position, and magnetic means attracted by said core when said core moves toward said first position, said magnetic means including an arm for engaging said armature when said armature moves toward said second position, and said arm maintaining said armature in said second position until said core returns to said first position.

5. An electromagnetic relay structure comprising a solenoid coil, a frame supporting said solenoid coil, an armature actuated by said coil from a first position to a second position, said coil including a magnetizable core movable from a first position to a second position, and magnetic means attracted by said core when said core moves toward said first position, said magnetic means including an arm for engaging said armature when said armature moves toward said second position, said magnetic means being biased so that said arm tends to engage said armature, and said arm maintaining said armature in said second position until said core moves toward said first position sufficiently for the magnetic force between said magnetic means and said core to overcome the bias on said magnetic means.

6. In a device of the character described the combination of a magnetically permeable frame, a time delay means associated with said frame, a solenoid coil encircling one portion of said time delay means, said time delay means including a movable magnetically permeable core, a pivotally mounted magnetic means associated with the portion of said time delay means removed from said solenoid coil, said magnetic means including a projecting finger, an armature associated with said solenoid coil and actuated upon energization of the coil, a pair of separable contacts, means for connecting said contacts to a circuit, said armature being operatively connected to said contacts, said magnetic means being biased away from said core, said core being movable from a first position to a second position upon the energization of said coil, the magnetic force between said magnetic member and said core overcoming the bias on said magnetic member when said core is in the first position, whereby the finger on said magnetic member retains said armature in its actuated position after said coil is deenergized and while said core is returning from its second position to its first position.

7. In a device of the character described a magnetically permeable frame, a time delay means associated with said frame, said time delay means including a tube, a solenoid coil encircling one portion of said tube, said time delay means including a movable magnetically permeable core, a pivotally mounted permanent magnet means associated with a second portion of said tube, said permanent magnet means including a projecting finger, said core being movable from a first position to a second position upon the energization of said coil, an armature associated with said solenoid coil and actuated upon energization of the coil, stationary and movable contacts, means for connecting said contacts to a circuit, said armature being operatively connected to the movable contact, spring means for biasing said permanent magnet means away from said core, the magnetic force between said permanent magnet means and said core overcoming the spring bias on said permanent magnet means during the movement of said core toward the first position, the magnetic force between

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said permanent magnet means and said core becoming less than the spring bias on said permanent magnet means during the movement of said core toward the second position, said projecting finger engaging said armature upon the actuation of said armature and retaining said armature in the actuated position until the core moves sufficiently toward the first position so that the magnetic force between said permanent magnet means and said core overcomes the spring bias on said permanent magnet means whereupon said projecting finger releases said armature.

8. In a device of the character described the combination of a magnetically permeable frame, a time delay means associated with said frame, a solenoid coil for actuating said time delay means, said time delay means including a movable magnetically permeable core, a movable permanent magnet associated with said time delay means for introducing a second time delay period, said permanent magnet means including an abutment, an armature actuated by said solenoid coil for controlling a pair of separable contacts, said armature being operatively connected to said contacts, said permanent magnet means being biased away from said core, said core being movable from a first position to a second position, the magnetic force between said permanent magnet means and said core overcoming the bias on said permanent magnet means when said core is in the first position, whereby the abutment of said permanent magnet means retains said armature in its actuated position while said core is returning from its second position to its first position.

9. An electromagnetic relay structure comprising a solenoid coil, a frame for said solenoid coil, contact supporting structure including a pair of separable contacts, means for connecting said contacts to a circuit, an armature actuated by said coil between first and second positions for controlling said contacts, said coil including a core of magnetic material movable from a first position to a second position, and magnetic means attractable by said core when said core moves toward said first position, said magnetic means including a portion for restraining relative movement of said contacts after said armature moves to said second position until said core moves toward said first position.

10. The structure recited in claim 9 wherein said magnetic means comprises a permanent magnet.

11. An electromagnetic relay structure comprising a solenoid coil, a frame for said solenoid coil, a pair of separable contacts, means for connecting said contacts to a circuit, a contact actuator for said contacts including an armature moved by said coil between first and second positions, said coil including a core of magnetic material movable from a first position to a second position, and magnetic means attractable by said core when said core moves toward said first position, said magnetic means including a portion cooperating with said contact actuator for restraining movement of said contacts after said armature moves to said second position until said core moves toward said first position.

12. The structure recited in claim 11 in which said magnetic means includes a permanent magnet.

13. An electromagnetic relay structure comprising a solenoid coil, a frame supporting said solenoid coil, an armature pivotally supported by said frame and actuated by said coil upon energization thereof between a first position and a second position, said coil including a core of magnetic material movable between a first position and a second position, and a restraining structure including a permanent magnet cooperating with said core when said core moves toward said first position, said restraining structure including an abutment for engaging said armature when said armature moves toward said second position, and said abutment maintaining said armature in said second position after said solenoid coil is deenergized while said core moves toward its said first position.

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14. An electromagnetic relay structure comprising a solenoid coil, a frame supporting said solenoid coil, an armature actuated upon energization of said coil from a first position to a second position, said coil including a core of magnetizable material movable upon energization of said coil from a first position to a second position, said core being biased to said first position, said armature being biased to said first position, and a pivotal restraining structure, said restraining structure including a permanent magnet and an arm, said permanent magnet and core cooperating to move said restraining means toward said core when said core moves toward said first position, said arm engaging said armature when said armature moves toward said second position, said restraining means being biased so that said arm tends to engage said armature, and said arm maintaining said armature in said second position until said core moves toward said first position sufficiently to develop a force between said permanent magnet and said core which overcomes the bias on said restraining means.

15. An electromagnetic structure comprising an armature, an electromagnet in operative association with said armature, said electromagnet including a single coil and a magnetizable frame in the magnetic field of said coil, a single magnetizable core, said core being movable against a biasing force by the magnetic field and returnable by

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said biasing force to its initial position, and a device magnetically attractable to said core and movable toward and away from said core dependent upon the position of said core for controlling said armature.

16. An electromagnetic structure comprising an armature, an electromagnet in operative association with said armature, said electromagnet including a coil and a magnetizable frame in the magnetic field of said coil, a magnetizable core, said magnetizable core and said armature being both actuatable by said coil, means for delaying movement of said core, and magnetic means responsive to the position of said core for impeding movement of said armature temporarily.

17. The structure recited in claim 2 wherein as between the magnetizable core and the magnetizable means only one comprises a permanent magnet attractable by the other.

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