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ELECTROMAGNETIC RELAY

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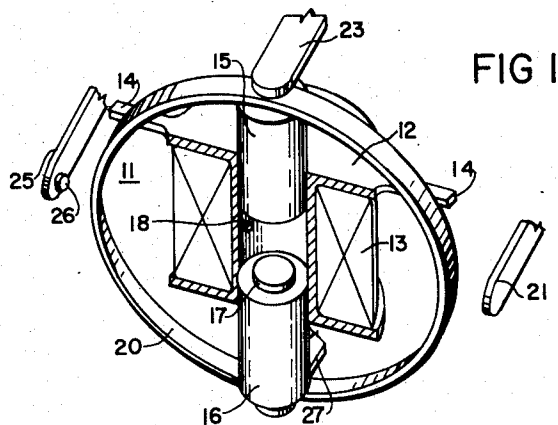


FIG 1

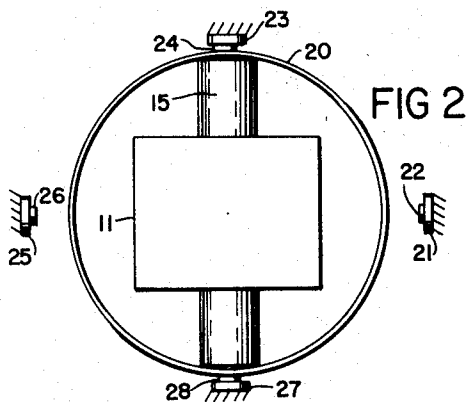


FIG 2

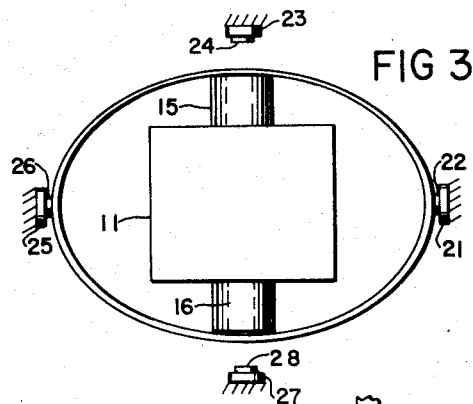


FIG 3

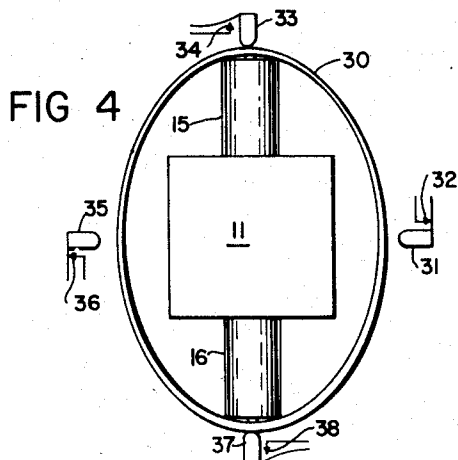


FIG 4

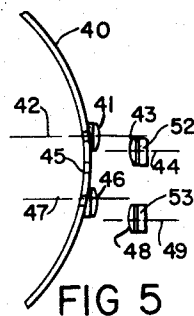


FIG 5

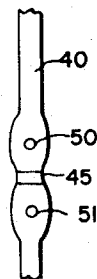


FIG 6

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ELECTROMAGNETIC RELAY

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My invention relates generally to electromagnetic relays, and more particularly, to relays having a plurality of magnetically movable members mounted in the flux path of a conventional relay coil, said members being arranged to move in opposite directions when the coil is energized.

The ordinary type of relay presently in widespread use is provided with a single, spring-loaded, magnetically-movable member or armature, mounted in the magnetic path of the relay coil, said armature being moved by the magnetic force resulting from energizing the coil. Such relays are often undesirable for use in acceleration or vibration environments, since an accelerating movement of the relay along an axis parallel to the axis of armature movement could prevent or delay the proper operation of the relay.

My invention discloses a relay mechanism in which the magnetic field of a conventional relay coil is effective to move a pair of magnetically movable members toward each other, the combined movements of these members being effective to cause the switching action. The members are normally biased away from each other by a resilient metallic band, and energization of the relay causes a switching action by moving said members and thereby deforming the resilient band out of engagement with one switching device and into engagement with another. This arrangement causes my relay to be relatively free from the effects of acceleration or vibration, since an accelerating force tending to prevent one member from moving is overcome by the magnetic force developed as the other member moves easily under the influence of said force.

Thus, it is a primary object of my invention to provide an improved electromagnetic relay mechanism in which magnetically movable members are moved under the influence of the magnetic field created by energizing the relay coil, the combined movements of said members being effective to cause the relay switching action.

A further object of my invention is to provide such an improved electromagnetic relay mechanism wherein the switching action is relatively free from the effects of vibration or acceleration.

These and other objects of my invention will become apparent from the following description of a preferred form thereof and the single sheet of drawings illustrating that form, in which:

Figure 1 is an isometric view of my relay mechanism shown in the de-energized state, with the relay coil and coil-form shown in cross-section;

Figure 2 is a front view of the device of Figure 1, illustrating the relationship of the individual components when the relay is not energized;

Figure 3 is a view similar to Figure 2 but showing my relay mechanism when energized;

Figure 4 is a front view of an alternative form of my relay mechanism shown in the de-energized condition;

Figure 5 is a front view of a portion of the structure,

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illustrating a modification of the relay contact arrangement; and

Figure 6 is a side view of the resilient band portion of Figure 5.

In Figure 1, my relay mechanism is shown to consist of a solenoid 11, including coil-form 12 and coil 13; two movable plungers 15 and 16; resilient metallic band 20 which is securely mounted to the outer ends of plungers 15 and 16; and contact arms 21, 23, 25 and 27. A mounting structure (not shown) is provided to hold these contact arms in spaced relationship with solenoid 11.

Coil 13 is wound on coil-form 12 in a conventional manner, coil-form 12 being formed of non-magnetic material with a cylindrical sleeve through the center to receive plungers 15 and 16. A mechanical stop such as 18 is secured to the wall of said sleeve as shown, so as to cause the plungers to be properly centered within the coil-form when coil 13 is energized. Where necessary, the efficiency of this coil could be increased by providing a magnetic path on the outside of the coil and magnetic end caps (not shown).

Plungers 15 and 16 have a generally cylindrical shape with an outside diameter slightly smaller than the diameter of the coil-form sleeve. Plungers 15 and 16 are preferably made of soft iron, thereby being magnetically attracted to one another when coil 13 is energized, while retaining a minimum amount of residual magnetism when coil 13 is again de-energized. Shoulder 17 at the upper end of plunger 16 has a height approximately equal to the diameter of stop 18, so as to eliminate the air-gap between plungers 15 and 16 when coil 13 is energized.

Band 20 is securely attached to the ends of plungers 15 and 16 as shown, and preferably insulated therefrom by a suitable insulating material (not shown). Band 20 is formed of metal, and has sufficient resilience to hold plungers 15 and 16 in the position shown in Figures 1 and 2 when coil 13 is de-energized. For low current applications, band 20 is used as a current carrying member. Should it be desired to increase the current carrying capacity of the relay, flexible conductors (not shown) may be connected between the contact points on the band.

Contact arms 21, 23, 25 and 27 are mounted in spaced relation with respect to solenoid 11, and each is provided with a contact such as 22, 24, 26 and 28, respectively. These contact arms are preferably current carrying members, and formed of suitable material for that purpose. These arms also serve as mechanical stops for band 20, and the mounting structure that supports these arms (not shown) is arranged to restrain movement of the arms within predetermined limits, to assure a uniform contact pressure between band 20 and contacts 22, 24 or 26, 28.

Guides, such as integrally molded projections 14 on coil form 12, are provided to prevent misalignment of the band 20 with contacts 22 and 26. This alignment could also be maintained by providing a hexagonal or other non-round sleeve in coil-form 12 and corresponding non-round plungers, or by any other suitable means.

Referring to Figure 2, it is seen that when the relay is de-energized, resilient band 20 engages contacts 24 and 28, and completes a circuit therebetween. When the relay is energized, plungers 15 and 16 are pulled into coil-form 12 as shown in Figure 3, thereby deforming band 20 to the elliptical shape shown. The circuit between contacts 24 and 28 is broken, and a circuit is completed between contacts 22 and 26. When the relay is again de-energized, resilient band 20 returns to the circular form shown in Figure 2, thereby opening the circuit between contacts 22 and 26, and reclosing the circuit between contacts 24 and 28.

In Figure 4 resilient band 30 is shown to have a generally elliptical shape. Thus, with this configuration, the band would have a generally circular shape when the relay is energized, and return to the elliptical shape as shown when the relay is de-energized. The band could, of course, have an irregular shape, and numerous other contacts could be provided to engage the irregular conformations of the band during either the energized or de-energized condition. Thus, numerous combinations of band design and contacts could be provided.

It should also be noted in Figure 4 that the resilient band 30 is not a current carrying member. In this configuration, I have shown mechanical actuators, such as plungers 31, 33, 35 and 37, for completing circuits through contacts 32, 34, 36 and 38, respectively. Thus, the resilient band, could be used to operate the mechanical actuators of micro switch type precision-snap-switches.

In Figures 5 and 6, I have shown a section of the resilient band, designated 40, with a pair of precious metal contacts 41 and 46 rigidly mounted thereto. These contacts are preferably mounted to the outside of the band as shown, with integrally formed shanks that extend through holes 50 and 51, being then staked from the inside of the band in the conventional manner. Such contacts may be used at each contact point along bands such as 20 and 30 to compensate for the relatively poor contacting qualities of the resilient band material.

Figure 5 also illustrates one method for obtaining a wiping action between the contacts, to improve switching action. In this arrangement, contacts 43 and 48 are rigidly mounted along axes 44 and 49, respectively, to contact arms 52 and 53, respectively. Assuming that band 40 is shown with the corresponding relay coil de-energized, then energization of the coil would cause contacts 41 and 46 to move along axes 42 and 47, respectively, and the rounded portions of contacts 41 and 46 would engage contacts 43 and 48, respectively, with a wiping action. It should be noted that band 40 has been enlarged in the area of contact-mounting holes 50 and 51 to insure adequate fatigue life of said band.

It should also be noted in Figures 5 and 6 that band 40 is provided with an insulating member 45 formed as an integral part thereof. Such members may be used at various points along the band, to provide a plurality of electrically isolated segments. This feature, combined with the possibility of using additional contacts and an irregularly shaped band, as described above, makes it obvious that numerous circuit combinations could be provided.

The use of two moveable plungers, as I have shown in Figure 1, causes the operation of my relay mechanism to be substantially independent of an acceleration or vibration environment in which the relay may be used. Assume, for example, that the relay mechanism as shown in Figure 1 is accelerating downward toward the bottom of the sheet of drawings. The accelerating force would then tend to prevent plunger 15 from pulling into coil-form 12 when coil 13 is energized. However, this same accelerating force causes plunger 16 to be forced into the coil-form under the influence of a smaller magnetic force than was previously required. This tendency of plunger 16 to be pulled in more easily tends to reduce the air gap between plungers 15 and 16, thereby increasing the magnetic pull on plunger 15. Thus, the extra accelerating force on plunger 15 is overcome by the extra magnetic force caused by the additional flux developed as plunger 16 moves into the coil-form more easily.

What has been described is considered to be the preferred embodiment of my invention, but it is apparent that numerous modifications thereof are possible. Therefore, I do not wish to be limited to the form shown except as indicated by the following claims.

I claim:

1. An electromagnetic relay mechanism comprising: a

coil-form, a relay coil wound on said form, a plurality of magnetically movable members arranged in the magnetic path of said coil so as to form a part thereof, bias means connected to said members and effective to hold said members in spaced-apart relation, said members being caused to move toward each other under the influence of the magnetic field created by energizing said coil, and switching means operated responsive to the combined movements of said members and bias means.

2. A relay mechanism for severe vibration and acceleration environments comprising: a coil-form, a relay coil wound on said form, a plurality of magnetically movable members arranged in the magnetic path of said coil so as to form a part thereof, whereby the direction of movement of certain of said members is parallel to the direction of a first vibration or acceleration force applied to the relay mechanism, a spring bias member connected to apply a second force to said certain members and thereby maintain a maximum air gap in said magnetic path, the magnetic force created by energization of said relay coil being effective to aid said first force and oppose said second force to thereby operate at least one of said certain members, thereby reducing said air gap and causing said magnetic force to exceed said first and second forces on the other of said certain members and thereby operate the other of said certain members, and switching means operated responsive to the combined movements of said members.

3. A relay mechanism for severe vibration and acceleration environments comprising: a coil-form having a sleeve through the center thereof, a relay coil wound on said form, a pair of magnetically movable plungers mounted in said sleeve at opposite ends thereof, means for limiting the outward movement of said plungers, a resilient ring member connected along one diameter to the outer ends of said plungers and arranged to hold said outer ends against said limiting means and thereby maintain a maximum air gap between the inner ends of said plungers, and means for energizing said coil, the magnetic pull caused by said energization of said coil being effective to overcome said resilience and move at least one of said plungers into said sleeve in spite of an opposing force due to said acceleration or vibration, said air gap being thereby reduced so as to cause said pull to exceed the combined effect of said force and said resilience whereby the other plunger is moved into said sleeve.

4. A relay mechanism as claimed in claim 3, additionally comprising a mechanical stop mounted to the inner wall of said sleeve at a point midway between the ends of said form, said stop being effective to center said plungers when said coil is energized.

5. A relay mechanism as claimed in claim 3, wherein said limiting means includes a first pair of electrical contacts whereby a first electrical circuit is completed between said contacts by said ring when said relay coil is de-energized, a second pair of electrical contacts mounted along an axis transverse to said diameter, movement of said plungers upon energization of said coil being effective to deform said ring and thereby complete an electrical circuit including said ring and said second pair of contacts.

6. A relay mechanism as claimed in claim 5, wherein the relative positions of said ring and said contacts is such that the ring engages the contacts with a wiping action.

7. A relay mechanism comprising: a relay coil; a magnetically movable member mounted at each end of said coil; a plurality of electrical contacts; and means for biasing said members away from the magnetic pull of said coil and for completing a first electrical circuit between certain of said contacts when said coil is de-energized, and for opening said first circuit and completing a second electrical circuit between other of said

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contacts when said members are moved under the influence of the magnetic field created when said coil is energized.

8. A relay mechanism as claimed in claim 7 wherein said biasing means includes a resilient ring of conductive material connected along one diameter to said movable members.

9. A relay mechanism comprising: a relay coil, a magnetically movable member mounted at each end of said coil, a resilient band of conductive material connected to said movable members so as to hold said members away from the magnetic pull of said coil when said coil is de-energized, a plurality of electrical contacts, certain of said contacts being positioned so as to function as mechanical stops for said band thereby limiting the amount of said movement while simultaneously completing electrical connections between said band and said certain contacts, and means for energizing said coil, energization of said coil being effective to move said members toward each other thereby moving said resilient band away from said certain contacts and deforming said band into engagement with others of said contacts.

10. A relay mechanism as claimed in claim 9, wherein said resilient band is formed with a plurality of separate conducting segments, said band being effective to complete one or more electrical circuits between various combinations of said contacts during both the energized and de-energized condition of said relay coil.

11. A relay mechanism comprising: a relay coil having a magnetic path associated therewith, a pair of independently movable members mounted in said path, a resilient band connected between said members so as to bias said members away from each other, and control means, energization of said coil causing movement of said members toward each other to thereby deform said biasing means into engagement with said control means.

12. A relay mechanism as claimed in claim 11 additionally comprising a second control means, the resilience of said band being effective to hold said band in engagement with said second control means until said relay coil is energized.

13. A relay mechanism comprising: a coil-form having a sleeve through the center thereof; a relay coil wound on said form; a pair of magnetically movable plungers mounted in said sleeve at opposite ends thereof; first mechanical stops mounted adjacent to the outer end of each plunger along the axis of said coil form; a resilient band-member connected between the outer ends of said plungers and tensioned to engage said first stops, there-

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by biasing said plungers away from said coil so as to maintain a maximum air gap between the inner ends of said plungers; second mechanical stops mounted in a plane parallel to the plane of said biasing means and along an axis transverse to said coil-form axis, energization of said coil being effective to pull the plungers into the coil and thereby move the resilient band out of engagement with said first mechanical stops and into engagement with said second mechanical stops.

14. A relay device as claimed in claim 13 wherein said mechanical stops include actuating levers, said levers being actuated when said resilient band engages said stops.

15. A relay mechanism as claimed in claim 13 wherein said mechanical stops include electrical contacts, said resilient band being effective to complete electrical circuits between said contacts when in engagement with the corresponding mechanical stops.

16. A relay mechanism comprising: a relay coil having a magnetic path associated therewith; magnetically movable means mounted in said path; a plurality of control means mounted in relatively fixed position in relation to said coil; and a resilient member connected to said movable means, and in engagement with certain of said control means when said coil is deenergized, energization of said coil being effective to move said movable means and thereby carry said resilient member out of engagement with said certain control means and into engagement with other of said control means.

17. A relay mechanism, comprising: a relay coil; magnetically movable means mounted to be moved responsive to the magnetic field created by energizing said coil; a plurality of control means mounted in relatively fixed position in relation to said coil; a resilient member attached only to said movable means and effective, with said coil deenergized, to engage certain of said control means and to hold said movable means in a first predetermined position in relation to said coil, energization of said coil being effective to exert a force on said movable means greater than the resilience of said member to thereby move said movable means to a second predetermined position in relation to said coil and carry said resilient member out of engagement with said certain control means and into engagement with other of said control means.

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