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Fort Wayne, Ind.
Continuation of application Ser. No.
728,477, May 13, 1968, now abandoned.

3,115,561	12/1963	Lewis	335/203
3,089,064	5/1963	Bennetot	335/229
3,138,678	6/1964	Raab	335/203
3,278,872	10/1966	Maynard	335/128

FOREIGN PATENTS

253,001	6/1926	Great Britain	
574,629	1/1946	Great Britain	335/232

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[54] ELECTROMAGNETIC RELAYS

16 Claims, 8 Drawing Figs.

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 335/195
 [51] Int. Cl. H01h 9/30
 [50] Field of Search 335/203,
 195, 187, 229, 128, 202, 232; 337/110

[56] References Cited

UNITED STATES PATENTS

1,858,562	5/1932	Schedlbauer	335/187
2,467,653	4/1949	Berthier	337/110
2,502,842	4/1950	Hickman	335/202
2,839,632	6/1958	Varichon	335/195

ABSTRACT: Electromagnetic relays include a base member, coil, a core extending through the coil, a leaf spring, and an armature staked to the leaf spring and moveably responsive to the magnetic field of the coil core produced by the coil. The base member is recessed and a moveable contact is carried by the leaf spring or armature and is adapted to engage a stationary contact located either above or below the moveable contact in the recess in response to the current flow condition through the coil. In a second embodiment a second pair of leaf springs are provided carrying the moveable contacts, the second leaf springs being actuated by a rigid arm attached to the armature and its leaf spring. The contacts are located closely adjacent the magnetic circuit formed by the core and armature, the magnetic flux at the contacts being substantially increased to effect magnetic blowout at the contacts.

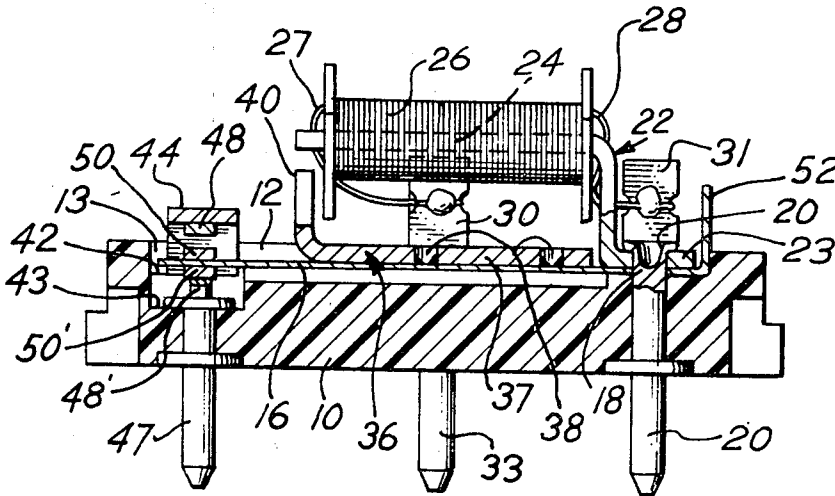


Fig. 1

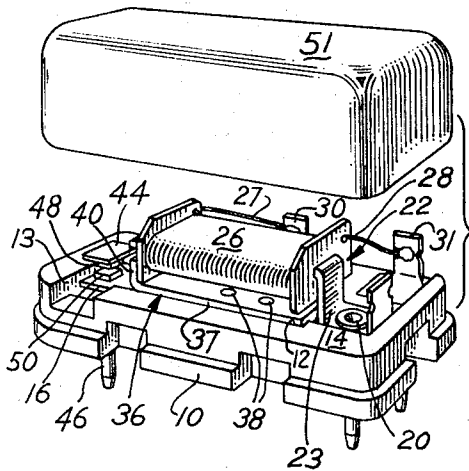


Fig. 2

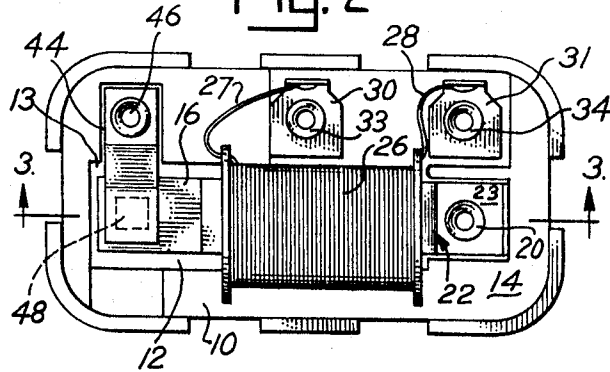


Fig. 3

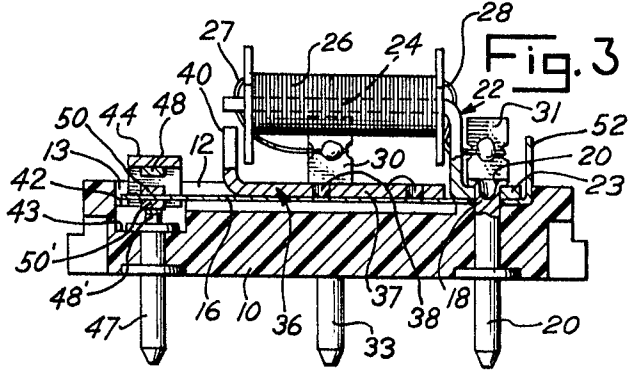


Fig. 4

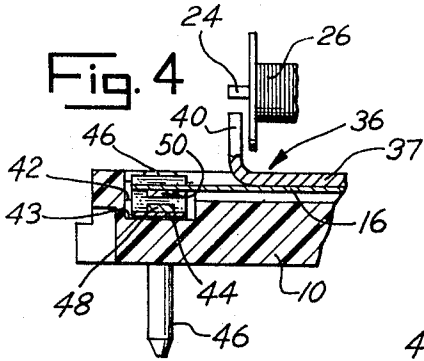


Fig. 6

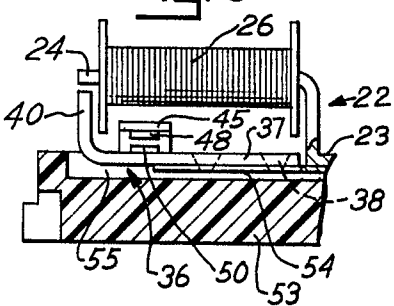


Fig. 5

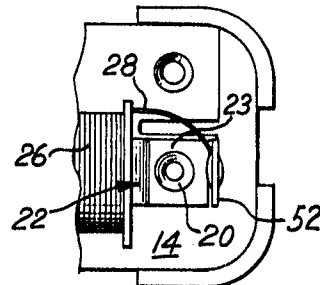


Fig. 7

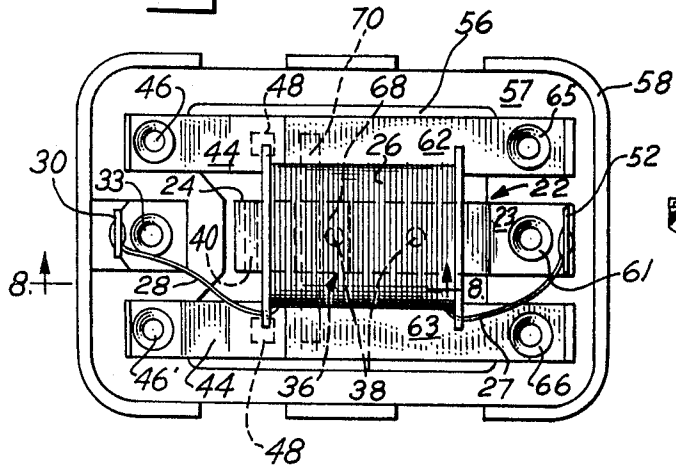
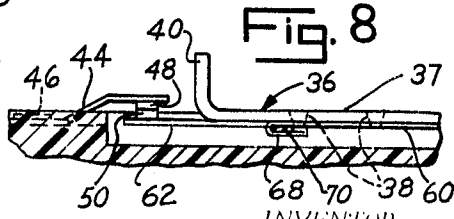


Fig. 8



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ELECTROMAGNETIC RELAYS

RELATED APPLICATION

This application is a continuation-in-part of my copending application, Ser. No. 728,477, filed May 13, 1968 and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to electromagnetic relays. Prior electromagnetic relays are constructed of a plurality of elements which are generally not interchangeable between relays having varying operating characteristics. For example, if the relay is designed to be normally open, its base plate and contact construction are generally not interchangeable with a relay which is designed to be normally closed. Also in prior relays, where the magnetic circuit is constructed entirely of flat sheet metal stampings, such relays have to be preadjusted or precalibrated and are not adjustable after their final assembly is completed. Moreover, the construction of the prior relays generally renders it difficult, if not impossible, to rapidly and easily remove the installed coil and replace the coil with another coil. If a different capacity coil is substituted without alteration to many of the other elements of the prior relays, the relays will not function properly particularly since these relays were incapable of subsequent adjustment and calibration. Moreover, due to the construction limitations of the prior relays, such relays are frequently bulky and of relatively large size for a given load rating. Also the prior relays suffer from an electrical life which is usually shorter than their mechanical life since their contacts are subject to arcing and consequent contact surface deterioration. The electrical life of the relay is thus frequently the limiting life even through the relay is capable of further mechanical operation. Such arcing could be prevented and the electrical life of the relay increased by the addition of a separate magnet or coil blowout feature arranged adjacent the contacts. However, where such additional separate blowout feature is provided both the size and cost of the relay substantially increases.

An electromagnetic relay constructed in accordance with the principles of my invention, is capable of substantially complete interchangeability of its elements between relays having other operating characteristics. Also, in general, even though the magnetic circuits of my electromagnetic relays are formed of flat sheet metal stampings, they need not be precalibrated but may be calibrated shortly before use and after they have been completely assembled. Moreover, the relays incorporating the principles of my invention may be easily adapted to operate at either a relatively low or a high release voltage. The relays of my invention are constructed to allow easy removal and replacement of the coil with a new coil of either the same capacity or a different capacity. Finally the relay of my invention may be substantially smaller in size than a comparable prior relay of substantially the same load rating and the contacts are located closely spaced from the magnetic circuit affording the realization of magnetic blowout at the contacts without the necessity of providing a separate additional blowout construction. The cost and size of the relay is substantially reduced and the electrical life is substantially increased to the point where it may well exceed the normal mechanical life of the relay.

SUMMARY OF THE INVENTION

In a principal aspect, electromagnetic relays constructed in accordance with the principles of my invention include a magnetic circuit having a magnetizable core which carries a coil and a magnetically responsive armature spaced from the core and arranged to be attracted to the core. Contact means are moveable into and out of engagement in response to the magnetic condition of the core and are positioned sufficiently close to the magnetic circuit such that the magnetic flux of the circuit produces a magnetic blowout effect at the contact means.

These and other objects, features and advantages of the present invention will be more clearly understood when the following detailed description is considered.

BRIEF DESCRIPTION OF THE DRAWINGS

In this description, reference will frequently be made to the attached drawings in which:

FIG. 1 is an exploded isometric view of one preferred embodiment of electromagnetic relay constructed in accordance with the principles of my invention;

FIG. 2 is a plan view of the relay of FIG. 1 with the cover removed;

FIG. 3 is a substantially cross sectioned elevation view of the relay taken along line 3-3 of FIG. 2;

FIG. 4 is a fragmentary elevation view of a relay showing a second arrangement of fixed and moveable contacts;

FIG. 5 is a fragmentary plan view of a relay showing a second arrangement of coil conductor connections;

FIG. 6 is a fragmentary cross sectioned elevation view of another relay embodiment;

FIG. 7 is a plan view of a double contact embodiment of electromagnetic relay; and

FIG. 8 is a fragmentary cross sectioned elevation view of the double relay taken along line 8-8 of FIG. 7 with the coil removed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1-3, one preferred embodiment of electromagnetic relay is shown. The relay comprises a generally rectangular base member 10 having a pair of elongated recesses 12 and 13 arranged substantially perpendicular to each other in one of the faces 14 of the base member. A flexible leaf spring 16 extends longitudinally along the longer of the recesses 12 and is fixed at one end 18 by pin terminal 20. A bent core 22, formed of a stamped magnetizable metallic material, is also attached at one end 23 in the recess 12 and extends upwardly above the face of the base member terminating in a flat portion 24 extending parallel to the face 14. The raised portion 24 of the core 22 carries coil 26 having a plurality of turns of electrically conductive wire. The coil 26 is inserted over the end of the raised portion 24 and the end leads 27 and 28 of the wire turns are attached to terminal lugs 30 and 31 which are mounted on the face 14 of the base member by rivet pin terminals 33 and 34, respectively. An L-shaped armature 36, having a leg 37 staked to the leaf spring 16 by one or more rivet-type stakes 38, completes the magnetic circuit and extends along the recess 12 beneath the raised portion 24 of the core and the coil 26. The other leg 40 of the armature 36 extends upwardly toward the end of the raised portion 24 of the core and is adapted to be attracted to the core in response to the current flow condition through the coil 26. Both the core 22 and the armature 36 are stamped of a magnetizable material, such as ferrous metal.

Recess 13 extends generally perpendicular to the recess 12 and a shallow depth shoulder 42 is provided in the recess 12, the deeper portion 43 of recess 13 being generally aligned with the longer recess 12. A bent rigid arm 44, formed of stamped metal, is riveted at one end to the shoulder 42 by pin terminal 46, and the other end of the arm carries a downward facing stationary contact 48 which is positioned closely adjacent the magnetic circuit formed by the armature and core. The end of the leaf spring 16, opposite its attached end 18, also carries a contact 50 which faces in an upward direction also closely adjacent the magnetic circuit and is adapted to move with the leaf spring to engage the stationary contact 48. A suitable cover 51 is provided to fit over the relay assembly to protect the assembly from dirt and other foreign matter.

The electromagnetic relay of FIGS. 1-3 is of the single pole normally open-type where only a single stationary contact 48 is disposed above the moveable contact 50. In such relay when no current flows through the coil 26, the core 22 is demagnetized and the armature 36 is not attracted to the core.

The resiliency of the leaf spring 16 causes the leaf spring to move downwardly, breaking the engagement of its moveable contact 50 with the stationary contact 48. As current is passed via the terminal lugs 30 and 31 through the coil 26, the electromagnetic flux field produced by the current flow magnetizes the core 22. Since the armature 36 is constructed of a magnetizable material, it will be attracted by the core 22 due to the flux field which bridges the gap between the raised portion 24 of the core and the upwardly extending leg 40 of the armature and will move in an upward direction as viewed in FIG. 3. As the armature 36 moves upwardly, the leaf spring 16 will also move in an upward direction since the leaf spring is staked at 38 to the armature. The moveable contact 50 will now engage the stationary contact 48 and a circuit will be completed through the pin terminal 20, leaf spring 16, moveable contact 50, stationary contact 48, rigid contact arm 44 and pin terminal 46.

The relay of FIGS. 1—3 may be adapted to provide a single pole double throw relay, if desired, by providing another pin terminal 47 as shown in FIG. 3. Terminal 47 carries a stationary contact 48' at its end in recess 43 and closely positioned adjacent the magnetic circuit, the stationary contact being arranged to contact a downwardly extending moveable contact 50'. Thus, when the leaf spring 16 is disposed in its lowermost position, the contacts 48' and 50' will contact each other establishing a circuit through terminal 47 and when the spring 16 is disposed in its uppermost position, the contacts 48' and 50' will be broken and the contacts 48 and 50 will contact each other establishing a circuit through terminal 46.

If a single pole normally closed relay is desired, the rigid contact arm 44 need only be inverted, as shown in FIG. 4. In this position the stationary contact end of the arm 44 is disposed in the deepest portion 43 of the recess 13 beneath the moveable contact 50. When no current flows through the coil 26, the armature 36 will not be attracted upwardly toward the raised portion 24 of the core and the resiliency of the leaf spring 16 causes the moveable contact 50 to be disposed in its lowermost position in engagement with the stationary contact 48 beneath the moveable contact. Thus, a circuit is established through terminal 20 (see FIG. 3), leaf spring 16, moveable contact 50, stationary contact 48, rigid contact arm 44, and terminal 46.

Another relay arrangement is shown in FIG. 5 wherein one of the coil leads ends 28, rather than being connected to a separate terminal, as shown in FIGS. 1—3, is connected to a terminal lug 52 which is an integral bent portion of the leaf spring 16, as best seen in FIG. 3. The current flow through the coil is controlled merely by opening and closing the circuit through the pin terminal 33, which is connected to other lead end 27 of the coil 26. Therefore, in this arrangement the main current enters pin terminal 20, and if a circuit is completed through lead end 27 of the coil circuit, a portion of the main current passes through the coil 26, magnetizing its core and attracting the magnetizable armature 36 either engaging the moveable contact 50 and stationary contact 48 if the contacts are arranged as shown in FIG. 3, or disengaging the contacts if the contacts are arranged as shown in FIG. 4.

Although the single pole fixed contact above moveable contact arrangement shown in FIGS. 1—3 has been described in terms of a normally open relay, a normally closed latching relay may also be provided if desired. If the core 22 is a permanent magnet, the moveable contact will normally assume a closed position with the upper fixed contact. Therefore, when no current flows through the coil 26, the permanent magnet core 22 will attract the armature 36, moving the leaf spring 16 and its associated moveable contact 50 into engagement with the stationary contact 48. To open the contacts, current is passed through the coil 26 such that the electromagnetic flux produced by the flowing current will counteract the magnetism of the permanent magnet core 22, demagnetizing the core. When the core is demagnetized, the armature 36 and leaf spring 16 will no longer be attracted toward the core 22, and the resiliency of the leaf spring 16 will cause the moveable

contact 50 to move downwardly out of engagement with the stationary contact 48.

It will be observed that, although the magnetic circuit is formed entirely of stamped forms, the arrangement and construction of the relays will allow adjustment of the contacts subsequent to the complete assembly of the relay, thus avoiding the need for preadjustment or precalibration of the relay. Since the leaf spring 16 is relatively flexible as compared to the rigid stamped elements, the contacts may be easily adjusted simply by bending the end of the leaf spring 16 carrying the moveable contact 50 toward or away from the stationary contact 48.

Referring to FIG. 6, a preadjusted electromagnetic relay is shown mounted on base member 53. In this relay embodiment, the leaf spring 54 does not extend beyond the armature 36 as in the previous relays, but terminates short of leg 40 of the armature. The armature 36 and leaf spring 54 extend in a recess 55. The armature 36 itself provides a portion of the main circuit and carries the moveable contact 50 on the upper face of its staked leg 37; the stationary contact 48 being carried by a resilient spring arm 45 extending above the moveable contact 50 and closely adjacent the magnetic circuit. As current flows through the coil 26 and the core 22 becomes magnetized, the armature 36 is attracted upwardly toward the core 22, closing the moveable contact 50 and stationary contact 48. The main current then flows through terminal 20 (see FIG. 2), leaf spring 54, armature 36, moveable contact 50, stationary contact 48, resilient spring arm 45 and on through the pin terminal 46 (again see FIG. 2). The recess 13 may be dispensed with or may be provided to house the resilient arm 45.

Referring to FIGS. 7 and 8, a double pole electromagnetic relay is shown. A large recess 56 extends over the face 57 of base member 58. A leaf spring 60, staked to the armature 36 at 38, and the armature are carried in the recess 56, the leaf spring 60 being pinned at one end to the face 57 of the base member 58 by pin terminal 61. Pin terminal 61 also pins the end 23 of the core 22 in the manner described previously. The second terminal lug 30 for completing the circuit through coil 26, 58 is carried at the other end of the base member 58 and is pinned to its face 57 by terminal pin 33 as previously described and the lead ends 27 and 28 of the coil are connected to terminal lugs 52 and 30, respectively. A pair of leaf springs 62 and 63 extend through recess 56 and straddle the armature 36 and are pinned to the base member at one end by pin terminals 65 and 66. The leaf springs 62 and 63 carry the moveable contacts 50 at their other ends and closely adjacent the magnetic circuit. A pair of bent rigid arms 44 also straddle the armature 36 and are attached at one end to the base member 58 by pin terminals 46 and 46', the other ends extending upwardly over the moveable contacts 50 of each of the leaf springs 62 and 63, and each carrying a stationary contact 48 lying in the path of movement of the moveable contacts. The leaf spring 60 is bent underneath itself at 68 for firmly mounting a rigid nonconductive bar 70 which extends laterally beneath the leaf springs 62 and 63. The armature 36 is staked to the leaf spring 60 at 38 as in the previously described relays, and one of the stakes 38 may also act to stake the bent portion 68.

When no current flows through the coil 26, the core 22 is demagnetized and the armature 36 assumes its lowermost position in the recess 56 due to the resiliency of the leaf spring 60. The rigid bar 70 also drops, allowing the resilient leaf springs 62 and 63 to move downwardly and cause the moveable contacts 50 to break contact with the stationary contacts 48. When current is passed through the coil 26, via the terminal lugs 30 and 52, a magnetic flux is induced in the core 22 attracting the armature 36 upwardly toward the core. As the armature 36 moves upwardly, the rigid bar 70 is carried upwardly, lifting the leaf springs 62 and 63 and their moveable contacts 50 into engagement with the stationary contacts 48 establishing a pair of main circuits. A first circuit is established through pin terminal 65, leaf spring 62, one of the moveable

contacts 50, one of the stationary contacts 48, one of the rigid arms 44 and pin terminal 46. A second circuit is established through pin terminal 66, leaf spring 63, the other moveable contact 50, the other stationary contact 48, the other rigid arm 44 and pin terminal 46'.

Although not shown in FIGS. 7 and 8, if desired, the double pole relay shown in those FIGS. may also be rendered double throw by providing additional pin terminals and stationary and moveable contacts as previously described with respect to the terminals 47 and contacts 48' and 50' of FIG. 3.

The release voltage of the relays may be increased or decreased by varying the number of rivetlike stakes 38 which stake the rigid armature 36 to its respective resilient leaf spring. It has been found that if leg 37 of the armature is staked to its leaf spring at only one point, a very low release voltage is sufficient to actuate the relay. Alternatively, if the armature 36 is staked at two or more points to the leaf spring, the release voltage necessary to operate the relay is correspondingly increased.

If it is desired to remove or replace the coil 26 of the relays, the lead ends 27 and 28 are disconnected from their terminal lugs and the raised portion 24 of the core 22 need only be bent upward by an amount sufficient to slip the coil 26 off the core past the leg 40 of the armature 36. The coil 26 may be readily slipped from the core 22 since the end of the core is straight. A new coil may then be slid onto the core and the raised portion 24 of the core is then bent back to its original position and the lead ends reconnected.

In each of the aforementioned embodiments, the construction and arrangement of the various component elements of the relays enables the miniaturization of the relays, thus enabling the relays to be of substantially smaller size than the prior known relays of substantially the same load rating. Moreover, such construction enables the location of the contacts sufficiently close to the magnetic circuit formed by the core, coil, armature and the gap therebetween to increase the flux density in the vicinity of the contacts by an amount sufficient to realize a magnetic blowout effect on the contacts. It has been found that the flux density at the contacts of the above described relays may be increased by as much as six times that of prior relays having the same electrical load. The substantial increase of flux density provides a sufficient flux across the contact surfaces to provide a magnetic blowout effect by purging the space obtaining between the contact surfaces during opening of arc conducting metal vapors. The increased flux density thus acts to prevent arcing and spurs or spikes from forming on the contact surfaces and substantially increases the electrical life of the relays without requiring the provision of additional separate magnets or coils to produce magnetic blowout. In fact an increase in life expectancy of more than twelve times that of the prior relays under substantially the same conditions has been realized by the above described relays.

It will of course be realized that the magnitude of the spacing of the contacts from the magnetic circuit which is sufficient to produce magnetic blowout will vary with numerous variables such as the current flow through the coil and/or the contacts, the actual spacing distance sufficient to produce the effect for any given relay at a given design load being readily determined by one of ordinary skill in the art after he has considered the detailed description and advantages of the instant disclosure.

Moreover, upon considering the above detailed description of the embodiments of my electromagnetic relays, it will be evident that the relay constructed in accordance with the principles of my invention, may include a plurality of elements which are completely interchangeable with relays having varying operating characteristics. As an example, the recessed plate 10 may be used interchangeably for either a normally open or a normally closed relay, for a relay utilizing either the main current or a separate source of current for energizing the coil 26 or for single or double throw relays. This interchangeability also obtains with respect to the leaf springs 16 or 62 and

63, armature 36, coil 26 and core 22, or the rigid stationary contact carrying arm 44. Moreover, since the leaf spring 16 extends beyond the rigid magnetic circuit armature 36 in most of the embodiments, the entire magnetic circuit may be formed of metal stampings and the relay will still be capable of adjustment even after complete assembly. Finally, the release voltage of the above described relays may be simply determined by the staking arrangement of the armatures 36 to their leaf springs.

It is to be understood that the embodiments of the invention which have been described are merely illustrative of an application of the principles of the present invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

I claim:

1. An electromagnetic relay comprising:

a magnetic circuit comprising a magnetizable metallic core having a coil of conductive wire wound thereon for establishing a magnetic flux field which selectively alters the magnetic condition of said core, and a magnetically responsive armature having an end normally spaced from said core, said end being moveable relative to said core in response to energization and deenergization of said core; contact means moveable into and out of engagement in response to the movement of said armature, said contact means being positioned sufficiently close to said magnetic flux field of the core such that a portion of the magnetic flux field sufficient to produce a magnetic blowout effect at said contact means traverses said contact means when said contact means is moving into and out of engagement; and

conductive means for conducting electrical current to said contact means and to said coil.

2. The relay of claim 1 wherein said means for conducting current to said coil are independent of said means for conducting current to said contact means.

3. The relay of claim 1 wherein said means for conducting current to said coil are dependent in part on said means for conducting current to said contact means.

4. The relay of claim 1 further comprising:

a nonconductive base member having at least one face defining a recess therein, said magnetizable metallic core comprising a flat portion upon which said coil of conductive wire is positioned and a portion bent at a substantial angle to said flat portion at one end thereof, said core being attached to said face at said bent portion, said flat portion being substantially linear between said one end and its other end and being spaced from said face, whereby said coil is suspended above said face;

a resilient leaf spring extending beneath said core and coil and being attached at one end between said bent portion of said core and said face, said armature being fixed to said leaf spring;

said contact means comprises a moveable contact operatively associated with said armature to move in the direction of movement of said armature; and

an arm fixed to said base member adjacent said recess, said arm carrying a stationary contact in the path of movement of said moveable contact.

5. The relay of claim 4 wherein said arm is curved, said stationary contact being located above said moveable contact such that when said armature is attracted to said core said contacts engage and when said armature is not attracted to said core said contacts disengage.

6. The relay of claim 4 wherein said arm is curved, said stationary contact being located in said recess beneath said moveable contact such that when said armature is attracted to said core said contacts disengage and when said armature is not attracted to said core said contacts engage.

7. The relay of claim 4 wherein said leaf spring extends beyond said armature, the extended end of said leaf spring carrying said moveable contact.

8. The relay of claim 4 wherein said armature extends beyond said leaf spring and said armature carries said moveable contact.

9. The relay of claim 4 wherein said leaf spring is fixed to said armature at a plurality of points spaced along its length to reduce the response of said armature to the attraction of said core.

10. The relay of claim 4 including second and third leaf springs and a second arm carrying a second stationary contact, each of said second and third leaf springs being attached at one of their ends to said face and carrying at their other ends said moveable contact and a second moveable contact, respectively, and rigid means engaging each of said second and third leaf springs to move said moveable contacts in the direction of movement of said armature.

11. The relay of claim 4 wherein said face of said base member includes a second recess extending substantially normal to the first recess, said arm being attached within the first recess and said armature and leaf spring being located in said second recess.

12. The relay of claim 1 wherein said core and armature comprise flat sheet metal stampings and said contact means are adjustable.

13. The relay of claim 1 wherein said armature is L-shaped, one leg of said L-shaped armature lying substantially parallel

to said core and the other leg extending in a direction substantially normal to said core and toward the end of said core adjacent the contact means.

14. The relay of claim 1 wherein said core is a permanent magnet and is demagnetized when current flows through said coil.

15. An electromagnetic relay comprising:
a core formed of magnetizable material and having a substantially planar leg terminating in a free end;
a conductive coil removably carried on said leg;
means for varying the electrical current in said coil to establish a magnetic flux field;
contact means; and

an armature formed of magnetizable material, said armature being mounted for movement relative to the free end of said leg in response to variations in the current of said coil for moving said contact means in response to said armature means mounting said armature and said leg for movement of the free end of said leg relative to the armature for removal of said coil from the free end

16. The relay of claim 15 wherein said contact means are mounted relative to the magnetic flux field of said coil to produce a magnetic blow out effect at said contact means.

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