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(54) **ELECTROMAGNETIC RELAY ASSEMBLY**

ELEKTROMAGNETISCHE RELAISBAUGRUPPE

ENSEMBLE RELAIS ÉLECTROMAGNÉTIQUE

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The disclosed invention generally relates to an electromagnetic relay assembly incorporating a uniquely configured armature assembly. More particularly, the disclosed invention relates to an electromagnetic relay assembly having a magnetically actuable rotor assembly for linearly displacing a switch actuator.

BRIEF DESCRIPTION OF THE PRIOR ART

[0002] Generally, the function of an electromagnetic relay is to use a small amount of power in the electromagnet to move an armature that is able to switch a much larger amount of power. By way of example, the relay designer may want the electromagnet to energize using 5 volts and 50 milliamps (250 milliwatts), while the armature can support 120 volts at 2 amps (240 watts). Relays are quite common in home appliances where there is an electronic control turning on (or off) some application device such as a motor or a light. The present teachings are primarily intended for use as a single pole, 120-amp passing electromagnetic relay assembly. It is contemplated, however, that the essence of the invention may be applied in multi-pole relay assemblies, having unique construction and functionality as enabled by the teachings of the single pole embodiment set forth in this disclosure. Several other electromagnetic relay assemblies reflective of the state of the art and disclosed in United States patents are briefly described hereinafter.

[0003] US 6,788,176 B2 discloses an electromagnetic relay according to the preamble of claim 1.

[0004] United Kingdom Patent No. 2,193,041 ('041 Patent), issued to Inventor Strack and Applicant Bach GmbH & Co., discloses a Relay. The '041 Patent describes a relay comprising a contact spring (9) connected to an armature (7) by way of a connecting member (8) which has a resilient spring pressing member (54), which in the contact closed position bears against the contact spring (9) to exert a force on the contact spring (9). The connecting member (8) also has a lifting member (57), which in the contact closed position is spaced from the contact spring (9) whereby the contact spring (9) bears with its contact with a high pressing force against the stationary contact (10) but can be quickly lifted therefrom to prevent arcing.

[0005] The reader should note from the '041 Patent, in particular, that this patent teaches a rotatable armature assembly (7) having an actuator element or spring pressing member (54) associated therewith. When current is driven through the coil assembly (1), the armature assembly (7) rotates and the actuator element (54) operates to press the contact spring (9) into engagement with an opposed stationary contact (10).

[0006] United States Patent No. 6,046,660 ('660 Patent), which issued to Gruner, discloses a Latching magnetic relay assembly with a linear motor. The '660 Patent teaches a latching magnetic relay capable of transferring currents of greater than 100 amps for use in regulating the transfer of electricity or in other applications requiring the switching of currents of greater than 100 amps. A relay motor assembly has an elongated coil bobbin with an axially extending cavity therein. An excitation coil is wound around the bobbin. A generally U shaped ferromagnetic frame has a core section disposed in and extending through the axially extending cavity in the elongated coil bobbin. Two contact sections extend generally perpendicularly to the core section and rises above the motor assembly. An actuator assembly is magnetically coupled to the relay motor assembly. The actuator assembly is comprised of an actuator frame operatively coupled to a first and a second generally U-shaped ferromagnetic pole pieces, and a permanent magnet. A contact bridge made of a sheet of conductive material copper is operatively coupled to the actuator assembly.

[0007] United States Patent No. 6,246,306 ('306 Patent), which issued to Gruner, discloses an Electromagnetic Relay with Pressure Spring. The '306 Patent teaches an electromagnetic relay having a motor assembly with a bobbin secured to a housing. A core is adjacently connected below the bobbin except for a core end, which extends from the bobbin. An armature end magnetically engages the core end when the coil is energized. An actuator engages the armature and a plurality of center contact spring assemblies. The center contact spring assembly is comprised of a center contact spring which is not pre bent and is ultrasonically welded onto a center contact terminal. A normally open spring is positioned relatively parallel to a center contact spring. The normally open spring is ultrasonically welded onto a normally open terminal to form a normally open outer contact spring assembly. A normally closed outer contact spring is vertically positioned with respect to the center contact spring so that the normally closed outer contact spring assembly is in contact with the center contact spring assembly, when the center contact spring is not being acted upon by the actuator. The normally closed spring is ultrasonically welded onto a normally closed terminal to form a normally closed assembly. A pressure spring pressures the center contact spring above the actuator when the actuator is not in use.

[0008] United States Patent No. 6,252,478 ('478 Patent), which issued to Gruner, discloses an Electromagnetic Relay. The '478 Patent teaches an electromagnetic relay having a motor assembly with a bobbin secured to a frame. A core is disposed within the bobbin except for a core end which extends from the bobbin. An armature end magnetically engages the core end when the coil is energized. An actuator engages the armature and a plurality of movable blade assemblies. The movable blade assembly is comprised of a movable blade ultrasonically welded onto a center contact terminal. A normally open

blade is positioned relatively parallel to a movable blade. The normally open blade is ultrasonically welded onto a normally open terminal to form a normally open contact assembly. A normally closed contact assembly comprised of a third contact rivet and a normally closed terminal. A normally closed contact assembly is vertically positioned with respect to the movable blade so that the normally closed contact assembly is in contact with the movable blade assembly when the movable blade is not being acted upon by the actuator.

[0009] United States Patent No. 6,320,485 ('485 Patent), which issued to Gruner, discloses an Electromagnetic Relay Assembly with a Linear Motor. The '485 Patent teaches an electromagnetic relay capable of transferring currents of greater than 100 amps for use in regulating the transfer of electricity or in other applications requiring the switching of currents of greater than 100 amps. A relay motor assembly has an elongated coil bobbin with an axially extending cavity therein. An excitation coil is wound around the bobbin. A generally U shaped ferromagnetic frame has a core section disposed in and extending through the axially extending cavity in the elongated coil bobbin. Two contact sections extend generally perpendicularly to the core section and rises above the motor assembly. An actuator assembly is magnetically coupled to the relay motor assembly. The actuator assembly is comprised ofan actuator frame operatively coupled to a first and a second generally U-shaped ferromagnetic pole pieces, and a permanent magnet. A contact bridge made of a sheet of conductive material copper is operatively coupled to the actuator assembly.

[0010] United States Patent No. 6,563,409 ('409 Patent), which issued to Gruner, discloses a Latching Magnetic Relay Assembly. The '409 Patent teaches a latching magnetic relay assembly comprising a relay motor with a first coil bobbin having a first excitation coil wound therearound and a second coil bobbin having a second excitation coil wound therearound, both said first excitation coil and said second excitation coil being identical, said first excitation coil being electrically insulated from said second excitation coil; an actuator assembly magnetically coupled to both said relay motor, said actuator assembly having a first end and a second end; and one or two groups of contact bridge assemblies, each of said group of contact bridge assemblies comprising a contact bridge and a spring.

[0011] United Kingdom Patent No. 2,418,780 ('780 Patent), issued to Inventors Connell et al. and Applicant BLP Components Limited, discloses certain Electrical Contactors. The '780 Patent describes an electrical contactor comprising a first electrically conductive cantilevered arm (201) carrying a first contact (203) adjacent its fixed end and a second contact (204) adjacent its free end and a second electrically conductive cantilevered arm (205) carrying a third contact (207) adjacent its fixed end and a fourth contact (208) adjacent its free end. The first and second contact arms are arranged in opposed alignment such that the fixed end of one arm is opposite the free end of the other arm, the first contact (203) is aligned with the fourth contact (205) and the second contact (204) is aligned with a third contact (207).

[0012] A first terminal (206) is connected to the fixed end of the first arm (201), and a second terminal (202) is connected to the fixed end of the second arm (205). The arrangement of the first and second arms (201, 205) is such that when the first and fourth contacts (203, 208) and second and third contacts (204, 207) are closed, current flowing between the first and second terminals (206, 202) through the first and second arms (201, 205) produces an attractive force between the first and second arms (201, 205). The reader is directed in particular to Figure Nos. 10 - 12, which figures depict a rotatable armature having actuator elements as at 122 and 123 in Figure No. 10; and as at 234 in Figure No. 11.

[0013] People's Republic of China Patent No. 101 335 156 ('156 Patent), issued to Applicant Xiamen Hongfa Electroacoustic, discloses an electromagnetic relay. Referencing the state of the art relay depicted in Figure No. 1a, the reader will there see a magnetic latching relay of the then existing technology or state of the art comprising a magnetic circuit part, a contact part, a push part and a substrate part. More particularly, Figure 1 a is a structural diagrammatic drawing of a typical high-power magnetic latching relay comprising, a stationary spring part 71 and a movable spring part mounted on the base 70. The push part is a push block 73 of which two sides each have slots. The magnetic circuit part comprises a movable magnetizer part 74 which is I-shaped, a spindle 75, a stationary magnetizer part 76 and a coil part 77.

[0014] The I-shaped movable magnetizer part rotates around the spindle 75, the left movable magnetizer part 74a and the right movable magnetizer part74b fit with the left stationary magnetizer part 76a and the right stationary magnetizer part 76b, so that the magnetic circuit part may operate. The reader will thus note that this patent teaches a rotatable armature as at part 74, which rotatable armature 74 comprises an actuator element as at 74a, which actuator element 74a operates to direct force into the member 73 for opening and closing the contacts via a spring construction as at 72.

SUMMARY OF THE INVENTION

[0015] It is an object of the present invention to provide an electromagnetic relay assembly according to the appended claims. According to embodiments, the electromagnetic relay assembly has certain means for damping contact vibration intermediate contacts of the switching assembly. It is a further object of the present invention to provide an armature assembly having an axis of rotation and which rotates under the influence of the magnetic field created or imparted from an electromagnetic coil assembly. The armature assembly linearly displaces a switch actuator for opening and closing the switch assembly of the relay. To achieve these and other readily apparent objectives, the electromagnetic relay assembly

of the present disclosure comprises an electromagnetic coil assembly an armatw:e bridge assembly, and a switch assembly as described in more detail hereinafter.

[0016] The coil assembly essentially comprises a coil, a C-shaped yoke assembly, and a coil axis. The coil is wound around the coil axis, and the yoke assembly comprises first and second yoke arms. Each yoke arm comprises an axial yoke portion that is coaxially alignable with the coil axis and together fonn the back of the C-shaped yoke assembly. Each yoke arm further comprises a yoke terminus, which yoke termini are coplanar and substantially parallel to the coil axis.

[0017] The armature bridge assembly is rotatable about an axis orthogonally spaced from the coil axis and coplanar with the yoke termini. The armature bridge assembly thus comprises a bridge axis of rotation, a bridge, and an actuator arm. The bridge comprises a medial field pathway relative closer in proximity to the coil axis, a lateral field pathway relatively further in proximity to the coil axis, and longitudinally or axially spaced medial-to-lateral or lateral-to-medial field pathways (or transverse field pathways) extending intermediate the medial and lateral pathways. The actuator arm is cooperable with the lateral field pathway via a first end thereof and extends laterally away from the lateral field pathway.

[0018] The switch assembly essentially comprises switch terminals and a spring assembly between the switch terminals. The spring assembly is attached a second end of the actuator arm. The yoke termini are received intermediate the medial and lateral pathways. As is standard and well-established in the art, the coil receives current and creates or imparts a magnetic field, which magnetic field is directable through the bridge assembly via the yoke termini for imparting bridge rotation about the bridge axis of rotation and linearly displacing the actuator arm. The displaceable actuator arm functions to actuate the spring assembly intermediate an open contact position and a closed contact position, which closed contact position enables current to pass through the switch assembly via the switch termini.

[0019] Certain peripheral features of the essential electromagnetic relay assembly include certain means for enhancing spring over travel, which means function to increase contact pressure intermediate the switch terminals when the spring assembly is in the closed position. The means for enhancing spring over travel further provide means for contact wiping or contact cleansing via the enhanced contact or increased contact pressure. In other words, the enhanced conduction path through the contact interface may well function to burn off residues and/or debris that may otherwise come to rest at the contact surfaces. The means for enhancing spring over travel may well further function to provide certain means for damping contact bounce or vibration intermediate the first and second contacts when switching from the open position to the closed position.

[0020] Other objects of the present invention, as well as particular features, elements, and advantages thereof, will be elucidated or become apparent from, the following description and the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Other features of our invention will become more evident from a consideration of the following brief description of patent drawings:

Figure No. 1 is a top plan view of the electromagnetic relay assembly of the present invention with the switch assembly in an open position.

Figure No. 2 is a top plan view of the electromagnetic relay assembly of the present invention with the switch assembly in a closed position.

Figure No. 3 is a top perspective exploded type depiction of the electromagnetic relay assembly of the present invention with showing an optional housing cover.

Figure No. 4 is an exploded perspective view of a first terminal assembly of the switch assembly of the electromagnetic relay assembly.

Figure No. 5 is an exploded perspective view of a second terminal assembly of the switch assembly of the electromagnetic relay assembly.

Figure No. 6 is an exploded perspective view of a coil assembly of the electromagnetic relay assembly of the present invention.

Figure No. 7 is an exploded fragmentary perspective view of a rotor assembly of the armature assembly of the electromagnetic relay assembly.

Figure No. 8 is an exploded perspective view of the triumvirate spring assembly and a contact button of the switch assembly of the electromagnetic relay assembly.

Figure No. 9 is a fragmentary side view depiction of the triumvirate spring assembly, the contact buttons, and the armature arm of the present invention showing the contact buttons in a closed position with the triumvirate spring assembly in a substantially coplanar position.

Figure No. 10 is a fragmentary side view depiction of the triumvirate spring assembly, the contact buttons, and the armature arm of the present invention showing the contact buttons in a closed position with the triumvirate spring assembly in an over travel position for enhancing contact pressure intermediate the contact buttons.

Figure No. 11 is an enlarged fragmentary side view depiction of the junction at the triumvirate spring assembly and the upper contact button otherwise shown in Figure No. 10 depicting the triumvirate spring assembly in the over travel position for enhancing contact pressure intermediate the contact buttons.

Figure No. 12 is a diagrammatic depiction of the flux flow through the C-shaped core assembly and the rotor assembly of the electromagnetic relay assembly depicting a diverted and divided field flow through the rotor assembly.

Figure No. 13 is a side view depiction of a switch terminal assembly as operatively connected to a triumvirate spring assembly and a contact button, the triumvirate spring assembly showing first and second springs with centrally located C-shaped folds, and a third spring with an end-located bend.

Figure No. 14 is an enlarged fragmentary sectional view as taken from Figure No. 13 depicting the end-located bend of the third spring in rater detail.

[0022] Figure No. 15 is a diagrammatic depiction of a threshold current path directed through the relay terminals as disposed in adjacency to the rotatable armature assembly and depicting a terminal-sourced magnetic field greater in magnitude than an armature-sourced magnetic field for rotating the armature assembly toward a circuit-opening position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0023] Referring now to the drawings, the preferred embodiment of the present invention concerns an electromagnetic relay assembly 10 as illustrated and referenced in Figure Nos. 1 - 3. The electromagnetic relay assembly 10 of the present invention essentially functions to selectively enable current to pass through switch termini 11 as illustrated and referenced in Figure Nos. 1 - 5. To achieve these and other readily apparent functions, the electromagnetic relay assembly 10 of the present invention preferably comprises an electromagnetic coil assembly 12 as generally illustrated and referenced in Figure Nos. 1 - 3, and 6; a rotatable armature assembly 13 as generally illustrated and referenced in Figure Nos. 1 - 3; and a switch assembly 14 as generally illustrated and referenced in Figure Nos. 1 - 5.

[0024] The coil assembly 12 of the present invention preferably comprises a current-conductive coil 15 as illustrated and referenced in Figure Nos. 1 - 3, and 6; a C-shaped core or yoke assembly 16 as illustrated and referenced in Figure Nos. 3, 6, and 12; and a coil axis 100 generally referenced and depicted in Figure Nos. 1, 2, 6, and 12. It may be seen or understood from an inspection of the noted figures that the current-conductive coil 15 is wound around the coil axis 100 and comprises first and second electromagnet-driving termini 17 as illustrated and referenced in Figure Nos. 1 - 3, and 6. The yoke assembly or C-shaped core assembly 16 of the present invention is axially received within the coil 15 and preferably comprises first and second yoke arms 18, one of which is illustrated and referenced in Figure Nos. 1 - 3, and both of which are illustrated and referenced in Figure No. 6. It may be seen from an inspection of Figure No. 6 that yoke arms 18 each comprise an axial yoke portion 19 and a substantially planar yoke terminus 20, which yoke termini 20 are preferably parallel to the coil axis 100 as further referenced and depicted in Figure No. 12.

[0025] It is contemplated that the rotatable armature assembly 13 of the present invention may be described as preferably comprising a rotor assembly 21 as generally illustrated and referenced in Figure Nos. 1 - 3, and 7; an actuator or actuator arm 22 as generally illustrated and referenced in Figure Nos. 1 - 3, 9, and 10; and an armature axis of rotation 101 as depicted and referenced at a point in Figure Nos. 1, 2, 12, and 15, and as a line in Figure Nos. 3 and 7. The rotor assembly 21 preferably comprises first and second uniformly directed or polarized rotor magnets 23 as illustrated and referenced in Figure Nos. 7 and 12; a rotor plate 25 as illustrated and referenced in Figure Nos. 1 - 3, 7, and 12; a rotor bracket 26 as illustrated and referenced in Figure Nos. 1 - 3, 7, and 12; a rotor housing 27 as illustrated and referenced in Figure Nos. 1 - 3, and 7; a return spring 28 as illustrated and referenced in Figure Nos. 3 and 7; a rotor pin 29 as illustrated and referenced in Figure Nos. 1 and 3; and a rotor mount 30 as illustrated and referenced in Figure Nos. 1 - 3.

[0026] It may be seen from an inspection of the noted figures that the rotor bracket 26 is attached or otherwise cooperatively associated with a first end of the actuator arm 22, and that the rotor plate 25 and the rotor bracket 26 (or portions thereof) are preferably oriented parallel to one another by way of the rotor housing 27. In this regard, it may be further seen that the first and second rotor magnets 23 are equally dimensioned and extend intermediate the rotor plate 25 and the rotor bracket 26 for simultaneously and equally spacing the rotor plate 25 and the rotor bracket 26 and for further providing a guide way or pathway for so-called Lorenz current or magnetic flux to be effectively transversely directed across the rotor or bridge assembly 21 as diagrammatically depicted in Figure No. 12.

[0027] In this last regard, it is contemplated that the armature assembly 13 may be thought of as an armature bridge assembly, which bridge assembly comprises a bridge axis of rotation (akin to the armature axis of rotation 101) and a bridge in cooperative association with the armature arm 22. In this context, the bridge may be thought of or described as preferably comprising a medial pathway (akin to the rotor plate 25), a lateral pathway

(akin to the rotor bracket 26), and longitudinally or axially spaced medial-to-lateral or transverse pathways (akin to the first and second rotor magnets 23. The armature arm 22 may thus be described as extending laterally away from the lateral pathway or rotor bracket 26 for engaging the switch assembly 14.

[0028] The rotor housing 27 essentially functions to receive, house, and position the first and second rotor magnets 23, the rotor plate 25 and the rotor bracket 26 to form the bridge like structure of the armature assembly 13. The rotor magnets 23 are uniformly directed such that like poles face the same rotor structure. For example, it is contemplated that the north poles of rotor magnets 23 may face the rotor bracket 26 (the south poles thereby facing the rotor plate 25) or that the south poles of rotor magnets 23 may face the rotor bracket 26 (the north poles thereby facing the rotor bracket).

[0029] The rotor housing 27 may well further comprise a pin-receiving aperture or bore for receiving the rotor pin 29 as may be generally seen from an inspection of Figure Nos. 3 and 7. The pin-receiving aperture or bore of the rotor housing 27 enables rotation of the bridge or armature assembly 13 about the armature axis of rotation 101. The rotor pin 29, extending through the pin-receiving bore, may be axially anchored at a lower end thereof by way of a relay housing 48 as illustrated and referenced in Figure Nos. 1 - 3, and which relay housing 48 is sized and shaped to receive, house, and position the coil assembly 12, the armature assembly 13, and the switch assembly 14 as may be readily understood from an inspection of Figure No. 3. It may be further readily understood from an inspection of Figure No. 3 that the relay housing 48 may, but not necessarily, comprise or be cooperable with a relay cover 49.

[0030] In this last regard, it will be recalled that the armature assembly 13 of present invention may be anchored or mounted by way of the rotor mount 30. Rotor mount 30 may be cooperatively associated with the relay housing 48 (i.e. anchored to the relay housing 48) for axially fixing the rotor pin 29, the fixed rotor mount 30 receiving and anchoring an upper end of the rotor pin 29 so as to enable users of the relay to effectively operate the electromagnetic relay assembly 10 of the present invention without the relay cover 49. The rotor mount 30 or bridge mount or means for mounting the rotor assembly or bridge assembly may thus be described as providing certain means for enabling open face operation of the electromagnetic relay assembly 10. It is contemplated, for example, that in certain scenarios a coverless relay assembly provides a certain benefit. For example, the subject relay assembly may be more readily observed during testing procedures. In any event, it is contemplated that the rotor mount 30 of the present invention enables cover-free operation of the electromagnetic relay assembly 10 by otherwise fixing the armature assembly 13 to the relay housing 48.

[0031] The switch assembly 14 of the present relay assembly 10 preferably comprises a first switch terminal assembly 31 as generally illustrated and referenced in Figure Nos. 1 - 4; and a second switch terminal assembly 32 as illustrated and referenced in Figure Nos. 1-3, 5, 13, and 14; and a triumvirate or three-spring spring assembly 33 as illustrated and referenced in Figure Nos. 1 - 3, 5, 8 - 11, 13, and 14. From an inspection of the noted figures, it may be seen that the first switch terminal assembly 31 preferably comprises a first contact button 34 and a first switch terminus as at 11. Further, the second switch terminal assembly 32 preferably comprises a second switch terminus as at 11.

The triumvirate or three-spring spring assembly 33 preferably comprises a longitudinal spring assembly axis 105 as depicted in Figure No. 8 and a second contact button 37 as illustrated and referenced in Figure Nos. 1, 2, 9 - 11, 13, and 14; and a first spring element 38, a second spring element 39, and a third spring element 40 as further illustrated and referenced in Figure Nos. 5, 8 - 10, and 13. It may be further seen that the first spring 38 preferably comprises a first contact-receiving aperture as at 41 and a first C-shaped aperture as at 42 in Figure No. 8, as well as an end-located offset or bend as at 70 in Figure Nos. 13 and 14. Notably, the first C-shaped aperture 42 is preferably concentric about the first contact-receiving aperture 41. The second spring 39 preferably comprises a second contact-receiving aperture as at 43 and a first C-shaped fold as at 44 in Figure No. 8. It may be seen from an inspection of Figure No. 8 that the first C-shaped fold 44 has a certain first radius of curvature. The third spring 40 preferably comprises a third contact-receiving aperture as at 45, a second C-shaped aperture as at 46, and a second C-shaped fold as at 47.

It may be further seen that the second C-shaped aperture 46 is preferably concentric about the third contact-receiving aperture 45, and that the second C-shaped fold 47 has a certain second radius of curvature, which second radius of curvature is greater in greater in magnitude than the first radius of curvature (of the first C-shaped fold 44). The second spring 39 is sandwiched intermediate the first and third springs 38 and 40 via the second contact button 37 as received or extended through the contact-receiving apertures 41, 43, and 45. The first C-shaped fold 44 is concentric (about a fold axis) within the second C-shaped fold 47. The first and second contact buttons 34 and 37 or contacts are spatially oriented or juxtaposed adjacent one another as generally depicted in Figure Nos. 1, 2, 9, and 10. hi the preferred embodiment, the triumvirate spring assembly 33 is biased in an open contact position intermediate the first and second switch termini 11 and attached to (the lateral end of) the armature arm 22 as perhaps mostly clearly depicted in Figure Nos. 9 and 10.

It is contemplated that the first and second C-shaped apertures 42 and 46, and the end-located offset or bend 70 may well function to provide certain means for enhanced over travel for increasing contact pressure intermediate the first and second contact buttons 34 and 37.

In this regard, the reader is further directed to Figure Nos. 9 and 10. From a comparative consideration of the noted figures, it may be seen that the terminal side ends 53 of the spring assembly 33 may be actuated past the planar portions of the spring assembly 33 immediately adjacent the stem 51 of contact button 37. The planar portions of the spring assembly 33 immediately (and radially) adjacent the stem 51 of contact button 37 thus form button-stackable spring portions as at 52 in Figure Nos. 8 and 11. From an inspection of Figure Nos. 8 and 11, it may be seen that the button-stackable portions 52 stack upon the contact button 37 and that terminal side ends 53 of the first and third springs 38 and 40 of the spring assembly 33 elastically deform as at 50 for enabling said over travel. In other words, the material (preferably copper) of the spring elements having the C-shaped apertures is more readily and elastically deformable at the termini of the C-shaped apertures as at 50 in Figure No. 8. Notably, the elastic deformation of the material adjacent termini 50 does not result in appreciable embrittlement of the underlying material lattice (i.e. does not appreciably impart undesirable lattice dislocations) and thus the C-shaped aperture structure or feature of the triumvirate spring assembly provides a robust means for enhanced over travel for further providing a certain added pressure intermediate the contact buttons 34 and 37 for improving conductive contact(s) therebetween. The end-located offset or bend 70 further provides a means for enhanced over-travel for increasing contact pressure and reducing contact bounce of the contacts 34 and 37.

[0032] Conduction through the contact buttons 34 and 37 is thus improved by way of the C-shaped aperture-enabled and/or enhanced over travel as generally depicted in Figure No. 10. It is contemplated that the enhanced contact and resulting conduction provides certain means for improved contact wiping, the means for contact wiping or contact cleansing thus being further enabled by way of the enhanced over travel. In this regard, it is contemplated that the relay assembly 10 of the present invention inherently has a self-cleansing feature as enabled by the C-shaped apertures 42 and 46. Further, it is contemplated that the C-shaped apertures 42 and 46 (and offset or bend 70) may well provide certain means for reducing contact bounce or for otherwise damping contact vibration intermediate the contact buttons 34 and 37 when switching from an open contact state or open switch position (as generally depicted in Figure No. 1) to a closed contact state or closed switch position (as generally depicted in Figure No. 2).

[0033] From an inspection of Figure No. 12, it may be readily understood that the core or yoke termini 20 are loosely received intermediate the rotor plate 25 and the rotor bracket 26, and that the armature axis of rotation 101 is coplanar with the yoke termini 20, which axis of rotation 101 extends through the rotor pin 29 (not specifically depicted in Figure No. 20). As should be readily understood, the current-conductive coil 15 functions to receive current and thereby creates a magnetic field as further depicted and referenced at vectors 102 in Figure No. 12. As may be seen from an inspection of the noted figure, the magnetic field 102 is directed through the yoke termini 20 via the rotor assembly (essentially defined by the rotor bracket 26, the rotor magnets 23, and the rotor plate 25) for imparting armature or bridge rotation about the armature axis of rotation 101 via a magnetically induced torque.

[0034] The rotor bracket 26 thus functions to linearly displace the actuator arm 22, which displaced actuator arm 22 functions to actuate the triumvirate spring assembly 33 from a preferred spring-biased open position (as generally depicted in Figure No. 1) to a spring-actuated closed position (as generally depicted in Figure No. 2). The material construction of the relay assembly 10 (believed to be within the purview of those skilled in the art) and the closed position essentially function to enable 120-amp current to pass through the switch assembly 14 via the first and second contact buttons 34 and 37 and the switch termini 11. When the coil assembly 12 is currently dormant and the magnetic field is effectively removed, the return spring 28 may well function to enhance return of the triumvirate spring assembly 33 to the preferred spring-biased open position as generally depicted in Figure Nos. 11. Should a fault current condition arise, it is contemplated that the electromagnetic relay 10 may preferably further comprise certain closed contact default means, the closed contact default means for forcing the first and second contact buttons 34 and 37 closed during said fault current or short circuit condition(s). In this regard, it is contemplated that the path followed by the Lorenz current or magnetic field path as generally depicted in Figure No. 12 by vector arrows 102.

[0035] It is further contemplated that the electromagnetic relay according to the present invention may comprise certain means for defaulting to an open contact position during threshold terminal-based current conditions. In this regard, it is noted from classical electromagnetic theory that streaming charge carriers develop a magnetic field in radial adjacency to the direction of the carrier stream. The reader is thus directed to Figure No. 15 which is a diagrammatic depiction of a threshold current path as at 71 being directed through the relay terminals 31 and 32 via the contact buttons 34 and 37. A magnetic force vector as at 103 is depicted as terminal-sourced via the charge carrier current flowing through the path 71. After reaching certain threshold amperage, the magnetic field generated through the terminals 31 and 32 will interact with the permanent magnets or rotor magnets 23 of the rotatable armature assembly 13. The magnets 23 have an inherent magnetic field directed outward as referenced at vector arrow 104, the force of which is lesser in magnitude than the force at vector arrow 103. The difference in force between 104 and 103 as directed causes the rotatable armature assembly 13 to rotate toward an open contact position as diagrammatically shown in Figure No. 15. This feature can be calibrated by the size and strength of the magnets 23 and the dis-

tance between the armature and stationary contacts.

[0036] While the above descriptions contain much specificity, this specificity should not be construed as limitations on the scope of the invention, but rather as an exemplification of the invention. For example, the invention may be said to teach or disclose an electromagnetic relay assembly for enabling current to pass through switch termini, which electromagnetic relay assembly comprises a coil assembly, a rotatable armature or bridge assembly, and a switch assembly characterized by an inventive three-spring spring assembly. The coil assembly comprises a coil, a coil axis, and a C-shaped core. The coil is wound around the coil axis 100, and the coil axis extends 100 through the core as at 60 in Figure No. 12. The core 60 comprises core termini 20, which core termini 20 are substantially parallel to the coil axis 100.

The bridge assembly comprises an axis of rotation as at 101 and a bridge as at 61 in Figure Nos. 12 and 15; and a switch actuator as at 22. The bridge 61 comprises a medial field pathway 63 (i.e. a pathway relatively closer in proximity to the core 60), a lateral field pathway 64 (i.e. a pathway relatively further in proximity to the core 60), and axially spaced transverse pathways 65 for guiding the field as at 102 intermediate the medial and lateral field pathways 63 and 64. The actuator arm 22 is cooperable with, and extends away from, the lateral pathway 64 (not specifically depicted in Figure No. 12). The core termini 20 are preferably coplanar with the axis of rotation 101 and received intermediate the medial and lateral pathways 63 and 64.

It is contemplated that the transverse pathways 65 provide certain field-diversion means for transversely diverting the magnetic field 102 relative to the coil axis 100 and magnetically inducing a torque, which magnetically induced torque functions to actuate the switch actuator 22. Said field diversion means may be further described as comprising certain field division means (there being two axis-opposing paths as at 66 in Figure No. 12) for creating a magnetic couple about the magnetically induced torque.

[0037] The switch assembly as at 14 is further cooperable with the actuator arm 22, which actuator arm 22 is essentially a coupling intermediate the bridge assembly 61 and the switch assembly 14. The coil functions to create or impart a magnetic field as vectorially depicted at 102. The magnetic field 102 is directable through the bridge assembly 61 via the core termini 20 for imparting bridge rotation about the axis of rotation 101 via magnetically induced torque. The bridge rotation functions to displace the actuator arm 22, which displaced actuator arm 22 physically opens and closes the switch assembly 14. As is most readily understood in the arts, the closed switch assembly 14 enables current to pass therethrough.

[0038] The switch assembly 14 comprises certain spring means for enhancing spring over travel, said means for enhancing the closed switch position by way of increasing the contact pressure intermediate contact buttons 34 and 37. The spring means for enhancing spring over travel further provide contact wiping means, and vibration damping means. The contact wiping means are contemplated to effectively self-cleanse the switch assembly 14, and the vibration damping means function to damp contact vibration when switching from open to closed switch positions. The spring means for enhancing spring over travel may thus be said to enhance the closed switch position by increasing contact pressure intermediate the contacts, by maintaining a residue free contact interface, and by damping contact vibration when closing the contacts.

[0039] Although the invention has been described by reference to a number of embodiments it is not intended that the novel device or relay be limited thereby, but that modifications thereof are intended to be included as falling within the broad scope and spirit of the foregoing disclosure and the appended drawings. For example, the foregoing specifications support an electromagnetic relay assembly primarily intended for use as a single pole, 120-amp passing relay assembly. It is contemplated, however, that the essence of the invention may be applied in multi-pole relay assemblies, having unique construction and functionality in their own right, but which are enabled by the teachings of the single pole embodiment set forth in this disclosure.

Claims

1. An electromagnetic relay (10) having a coil assembly (12), a rotatable armature assembly (13), and a switch assembly (14) wherein the switch assembly (14) comprises a three-spring, spring assembly (33), said spring assembly (33) comprising three stacked spring elements (40, 39, 38) and a longitudinal spring assembly axis (105), wherein said spring assembly (33) is **characterised by** a first spring element (40) comprising a first spring length, a first contact-receiving aperture (45), and a first elastically deformable terminal side end (53), the second spring element (39) comprising a second spring length abbreviated relative to the first spring length, a second contact-receiving aperture (43), and a first C-shaped button-stackable spring portion (52) extending in radial adjacency to the second contact-receiving aperture (43), the third spring element (38) comprising a third spring length equal to the first spring length, a first C-shaped aperture (42) for enabling spring over travel, a third contact-receiving aperture (41), a second C-shaped button-stackable spring portion (52) extending intermediate the first C-shaped aperture (42) and the third contact-receiving aperture (41), and a second elastically deformable terminal side end (53), the first C-shaped aperture (42) extending symmetrically about the longitudinal spring assembly axis (105), the second spring element (39) being sandwiched intermediate the first and third spring ele-

ments (40, 38) such that the first and second button-stackable spring portions (52, 52) are uniformly stacked, and the first and third spring elements (40, 38) are spaced in relation to one another by way of the sandwiched second spring element (39) for actuation by an actuator element (22) of the switch assembly (14), the first and third spring elements (40, 38), so spaced, being reconfigurable via the actuator element (22) intermediate (a) a closed position wherein the first and third spring elements (40, 38) are substantially planar along the first and third spring lengths and (b) an over travel position wherein the first and second elastically deformable terminal side ends (53, 53) are elastically deformed such that the first and third spring elements (40, 38) are non-planar along the first and third spring lengths.

2. The electromagnetic relay (10) of claim 1 wherein the terminal side ends (53, 53) extend obliquely relative to the button stackable portions (52) in lateral adjacency to the respective first and third contact-receiving apertures (45, 41) when in the over travel position.

3. The electromagnetic relay (10) of claim 1 wherein the first spring element (40) comprises a second C-shaped aperture (46) for enabling over travel, and a third button-stackable spring portion (52) extending intermediate the second C-shaped aperture (46) and the first contact-receiving aperture (45), the second C-shaped aperture (46) being symmetrical about the longitudinal spring assembly axis 105, the first, second and third button-stackable spring portions (52) being uniformly stacked.

4. The electromagnetic relay (10) of claim 3 wherein the first and second terminal side ends (53, 53) are actuated in parallel relation to one another by the actuator element (22) of the switch assembly (14).

5. The electromagnetic relay (10) of claim 1 wherein the three-spring, spring assembly (33) defines means for enhancing spring over travel and enhancing the closed switch position.

6. The electromagnetic relay (10) of claim 1 wherein the three-spring, spring assembly (33) defines contact wiping means, said means for cleansing the switch assembly (14).

7. The electromagnetic relay (10) of claim 1 wherein the three-spring, spring assembly (33) defines means for damping contact vibration when switching from open to closed switch positions.

8. The electromagnetic relay (10) of claim 1 wherein the rotatable armature assembly (13) is **characterized by** bridge-mounting means for enabling open face operation of the electromagnetic relay (10), the bridge-mounting means being defined by a rotor mount element (30), the rotor mount element (30) receiving a rotor pin (29) of the rotatable armature assembly (13).

9. The electromagnetic relay (10) of claim 5 wherein a select terminal side end (53) selected from the group consisting of the first and second terminal side ends (53) comprises an end-located offset (70), the end-located offset (70) defining the means for enhancing spring over travel and enhancing the closed switch position.

Patentansprüche

1. Elektromagnetisches Relais (10) mit einer Spulenanordnung (12), einer drehbaren Ankeranordnung (13) und einer Schalteranordnung (14), wobei die Schalteranordnung (14) eine Federanordnung (33) mit drei Federn umfasst, wobei die Federanordnung (33) drei gestapelte Federelemente (40, 39, 38) und eine Längsachse (105) der Federanordnung umfasst, wobei die Federanordnung (33) **gekennzeichnet ist durch** ein erstes Federelement (40) mit einer ersten Federlänge, einer ersten Kontaktaufnahmeöffnung (45) und einem ersten elastisch verformbaren anschlussseitigen Ende (53), **durch** das zweite Federelement (39) mit einer zweiten Federlänge, die relativ zu der ersten Federlänge verkürzt ist, einer zweiten Kontaktaufnahmeöffnung (43) und einem ersten C-förmigen, **durch** einen Knopf stapelbaren Federabschnitt (52), der sich radial benachbart zu der zweiten Kontaktaufnahmeöffnung (43) erstreckt, **durch** das dritte Federelement (38) mit einer dritten Federlänge, die gleich der ersten Federlänge ist, einer ersten C-förmigen Öffnung (42) zum Ermöglichen eines Federnachlaufs, einer dritten Kontaktaufnahmeöffnung (41), einem zweiten C-förmigen, **durch** einen Knopf stapelbaren Federabschnitt (52), der sich zwischen der ersten C-förmigen Öffnung (42) und der dritten Kontaktaufnahmeöffnung (41) erstreckt, und einem zweiten elastisch verformbaren anschlussseitigen Ende (53), wobei sich die erste C-förmige Öffnung (42) symmetrisch um die Längsachse (105) der Federanordnung herum erstreckt, das zweite Federelement (39) zwischen dem ersten und dritten Federelement (40, 38) derart eingeklemmt ist, dass die ersten und zweiten **durch** einen Knopf stapelbaren Federabschnitte (52, 52) einheitlich gestapelt sind, und das erste und dritte Federelement (40, 38) in Bezug zueinander aufgrund des eingeklemmten zweiten Federelements (39) für eine Betätigung **durch** ein Aktorelement (22) der Schalteranordnung (14) beabstandet sind, wobei die so beabstandeten ersten und dritten Federelemente (40, 38) mit Hilfe des Aktorelements (22) zwischen

(a) einer geschlossenen Position, bei der das erste und dritte Federelement (40, 38) entlang der ersten und dritten Federlänge im Wesentlichen eben sind, und (b) einer Nachlaufposition, bei der die ersten und zweiten elastisch verformbaren anschlussseitigen Enden (53, 53) elastisch derart verformt sind, dass das erste und dritte Federelement (40, 38) entlang der ersten und dritten Federlänge nicht eben sind, umkonfiguriert werden können.

2. Elektromagnetisches Relais (10) nach Anspruch 1, wobei sich die anschlussseitigen Enden (53, 53) relativ zu den durch einen Knopf stapelbaren Abschnitten (52) in seitlicher Nachbarschaft zu den jeweiligen ersten und dritten Kontaktaufnahmeöffnungen (45, 41) schräg erstrecken, wenn sie sich in der Nachlaufposition befinden.

3. Elektromagnetisches Relais (10) nach Anspruch 1, wobei das erste Federelement (40) eine zweite C-förmige Öffnung (46) zum Ermöglichen des Nachlaufs und einen dritten, durch einen Knopf stapelbaren Federabschnitt (52) umfasst, der sich zwischen der zweiten C-förmigen Öffnung (46) und der ersten Kontaktaufnahmeöffnung (45) erstreckt, wobei die zweite C-förmige Öffnung (46) um die Längsachse (105) der Federanordnung herum symmetrisch ist, wobei der erste, zweite und dritte, durch einen Knopf stapelbare Federabschnitt (52) einheitlich gestapelt sind.

4. Elektromagnetisches Relais (10) nach Anspruch 3, wobei das erste und zweite anschlussseitige Ende (53, 53) in einer parallelen Beziehung zueinander durch das Aktorelement (22) der Schalteranordnung (14) betätigt werden.

5. Elektromagnetisches Relais (10) nach Anspruch 1, wobei die Federanordnung (33) mit drei Federn ein Mittel zum Verbessern des Federnachlaufs und zum Verbessern der geschlossenen Schalterposition definiert.

6. Elektromagnetisches Relais (10) nach Anspruch 1, wobei die Federanordnung (33) mit drei Federn ein Kontaktabstreifmittel definiert, wobei das Mittel zum Säubern der Schalteranordnung (14) gedacht ist.

7. Elektromagnetisches Relais (10) nach Anspruch 1, wobei die Federanordnung (33) mit drei Federn ein Mittel zum Dämpfen von Kontaktvibrationen beim Umschalten von offenen in geschlossene Schalterpositionen definiert.

8. Elektromagnetisches Relais (10) nach Anspruch 1, wobei die drehbare Ankeranordnung (13) durch ein Brückenmontagemittel zum Ermöglichen eines Betriebs des elektromagnetischen Relais (10) im geöffneten Zustand gekennzeichnet ist, wobei das Brückenmontagemittel durch ein Rotormontageelement (30) definiert ist, das einen Rotorstift (29) der drehbaren Ankeranordnung (13) aufnimmt.

9. Elektromagnetisches Relais (10) nach Anspruch 5, wobei ein gewähltes anschlussseitiges Ende (53), das aus der Gruppe gewählt ist, die aus dem ersten und dem zweiten anschlussseitigen Ende (53) besteht, einen am Ende angeordneten Versatz (70) umfasst, wobei der am Ende angeordnete Versatz (70) das Mittel zum Verbessern des Federnachlaufs und zum Verbessern der geschlossenen Schalterposition definiert.

Revendications

1. Relais électromagnétique (10) ayant un ensemble de bobine (12), un ensemble d'armature rotatif (13) et un ensemble de commutateur (14), dans lequel l'ensemble de commutateur (14) comprend :

un ensemble de ressorts à trois ressorts (33), ledit ensemble de ressorts (33) comprenant trois éléments de ressort empilés (40, 39, 38) et un axe longitudinal d'ensemble de ressorts (105), ledit ensemble de ressorts (33) étant **caractérisé par** un premier élément de ressort (40) comprenant une première longueur de ressort, une première ouverture de réception de contact (45), et une première extrémité latérale terminale élastiquement déformable (53), le deuxième élément de ressort (39) comprenant une deuxième longueur de ressort raccourcie par rapport à la première longueur de ressort, une deuxième ouverture de réception de contact (43) et une première partie de ressort empilable de bouton en forme de C (52) s'étendant en adjacence radiale vers la deuxième ouverture de réception de contact (43), le troisième élément de ressort (38) comprenant une troisième longueur de ressort égale à la première longueur de ressort, une première ouverture en forme de C (42) pour permettre la course excessive du ressort, une troisième ouverture de réception de contact (41), une seconde partie de ressort empilable de bouton en forme de C (52) s'étendant entre la première ouverture en forme de C (42) et la troisième ouverture de réception de contact (41), et une seconde extrémité latérale terminale élastiquement déformable (53), la première ouverture en forme de C (42) s'étendant symétriquement autour de l'axe longitudinal de l'ensemble de ressort (105), le deuxième élément de ressort (39) étant pris en sandwich entre les premier et troisième éléments de ressort (40, 38) de sorte que les première et seconde parties

de ressort empilable de bouton (52, 52) sont empilées de manière uniforme, et les premier et troisième éléments de ressort (40, 38) sont espacés l'un par rapport à l'autre au moyen du deuxième élément de ressort pris en sandwich (39) pour l'actionnement par un élément d'actionneur (22) de l'ensemble de commutateur (14), les premier et troisième éléments de ressort (40, 38), ainsi espacés, pouvant être reconfigurés via l'élément d'actionneur (22) entre (a) une position fermée dans laquelle les premier et troisième éléments de ressort (40, 38) sont sensiblement plans le long des première et troisième longueurs de ressort et (b) une position de course excessive dans laquelle les première et seconde extrémités latérales terminales élastiquement déformables (53, 53) sont élastiquement déformées de sorte que les premier et troisième éléments de ressort (40, 38) ne sont pas plans le long des première et troisième longueurs de ressort.

2. Relais électromagnétique (10) selon la revendication 1, dans lequel les extrémités latérales terminales (53, 53) s'étendent obliquement par rapport aux parties empilables de bouton (52) en adjacence latérale par rapport aux première et troisième ouvertures de réception de contact (45, 51) respectives lorsqu'elles sont dans la position de course excessive.

3. Relais électromagnétique (10) selon la revendication 1, dans lequel le premier élément de ressort (40) comprend une seconde ouverture en forme de C (46) pour permettre la course excessive, et une troisième partie de ressort empilable de bouton (52) s'étendant entre la seconde ouverture en forme de C (46) et la première ouverture de réception de contact (45), la seconde ouverture en forme de C (46) étant symétrique autour de l'axe longitudinal d'ensemble de ressorts (105), les première, deuxième et troisième parties de ressort empilables de bouton (52) étant uniformément empilées.

4. Relais électromagnétique (10) selon la revendication 3, dans lequel les première et seconde extrémités latérales terminales (53, 53) sont actionnées parallèlement entre elles par l'élément d'actionneur (22) de l'ensemble de commutateur (14).

5. Relais électromagnétique (10) selon la revendication 1, dans lequel l'ensemble de ressorts à trois ressorts (33) définit des moyens pour améliorer la course excessive du ressort et améliorer la position de commutateur fermée.

6. Relais électromagnétique (10) selon la revendication 1, dans lequel l'ensemble de ressorts à trois ressorts (33) définit des moyens d'essuyage de contact, lesdits moyens étant prévus pour nettoyer l'ensemble de commutateur (14).

7. Relais électromagnétique (10) selon la revendication 1, dans lequel l'ensemble de ressorts à trois ressorts (33) définit des moyens pour amortir les vibrations de contact lors de la commutation de la position de commutateur ouverte à la position de commutateur fermée.

8. Relais électromagnétique (10) selon la revendication 1, dans lequel l'ensemble d'armature rotative (13) est **caractérisé par** des moyens de montage en pont pour permettre le fonctionnement à face ouverte du relais électromagnétique (10), les moyens de montage en pont étant définis par un élément de support de rotor (30), l'élément de support de rotor (30) recevant une broche de rotor (29) de l'ensemble d'armature rotative (13).

9. Relais électromagnétique (10) selon la revendication 5, dans lequel l'extrémité latérale terminale sélectionnée (53) sélectionnée dans le groupe comprenant les première et seconde extrémités latérales terminales (53) comprend un décalage positionné à l'extrémité (70), le décalage positionné à l'extrémité (70) définissant les moyens pour améliorer la course excessive du ressort et améliorer la position de commutateur fermée.

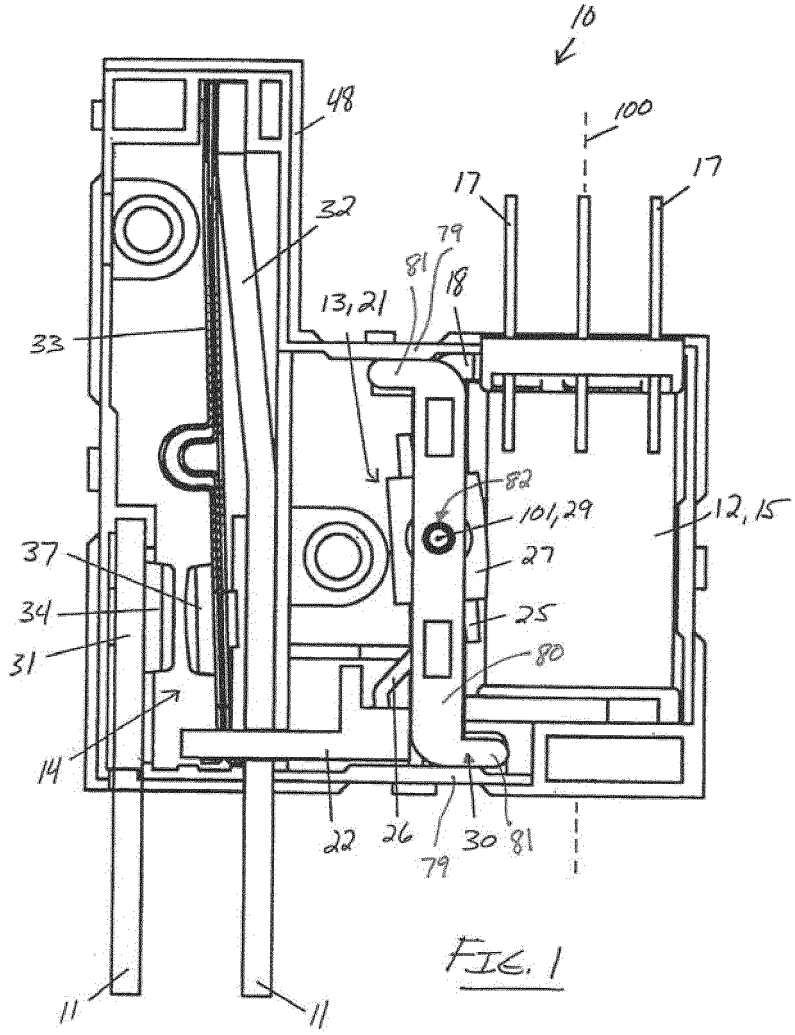
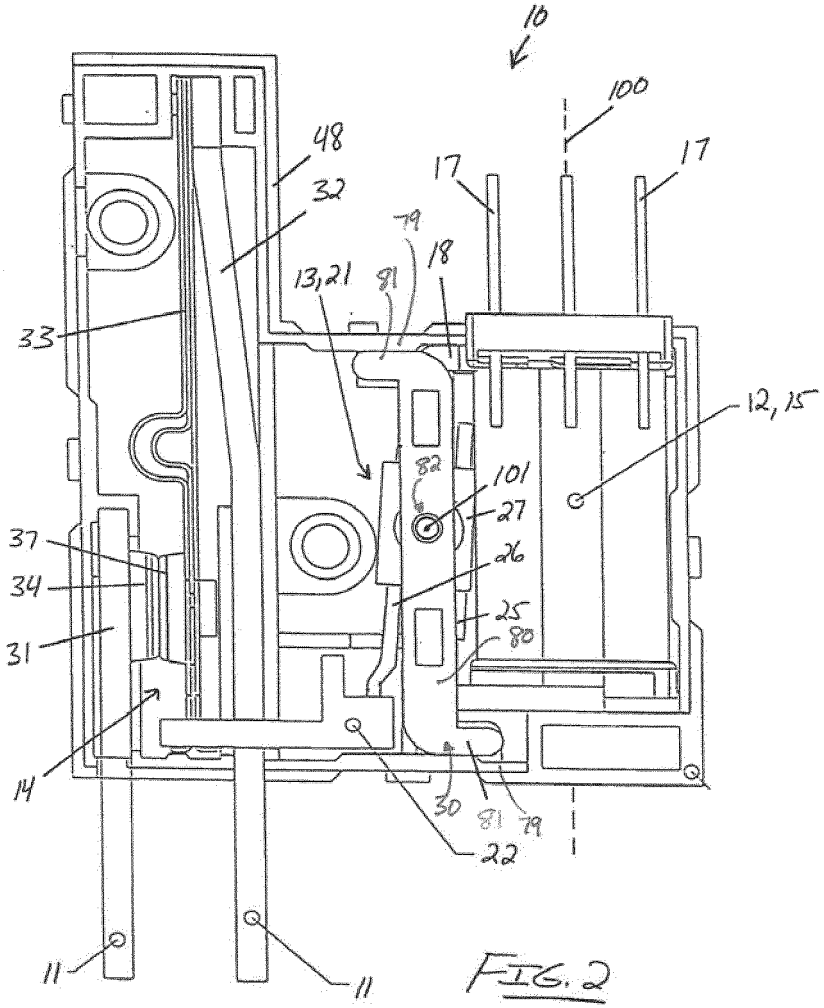

10
48
100
17
17
32
79
81
18
13,21
33
82
101,29
12,15
37
27
34
25
31
80
14
22
26
79
30
81
11
11

FIG. 1


10
100
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32
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11
11

FIG. 2

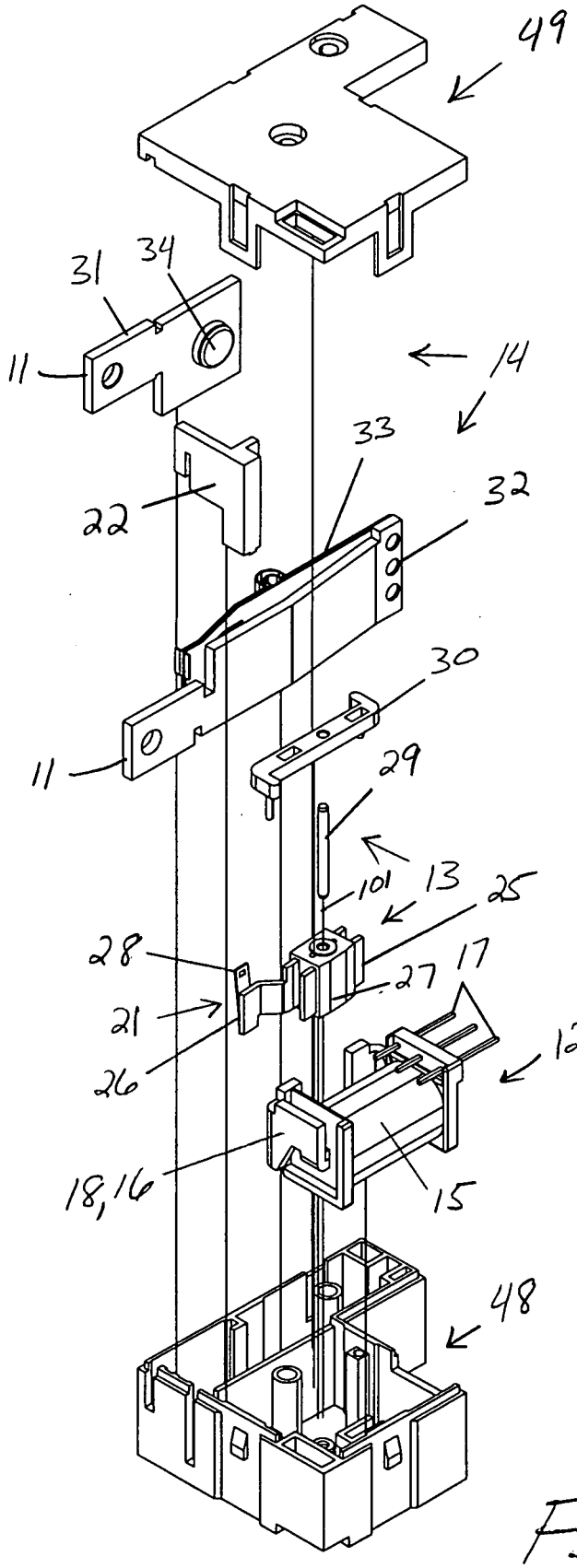

FIG. 3

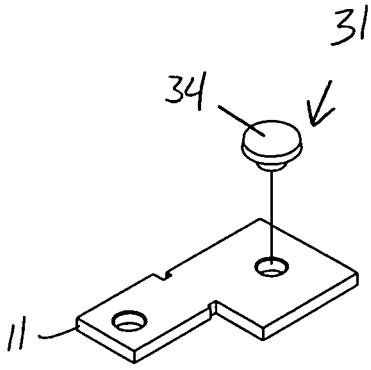

FIG. 4

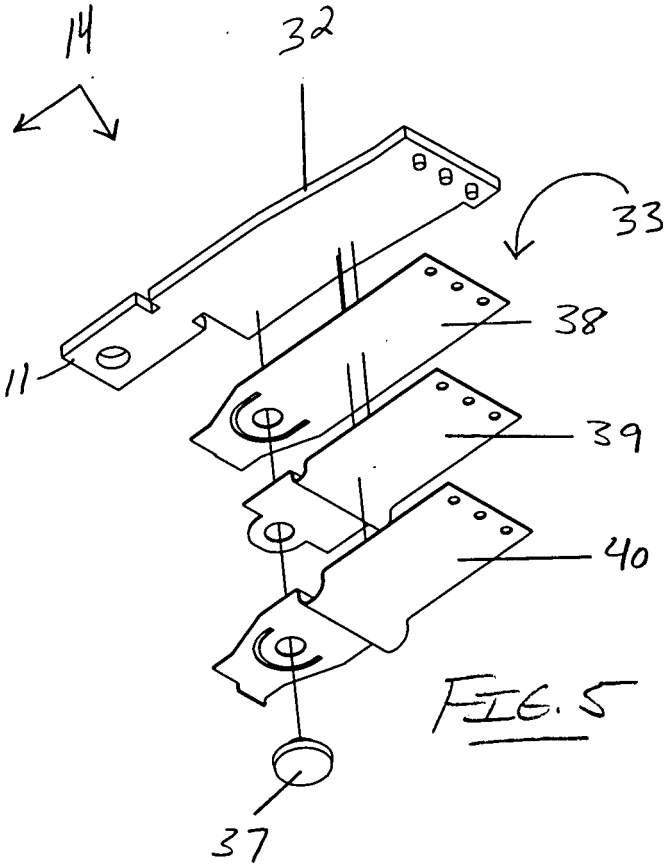

FIG. 5

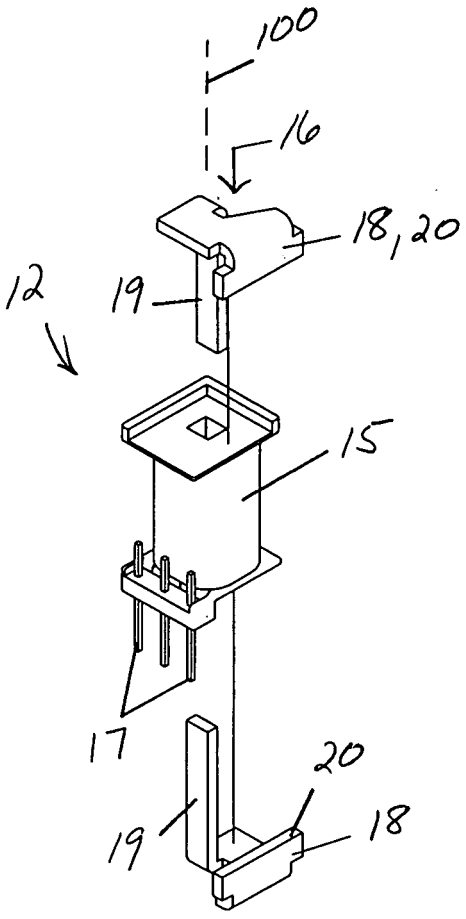

FIG. 6

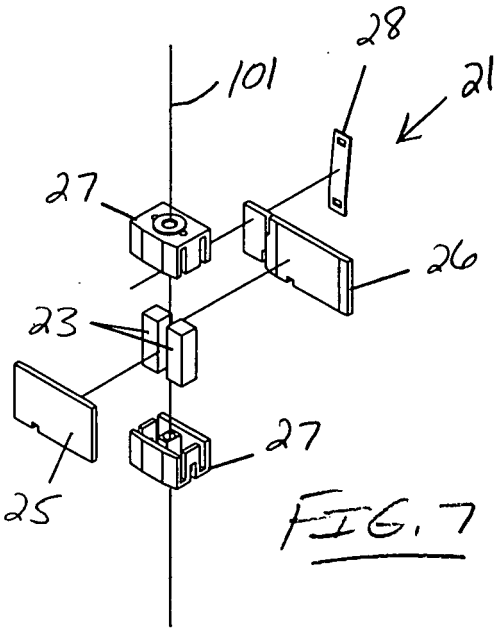

FIG. 7

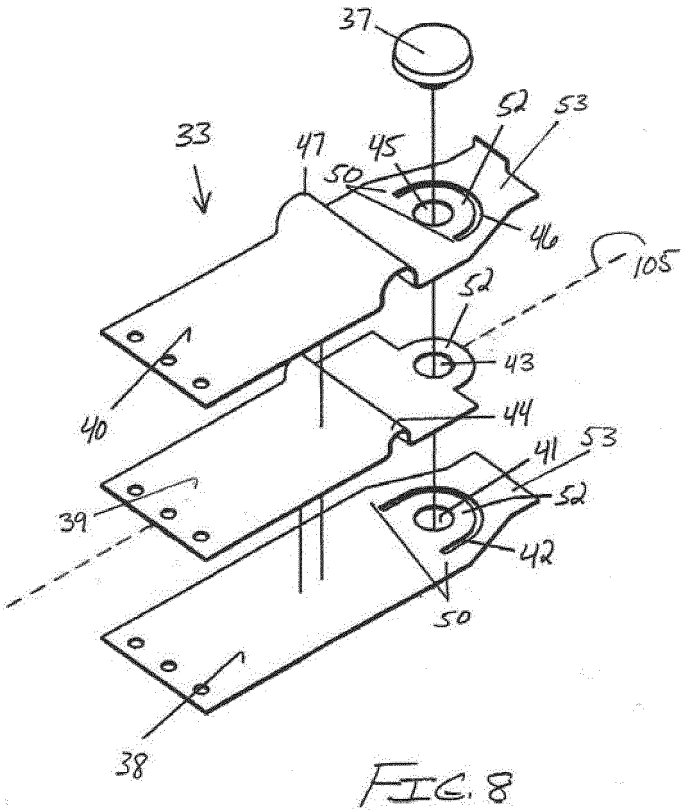

FIG. 8

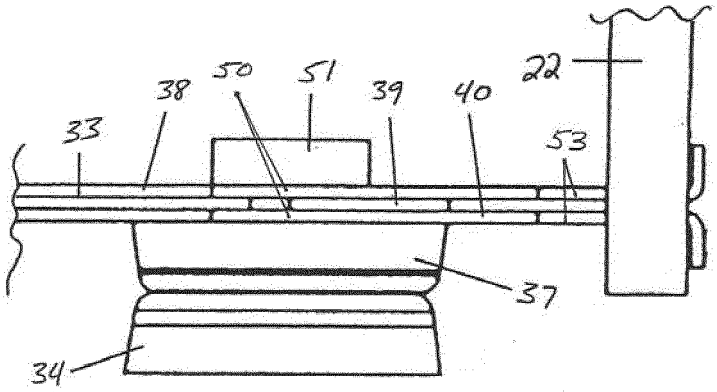

FIG. 9

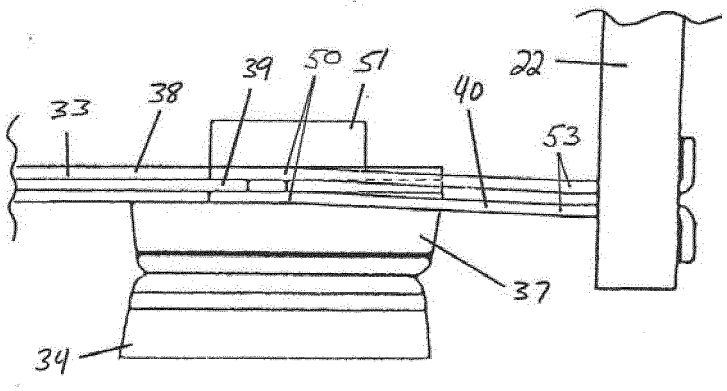

FIG. 10

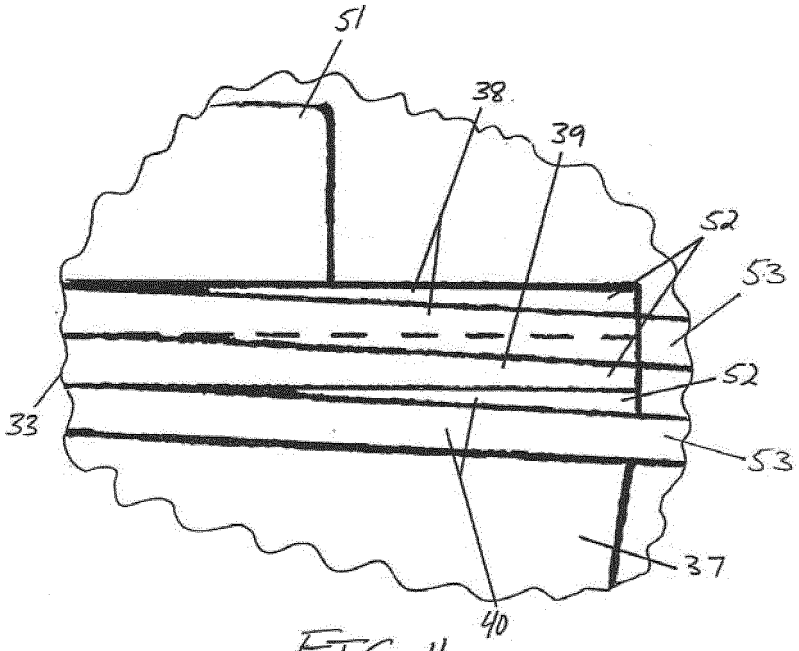

FIG. 11

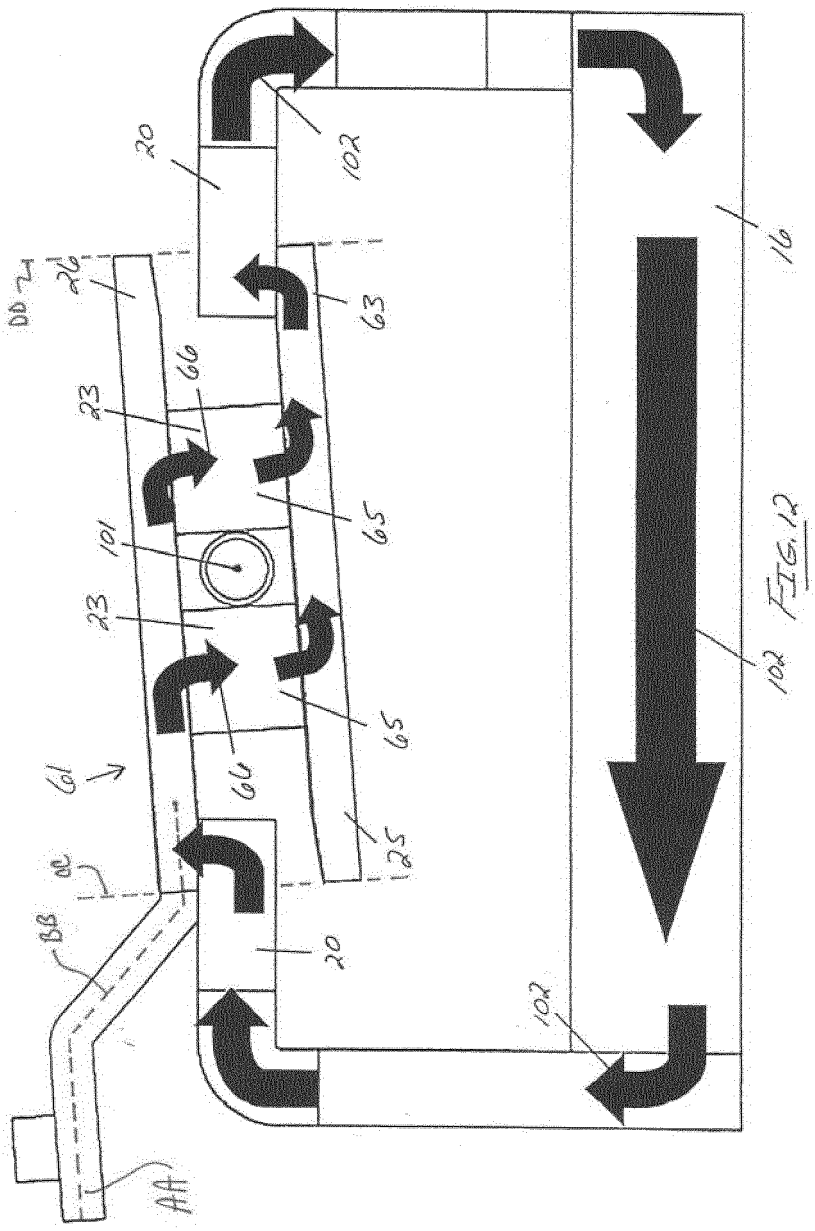

FIG. 12

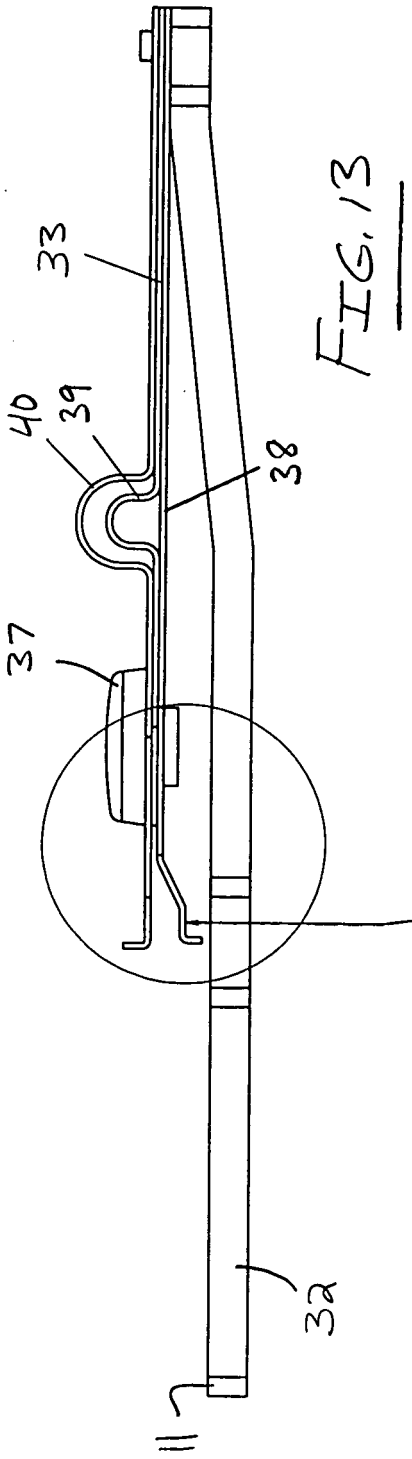

FIG. 13

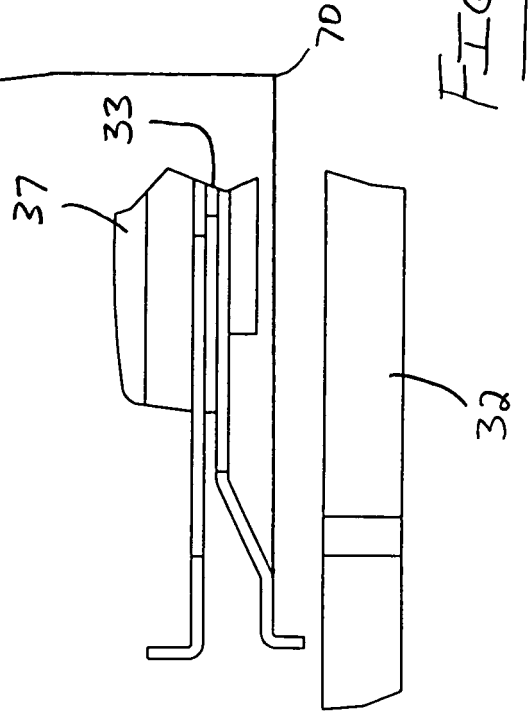

FIG. 14

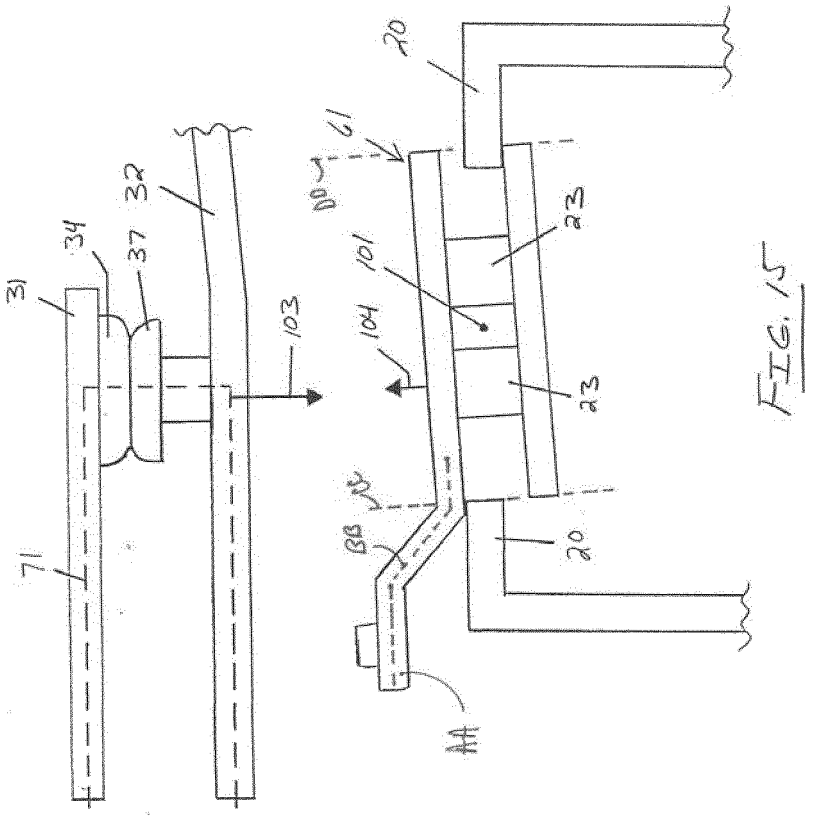

FIG. 15

REFERENCES CITED IN THE DESCRIPTION

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