Sept. 20, 1966 E. W. BAYER ETAL 3,274,523

ELECTROMAGNETIC SWITCHING RELAY HAVING A THREE PIECE U-SHAPED CORE

Filed March 2, 1964 3 Sheets-Sheet 1

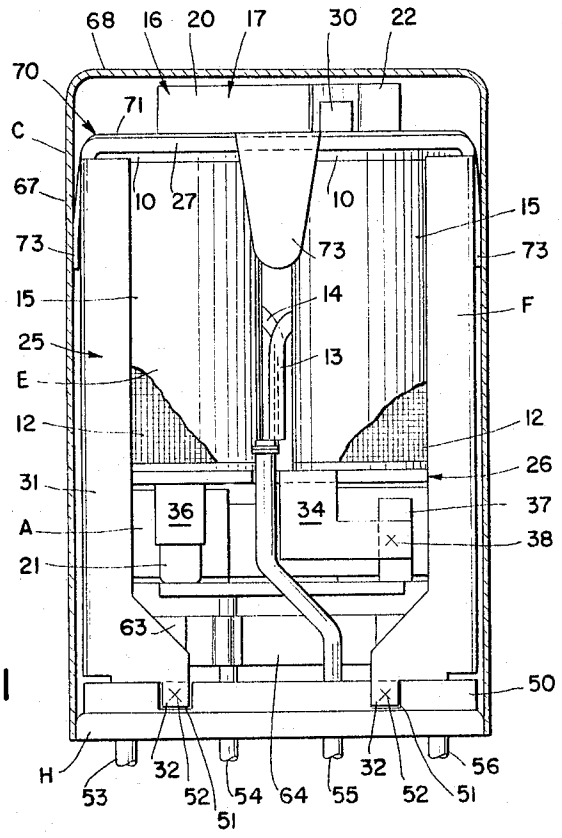


FIG. 1

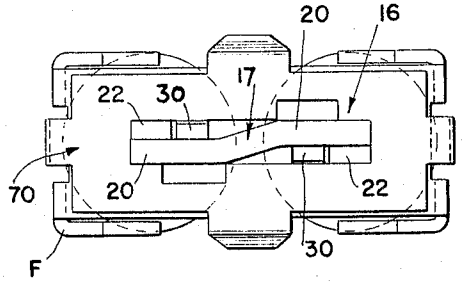


FIG. 2

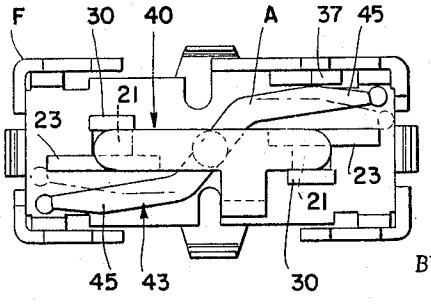


FIG. 3

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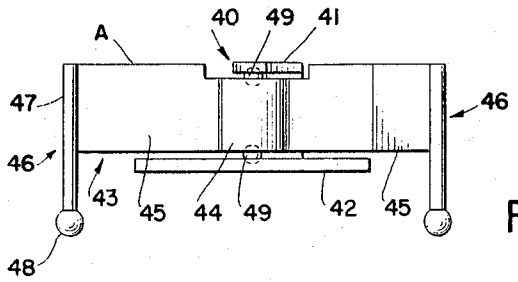


FIG. 4

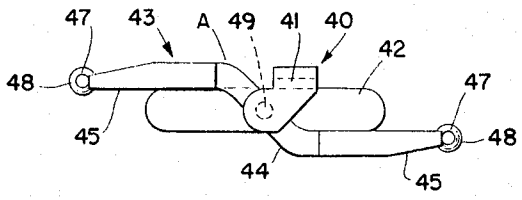


FIG. 5

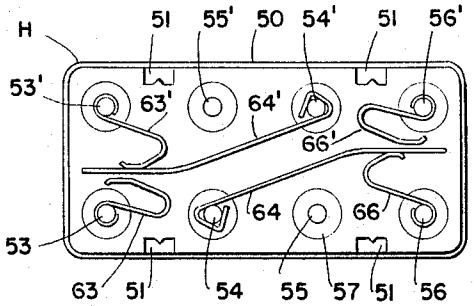


FIG. 6

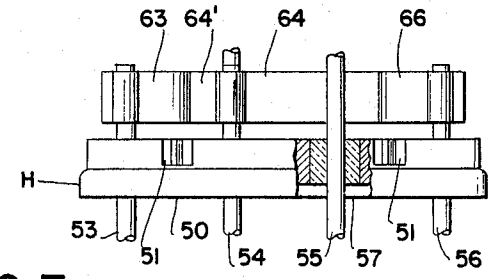


FIG. 7

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Filed March 2, 1964 3 Sheets-Sheet 3

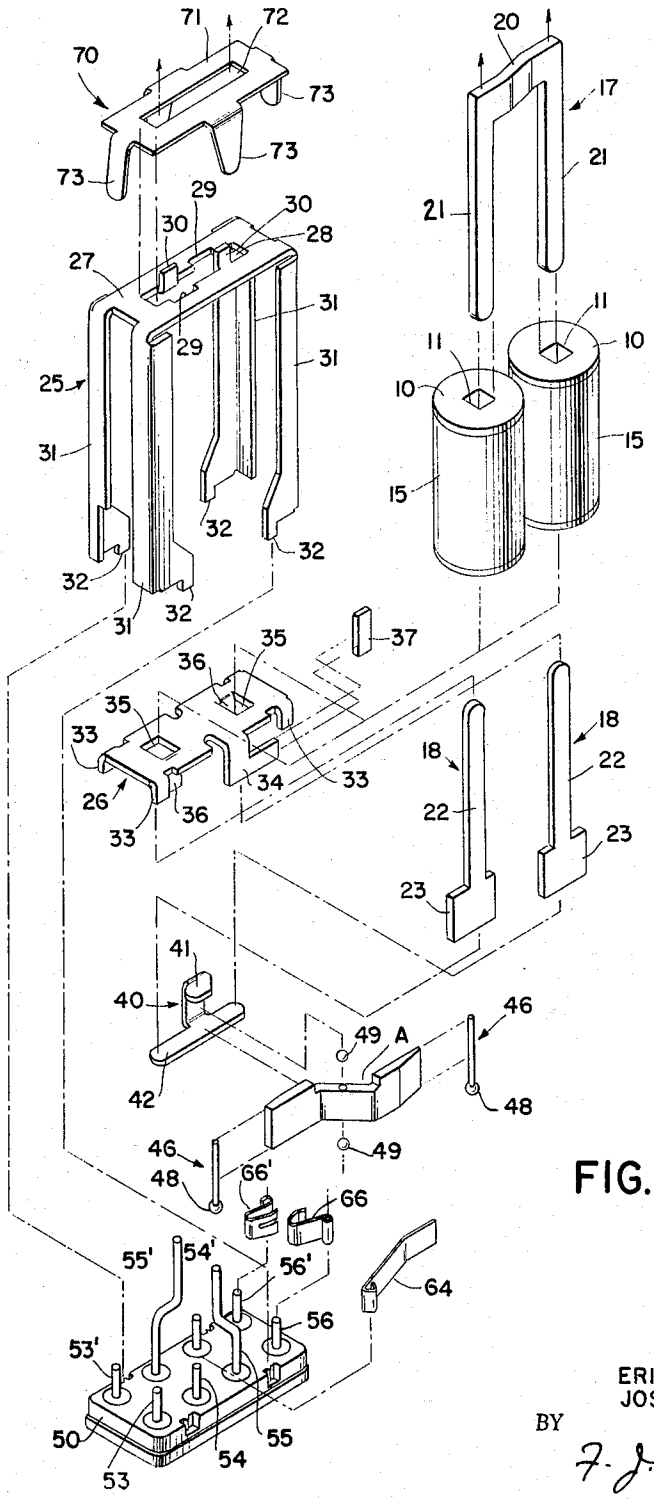


FIG. 8

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ELECTROMAGNETIC SWITCHING RELAY HAVING A THREE PIECE U-SHAPED CORE

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Filed Mar. 2, 1964, Ser. No. 348,404
6 Claims. (Cl. 335—121)

This invention relates to the art of electromagnetic devices and, more particularly, to an electromagnetic relay or switch having improved features of design and construction. The invention pertains, in one of its specific aspects, to an electromagnetic switching relay that is adapted to be readily made in small and miniature sizes and that is capable of rendering efficient and dependable service under various conditions of use.

The relay of this invention has wide application. It is specially useful in environments, such as in aircrafts, which may be subjected to high inertia forces due to shock, vibration and continued acceleration or deceleration and in which space for equipment is limited.

Incorporated in the relay of this invention are a number of novel and useful features which contribute to its utility and reliable performance over extended time periods and under severe use conditions.

One of the important features of the invention resides in the fact that the present relay, by virtue of the configuration, relative position and interconnection of its parts, effectively withstands shock and vibration forces and the like.

Another important feature of the relay of this invention resides in the provisions of an improved electromagnet including a pair of coils and a novel and relatively simple core assembly, certain parts of the electromagnet unit being firmly secured to an improved frame structure, the parts of the electromagnet unit and frame unit being so constructed and arranged as to facilitate assembly and adjustment and to obtain a rigid unitary structure.

Other important features of the present relay reside in the provision and use of (1) an improved and simplified balanced rotary armature arrangement and (2) a device cooperatively associated with the relay cover unit and frame unit and adapted to substantially eliminate or minimize the effect of objectionable resonance of the relay within the frequency range of externally applied vibrations during use.

The primary object of the present invention is to provide an electromagnetic device having improved and simplified features of design and construction.

Another object of the invention is to provide an electric relay that is capable of being made in small and miniature sizes and that is adapted to effectively withstand shock and vibration forces and conditions of acceleration or deceleration in the course of normal use.

A still further object of the invention is to provide a relay of the character indicated that is small, compact and lightweight in design; that is sturdy and durable in construction; that is reasonable in manufacturing cost and that is capable of performing its intended functions in a satisfactory and reliable manner.

The relay of this invention may be advantageously employed with various types of switch arrangements including, but not limited to, single pole double throw switches and multi-pole double throw switches. The ensuing detailed description and the accompanying drawings describe and illustrate, by way of example, a relay for operating a two pole double throw switch arrangement.

In the drawings, wherein like reference characters denote corresponding parts throughout the several views:

FIG. 1 is a view in side elevation of a relay constructed in accordance with the invention, the cover unit of the relay being shown in cross section and certain parts within the confines of the cover unit being broken away for better illustration;

FIG. 2 is a top plan view of the relay shown in FIG. 1, the cover unit and the header unit being omitted;

FIG. 3 is a bottom plan view of the relay shown in FIG. 1, the cover unit and the header unit being omitted;

FIG. 4 is a view in side elevation of an armature unit which is also shown in other views;

FIG. 5 is a top plan view of FIG. 4;

FIG. 6 is a top plan view of a header unit which is also shown in other views;

FIG. 7 is a side elevation view of FIG. 6 partly in cross section for better illustration; and

FIG. 8 is an exploded view of the relay on a reduced scale, the cover unit and certain duplicate parts of the header unit being omitted.

Referring initially to FIGS. 1, 2 and 3 of the drawings, the complete relay illustrated therein is made up of five principal parts, namely an electromagnet unit E, a frame unit F, an armature unit A, a header unit H, and a cover unit C, and a number of secondary units or parts, all of which will now be described.

Electromagnet unit E is best shown in FIGS. 1 and 8. This unit comprises a pair of upstanding bobbins **10**. Each bobbin defines a rectangular, axial through opening **11** and carries a magnetizing coil **12**. The coils are continuations of each other and terminate in a pair of electric leads **13** and **14**. Each coil is provided with an insulating outer wrapper **15**. The electromagnet unit also comprises a core assembly **16** (FIGS. 1 and 2) which is composed of an inverted generally U-shaped member **17** and a pair of planar T-shaped members **18** (FIG. 8). U-shaped member **17** consists of a web **20** and a pair of parallel arms **21** each of which extends through and beyond the lower end of a corresponding bobbin opening **11**. Arms **21** are offset from each other.

Each T-shaped member **18** consists of a stem element **22** and a cross element **23**. The stem element **22** of each T-shaped member extends through and beyond the upper end of a corresponding bobbin opening **11** and is in intimate contact with a corresponding arm **21** of the U-shaped member. The cross element **23** of each T-shaped member projects below the corresponding bobbin. Members **17** and **18** are firmly united whereby to maintain the bobbins and the coils in the illustrated relative position by spot welding the free end of each stem element **22** to web **20** and by spot welding each cross element **23** to the free end of a corresponding arm **21**. The T-shaped members **18** are offset from each other and their cross elements **23** serve as pole pieces in that they cooperate with armature A, as will be described, to actuate the armature when the coils are energized.

Frame F comprises a metal bracket **25** and a metal plate **26**. Bracket **25** includes a planar top wall **27** having a central through opening **28**, a pair of notches **29**, which merge with opening **28** and an upwardly projecting integral tongue **30** opposite each notch. Depending from the corners of the top wall and normal to that wall are four parallel legs **31** which are L-shaped in transverse cross section. Each leg **31** terminates in a foot element **32**.

Plate **26** is formed with an integral depending tongue **33** at each corner and with an integral depending L-shaped extension **34** along its forward edge. This plate is also struck and bent to define a pair of rectangular through openings **35** and a pair of depending tongues **36**.

A permanent magnet **37** is firmly secured to the free end of extension **34** by spot welding, as indicated at **38** in FIG. 1.

In assembling electromagnet unit E and frame F, bobbins **10** and their coils **12** are disposed within the confines of bracket legs **31**, so that the upper ends of the bobbins bear against bracket top wall **27** and the lower ends of the bobbins bear against plate **26**. Web **20** of the U-shaped member **17** bears against and is spot welded to bracket tongues **30** (FIG. 2) and the free end of each arm **21** of the U-shaped member bears against and is spot welded to a corresponding plate tongue **36**. It will be observed that the lower portion of each arm **21** and stem **22** registers with a corresponding plate opening **35**. Each tongue **36** of plate **26** bears against and is spot welded to a corresponding bracket leg **31**. The herein described arrangement of electromagnet unit and frame unit results in a rigid unitary construction that may be readily assembled and that is capable of successfully withstanding high forces due to shock vibrations and the like.

Reference is next had to FIGS. 4, 5 and 8 for an understanding of the details of construction of armature unit A. This unit includes a stainless steel bracket **40** comprising spaced, parallel, upper and lower flanges **41** and **42**, respectively. Positioned between these flanges is an armature **43** consisting of a central portion **44** and end portions **45** extending beyond corresponding ends of the central portion. As illustrated, the end portions of the armature are offset and parallel. Armature **43** is equipped with a pair of actuators **46**. Each actuator consists of a rod **47**, which is welded to and extends downwardly below one end of the armature, and an insulating element, such as a glass bead **48**, which is formed at the free end of the rod.

The armature is pivotal relative to bracket **40** through the medium of a pair of stainless steel balls **49**. In the interest of economy and ease of manufacture, armature **43** is initially fabricated without openings or depressions to accommodate the steel balls. Instead, the steel balls are pressed into the upper and lower faces of the armature, along its central axis, to form mating recesses therein, prior to assembling the armature in bracket **40**. The steel balls are similarly pressed into bracket flanges **41** and **42** and welded thereto. Thus, the steel balls permit low friction pivotal movement of the armature relative to its bracket. The armature unit A can be simply and properly mated with pole pieces **23**, at which time bracket flange **41** is welded to plate **26** whereby to firmly secure the armature unit to the frame. It will be appreciated that the present relay contemplates and, in fact, utilizes a balanced rotary armature characterized by simplicity and sensitivity, long life, high stability and ease of manufacture and assembly.

Header unit H will now be described, having reference to FIGS. 1, 6, 7 and 8. This unit comprises a base plate **50** having a plurality of peripheral notches **51** for receiving corresponding bracket feet **32** which are firmly anchored thereto by spot welding, as indicated at **52** in FIG. 1. The base plate carries a plurality of fixed electrical terminals, namely terminals **53** through **56** and **53'** through **56'**. These terminals extend through the base plate and are firmly secured thereto by corresponding masses of an appropriate, rigid insulating material, such as glass, as indicated at **57** in FIGS. 6 and 7. Terminals **53** through **56** are equi-spaced and arranged in a first row. Terminals **53'** through **56'** are also equi-spaced, but in a somewhat different order from terminals **53** through **56**, and are arranged in a second row which is parallel to the first row. Terminals **55** and **55'** are respectively connected to coil leads **13** and **14** and are adapted to be connected to a suitable source of electric energy supply (not shown). Anchored to terminals **53**, **56**, **53'** and **56'** are respective stationary contacts **63**, **66**, **63'** and **66'** These contacts are resilient, contacts **63** and **66'** being generally C-shaped and contacts **66** and **63'** being generally J-shaped.

The header unit also includes a pair of movable contacts in the form of electrically conductive leaf spring contact arms **64** and **64'** which are configured as best shown in FIG. 6. One end of contact arm **64** is anchored by brazing to terminal **54** and its free end portion is positioned between stationary contacts **66** and **66'**. Arm **64** is so configured and arranged that its free end portion normally and yieldingly engages stationary contact **66**. Similarly, one end of contact arm **64'** is anchored by brazing to terminal **54'** and its free end portion is positioned between stationary contacts **63** and **63'**. Arm **64'** normally and yieldingly engages stationary contact **63'**.

Contact arms **64** and **64'** extend across the paths of travel of corresponding actuator beads **48**. The arrangement of contact arms and actuator beads is such that, upon predetermined pivotal movement of armature **43** in one direction, arm **64** is flexed upwardly as viewed in FIG. **6**, and arm **64'** is flexed downwardly, as also viewed in FIG. 6, to thereby break contact with stationary contacts **66** and **63'** and make contact with stationary contacts **66'** and **63**.

Cover unit C cooperates with base plate **50** to encase the parts of the relay which are located above the base plate. The cover unit comprises a tubular side wall **67** and a top wall **68**. The cover unit is open at its lower end for reception of various parts of the relay and forms a snug fit with the base plate. The cover unit is hermetically sealed to the base plate at the time of assembly. The cover unit may be equipped with external brackets or the like (not shown) for use in mounting the relay to a panel board or other selected location.

In most structures of the size and character of the subject relay, objectionable resonance of the structure will usually occur within the frequency range of externally applied vibrations during use. The effect of such resonance is substantially eliminated or minimized by equipping the relay with a device **70** which is interposed between and bears against frame unit F and cover unit C. This device is made of a sheet of a resilient metal, such as stainless steel, which is cut and bent to obtain a planar plate **71**, having a central through aperture **72** for accommodating the parts of the electromagnetic unit which project above the frame unit and a plurality of, preferably four, spring fingers **73**. As is illustrated in FIGS. 1 and 8, each spring finger projects downwardly and outwardly of a corresponding side or end of plate **71**. Device **70** is positioned, as indicated in FIG. 1 with its plate **71** located directly above and welded to bracket top wall **27** and with its fingers **73** pressing against the inner surface of tubular side wall **67** of the cover unit. The fingers, due to their resilience, develop an adequate yielding frictional force that effectively resists and dampens induced motion which normally occurs in the frame unit and the parts confined therein during a resonant mode of the relay.

For the purpose of outlining the operation of the herein described form of the invention, it is assumed that the relay illustrated in the drawings is assembled and that the parts are in the relative position shown in FIGS. 1, 3 and 6. It is also assumed that magnetizing coils **12** are deenergized. Under these circumstances, armature **43** is biased by permanent magnet **37** in a counter-clockwise direction of rotation about the pivotal axis formed by steel balls **49**, as viewed in FIG. 3, and is held by the permanent magnet so that armature portions **45** are maintained away from corresponding pole pieces **23** and actuator beads **48** are out of engagement with corresponding movable contact arms **64** and **64'**.

When header terminals **55** and **55'** are connected to a suitable source of electric energy and the magnetizing coils are energized, pole pieces **23** exert sufficient attracting force on armature portions **45** to impart reverse pivotal movement to the armature against the action of permanent magnet **37**. Thus, the armature is swung toward the pole pieces to the extent allowed by the pole pieces. This movement of the armature causes one of the actuator beads **48** to engage and flex contact arm **64**

upwardly (FIG. 6), thereby breaking contact between contact arm **64** and stationary contact **66** and making contact between this contact arm and stationary contact **66'**. The armature simultaneously causes the other actuator bead to engage and flex contact arm **64'** downwardly (FIG. 6), thereby breaking contact between contact arm **64'** and stationary contact **63'** and making contact between this contact arm and stationary contact **63**. When the magnetizing coils are again deenergized, the parts automatically return to their original position due to the action of the permanent magnet.

From the foregoing, it is believed that the objects, construction and operation of our present invention will be readily comprehended by persons skilled in the art without further description. Although the invention has been herein shown and described in a simple and practicable form, it is recognized that certain parts thereof are representative of other parts which may be used in substantially the same manner to accomplish substantially the same results. Therefore, it is to be understood that the invention is not to be limited to the exact details described herein, but is to be accorded the full scope and protection of the appended claims.

We claim:

1. In an electromagnetic device, a frame comprising spaced upper and lower plates, a plurality of spaced upstanding legs secured to the plates and projecting below the lower plate, a pair of upstanding magnetizing coils positioned within the confines of the plates and the legs, a core assembly comprising a first member secured to the frame and including a web disposed above the coils and a pair of spaced arms depending from the web, each arm extending through a corresponding coil, and a pair of second members, each second member including a portion which extends through a corresponding coil and a portion which is wider than the first-mentioned portion and which is disposed beneath the lower plate and serves as a pole piece, each second member bearing against and being secured to a corresponding arm of the first member, an armature unit positioned below and secured to the lower plate comprising an armature that is pivotal relative to the frame and that includes a pair of spaced parts each of which is cooperatively associated with a corresponding pole piece, biasing means normally urging the armature in one direction of rotation relative to the frame and maintaining said armature parts in a position away from the pole pieces, the armature being adapted, upon energization of the coil, to be moved in a reverse direction against the action of the biasing means by magnetic attraction between the pole pieces and said armature parts, and a plurality of spaced resilient fingers carried by and projecting generally outwardly of the frame, said fingers being adapted to effect frictional engagement with the inner surface of the side wall of a cover unit that is adapted to encase parts of the device.

2. In an electromagnetic device, support means, a pair of upstanding magnetizing coils carried by the support means, a core assembly comprising a first member secured to the support means and including a web disposed above the coils and a pair of spaced arms depending from the web, each arm extending through a corresponding coil, and a pair of second members, each second member including a portion which extends through a corresponding coil and a portion which is wider than the first-mentioned portion and which is disposed beneath a corresponding coil and serves as a pole piece, each second member bearing against and being secured to a corresponding arm of the first member, an armature unit comprising a bracket secured to the support means and including a pair of spaced flanges, an armature positioned between the flanges and including a pair of spaced parts each of which is cooperatively associated with a corresponding pole piece and connector means pivotally connecting the armature to the bracket, said connector means comprising a pair of spaced ball elements, each ball element engaging a flange of the bracket and a corresponding portion of the armature, and biasing means normally urging the armature in one direction of rotation relative to the support means and maintaining said armature parts in a position away from the pole pieces, the armature being adapted, upon energization of the coil, to be moved in a reverse direction against the action of the biasing means by magnetic attraction between the pole pieces and said armature parts.

3. An electromagnetic device according to claim **2** wherein each ball element is affixed to a flange of the bracket and registers with an opening formed in a corresponding portion of the armature.

4. In an electromagnetic device, a frame comprising spaced upper and lower plates, a plurality of spaced upstanding legs secured to the plates and projecting below the lower plate, a plurality of spaced resilient fingers carried by and projecting generally outwardly of the frame, said fingers being adapted to effect frictional engagement with the inner surface of the side wall of a cover unit that is adapted to encase parts of the device, a pair of upstanding magnetizing coils positioned within the confines of the plates and the legs, a core assembly comprising an inverted U-shaped first member secured to the frame and including a web disposed above the coils and a pair of spaced arms depending from the web, said arms being parallel and offset, each arm extending through a corresponding coil, and a pair of inverted T-shaped, planar, second members, each second member including a stem element which extends through a corresponding coil and a cross element which is disposed beneath the lower plate and serves as a pole piece, said cross elements being parallel and offset each second member bearing against and being secured to a corresponding arm of the first member, an armature unit comprising a bracket positioned beneath and secured to the lower plate, said bracket including a pair of spaced flanges, an armature positioned beneath the flanges and including a pair of spaced, parallel, offset parts each of which is cooperatively associated with a corresponding pole piece and connector means pivotally connecting the armature to the bracket, and biasing means normally urging the armature in one direction of rotation about its pivotal connection and maintaining said armature parts in a position away from the pole pieces, the armature being adapted, upon energization of the coil, to be moved in a reverse direction against the action of the biasing means by magnetic attraction between the pole pieces and said armature parts.

5. An electromagnetic device according to claim **4** wherein the connector means comprises a pair of spaced ball elements, each ball element being affixed to a flange of the bracket and registering with an opening formed in a corresponding portion of the armature.

6. An electromagnetic device according to claim **4** wherein the biasing means comprises a permanent magnet which is carried by the frame.

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