

May 27, 1958

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2,836,674

ROTARY RELAY

Filed Nov. 26, 1954

2 Sheets-Sheet 1

FIG. 1

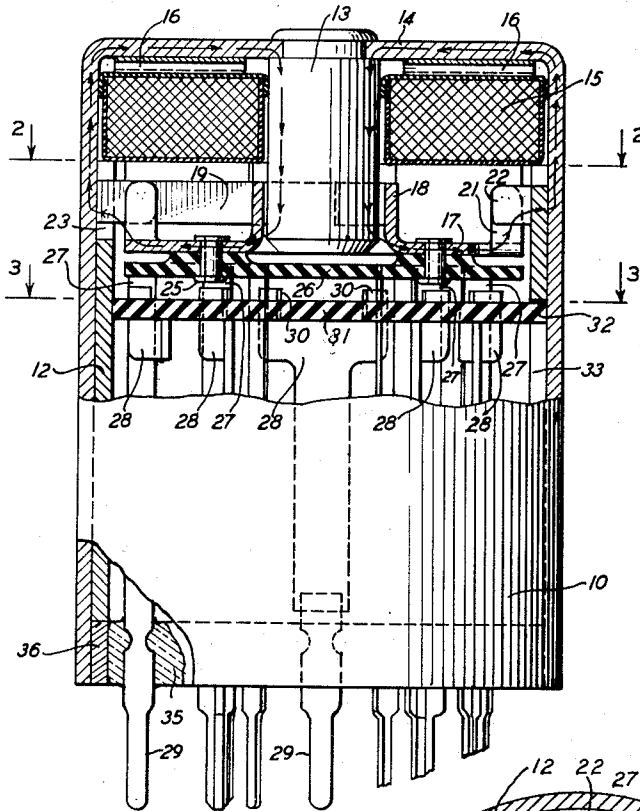


FIG. 2

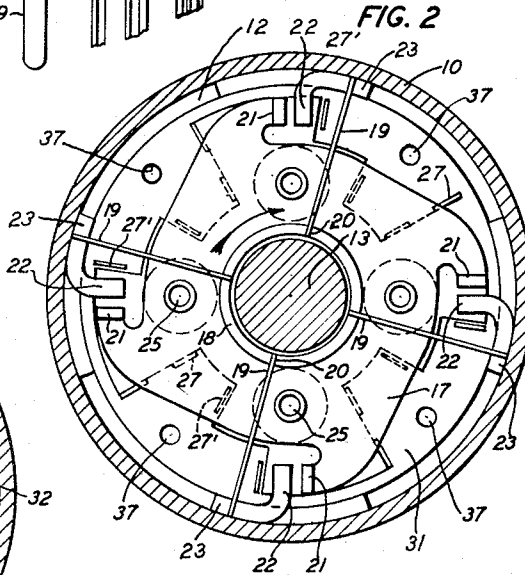
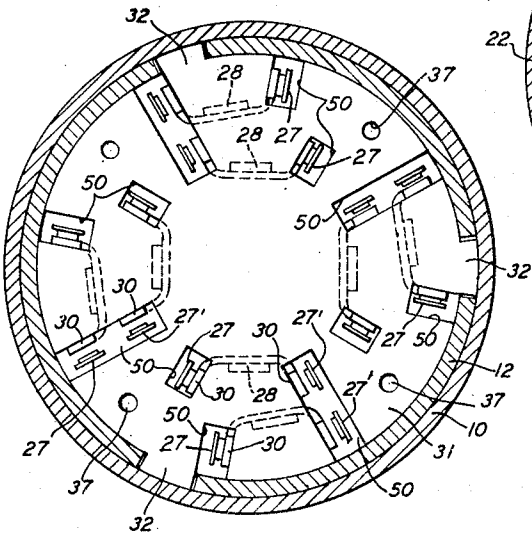


FIG. 3



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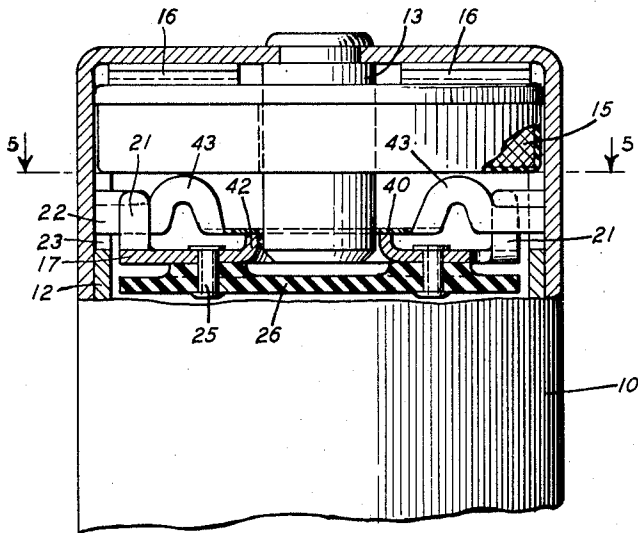
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## ROTARY RELAY

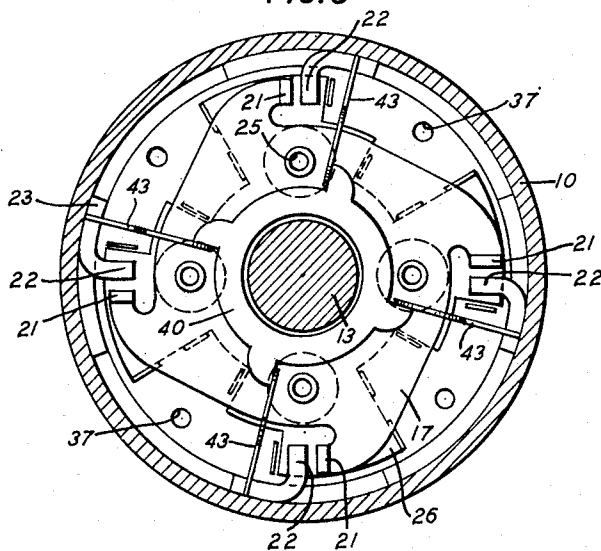
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**FIG. 4**



**FIG. 5**



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## ROTARY RELAY

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8 Claims. (Cl. 200—87)

This invention relates to electromagnetic switching devices and particularly to dynamically balanced relays of the rotary armature type.

In general, electromagnetic switching devices function to control the continuity of electric circuits by causing contact-bearing springs to be moved, under the action of an armature, into or out of engagement with stationary contact-bearing springs. Frequently, such devices are used under conditions which expose them to shock which results in abnormal armature vibrations and spring deflections and causes false and untimely circuit operations.

So-called "shock proof" relays have been designed in the past and in those instances wherein the result attained is substantial immunity to shock, the devices are generally characterized by a reduced sensitivity in operation, are limited to relatively small contact capacities and otherwise embody mechanical complexities which render the resulting structures impractical for general use.

It is one object of this invention to provide an improved dynamically balanced switching device, or relay, which is inherently insensitive to linear and non-linear shock and which is otherwise immune to conditions encountered in use which tend to cause false and untimely contact operation.

This object is attained in accordance with a feature of the invention by the use, in a circuit controller of the electromagnetic type, of a rotary, bearingless armature which is frictionally disassociated from the core both when the controller is unoperated and during the course of movement of the armature. More particularly, the controller, or relay of this invention comprises a stationary cylindrical core supporting an energizing coil, stationary pole-pieces, a substantially annular armature having pole-pieces and a centrally located collar portion, and means in the nature of leaf springs for rotatably supporting the armature at spaced intervals about its periphery and in a position such that the collar portion thereof circumscribes an end portion of the core and is held in spaced proximity thereto and its pole-pieces are maintained in normal relation to the stationary pole-pieces.

Another feature of the invention contemplates armature mounting springs which are of adequate stiffness to resist response of the armature to linear and non-linear shock and to otherwise preclude lateral or other abnormal shifting of the armature, and which are nevertheless, of such flexibility as to impart to the structure a high sensitivity to normal actuating forces.

A further feature of the invention resides in an arrangement of fixed and movable contacts which greatly increases the contact capacity of the relay and otherwise contributes to its overall shock proof character.

A still further feature of the invention provides a dynamically balanced relay which is small in size, compact, structurally simple in design, accurate in response and whose various components are readily accessible for maintenance and adjustment purposes.

These and other features of the invention will be readily understood from the following detailed description

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when read with reference to the accompanying drawing, in which:

Fig. 1 is a vertical elevation of the relay or circuit controller of this invention with a portion of the outer casing broken away to disclose the armature mounting, magnetic circuit and contact arrangement;

Fig. 2 is a horizontal section of the relay shown in Fig. 1 taken along the line 2—2 and looking in the direction of the small arrows;

Fig. 3 is a horizontal section of the relay shown in Fig. 1 taken along the line 3—3 and looking in the direction of the small arrows;

Fig. 4 is a vertical elevation of an upper portion of a modification of the relay shown in Fig. 1 and illustrates, particularly, an alternate form of armature mounting; and

Fig. 5 is a horizontal section of the relay shown in Fig. 4 taken along the line 5—5 and looking in the direction of the small arrows.

Referring now particularly to Figs. 1, 2 and 3 of the drawing, the relay of this invention includes an outer inverted cup-shaped shell 10 of magnetic material which is disposed in telescopic relation to an inner sleeve member 12, also of magnetic material.

A right circular cylindrical member 13 serves as a relay core and is centrally mounted on the base 14 of the cup-shaped shell 10 in any suitable manner so as to project from the base within the shell and assume a rigid position with respect to the shell. An exemplary method of mounting the core 13, as illustrated, contemplates a narrow shank or neck portion formed integrally with the main body portion of the core which extends through a centrally disposed aperture in the shell base and has its outer end turned over, rivet fashion, to effect a fixed association of the core and shell.

Near its upper end the core 13 supports an annular coil 15 whose outer lower edge abuts the upper edge of the inner sleeve 12. The coil is held in fixed association with the inner shell 12 by means of a ring-shaped spring washer 16 which is interposed between the upper face of the coil and the under surface of the shell base 14.

A disc-like armature 17 of magnetic material is stamped or otherwise formed of sheet metal and is generally annular in configuration. Its inner circular edge is turned in to effect a circular collar or shoulder portion 18 having an internal diameter only slightly in excess of the external diameter of the core 13. The armature 17 is supported in such a manner, with respect to core 13 by means of four thin flat spring members 19, that the collar portion 18 thereof circumscribes a lower portion of the core as indicated above and as clearly shown in Fig. 1. The collar or shoulder portion 18 of the armature is provided with four vertical slots 20 disposed about the collar at 90-degree intervals. In each of these slots is secured the inner end of one of the mounting springs 19.

The armature 17 is provided, near its outer periphery, with four projections 21, which extend perpendicular to its surface. These projections lie in spaced proximity to the face of four return pole-pieces 22 which are formed integrally with the inner sleeve 12 and extend a short distance radially inwardly toward the core 13. The spacings between juxtaposed faces of the pole-pieces 22 and the corresponding armature projections 21 constitute air gaps in the magnetic circuit of the relay.

A vertical slot 23 is cut in the inner sleeve 12 near each of the four pole-pieces 22, each in individual radial alignment with one of the slots 20 in the raised shoulder portion 18 of the armature 17. In the slots 23 are secured the outer ends of the flat springs 19. The springs 19 support the armature in proper position, permit the armature to be rotated into its operated position when the relay coil 15 is energized, and restore the armature

to its unoperated position upon deenergization of the coil.

Fixed to the inside of the armature by means of spaced rivets 25 is a rotary card 26 of insulating material. The rivets 25 rigidly mount the card 26 on the armature 17 so that the two rotate as a unit. As illustrated, the card 26 is provided with four bosses which serve to space the card from the armature and to provide additional thickness of material at the rivet points.

The rotary card 26 functions to move a series of movable contact springs, sixteen in the exemplary model illustrated, into and out of engagement with a corresponding number of fixed contacts. These contacts, 27 and 27', are carried on the upper ends of elongated springs which pass through suitable apertures 50 in a stationary card 31 located below the rotary card 26 and which are welded or otherwise fixed to spring terminals 29. The contacts 27 of the exemplary model illustrated, are "break" contacts while those designated 27' are "make" contacts. Four of each contact type are located in each of two concentric rows.

Each of the mating or complementary stationary contacts 28, as shown in Figs. 1 and 3, comprises an elongated flat spring welded at its lower end to a spring terminal 29 and terminating at its upper end in two joined spaced projections 30 which protrude through apertures 50 in the fixed card 31. The card 31 is provided with suitably spaced lateral projections or keys 32 which fit a corresponding number of similarly configured slots or key ways 33 in the inner sleeve member 12. Thus the stationary contacts are held in fixed position and are incapable of any chatter or untimely response to shock which would otherwise cause them to make false contact with their mating movable springs.

Each of the stationary spring units 28, as indicated above, is welded or otherwise secured to a spring terminal 29, which spring terminals, in turn, are embedded in a base 35 of glass or other suitable insulating material. The base 35 is circumscribed by the base ring 36. The latter forms an abutting edge which meets the lower edge of the inner sleeve 12 when the relay components are assembled and over which the lower end of the outer shell 10 fits in telescopic relation.

A series of holes 37 in the fixed plate 31 provides means for wiring the coil 15 to corresponding spring terminals 29.

When the coil 15 is energized, the generated magnetic flux traverses the paths indicated by the arrows in Fig. 1. This path includes the air gaps between adjacent armature projections 21 and pole-piece projections 22. The armature 17 and card 26 thereupon experience a clockwise rotational movement causing engagement of "make" contacts 27' with corresponding stationary contacts 30 and the disengagement of "break" contacts 27 with corresponding stationary contacts 30 and the disengagement of "break" contacts 27 from corresponding stationary contact elements 30, as clearly indicated in Fig. 3.

Due to the confinement of the ends of armature mounting springs 19 in the slots 20 and 23, the springs flex and offer little resistance to the armature in its rotational movement. Upon deenergization of the coil 15, the springs 19 function to restore the armature to its normal position.

As appears more clearly in Fig. 2, the movable card 26 is so configured as to provide a multiplicity of radial edges which cooperate with the movable springs in such a manner that when the armature is rotated, certain of the edges engage some of the movable springs and move them out of engagement with associated fixed springs and certain other of the edges release certain other movable springs and permit them to engage corresponding fixed springs. The movable contact springs are normally biased in the direction of their corresponding stationary contacts so that, in the case of the "break" contacts, the

movable springs are moved by the card 26 against the biasing force to effect contact separation and, in the case of the "make" contacts, the movable springs are released to effect contact closure.

It will be observed that the fixed card 31 is held against rotary displacement because of the confinement of the keys or lugs 32 in the slots 33. It will be observed also that the upper faces of these lugs abut the sleeve edges which determine the upper limits of the slots 33 and thus preclude upward movement of the card from the position it occupies in Fig. 1. The card 31 is prevented from being downwardly displaced from the illustrated position because of the engagement of the undersurface of the card with the bridging portions of the stationary springs 28 which interconnect the contact portions 30 of the springs as clearly indicated in Fig. 3.

Reference is now made to Figs. 4 and 5 which illustrate a variation of the armature mounting arrangement shown in Figs. 1 and 2. The armature mounting spring, exemplarily illustrated in Figs. 4 and 5, is a single punching comprising a substantially annular central portion 40 and a plurality of integrally formed spaced arms projecting radially therefrom. The annular portion 40 of the spring may be welded or otherwise secured to the body portion of the armature or to the rim edge of the armature collar 42 as illustrated. Each projecting arm is arched at 43 and otherwise formed so that it occupies a plane at right angles to the plane of the ring-shaped portion 40. The outer spring ends, in the exemplary form illustrated, are secured in slots 23 in the inner sleeve member 12. The relay of Figs. 4 and 5 functions in the manner described in connection with the operation of the relay of Figs. 1, 2 and 3. The effect of the arched spring is one of increased length which increases the sensitivity of the relay without decreasing the effectiveness of the spring in preventing displacement of the armature by shock.

While the exemplary forms of armature mountings illustrated, show the outer ends of the radially extending arms secured in slots in the sleeve member 12, it is understood that any suitable method of anchoring them to the sleeve may be resorted to. For example, they may be individually welded or otherwise fixed to the sleeve or may terminate in a common integral ring which, in turn, may be spot welded or otherwise secured to the inner face of the sleeve member.

The relay of this invention readily lends itself to moisture- and gas-proofing. To this end the coil 15 may be sealed in its own metal or gas-proof container or compartment 55 and a seal of solder or other suitable material applied at the junction of the base ring 36 and the outer shell 10. Also the fixed and rotary cards 31 and 26 may be made of ceramic or otherwise of inert material.

It is apparent that the relay of this invention is particularly suitable for use under conditions requiring moisture- or gas-proof equipment; provides a circuit controller which is substantially immune to false operation resulting from shock; is simple and compact in design thus rendering it particularly desirable for use in circumstances where size and weight are basic considerations; and is one in which the general component layout lends itself to simplified maintenance methods, inspection and adjustment. All these desirable characteristics, including large contact capacity, are obtained, furthermore, without a reduction in the overall sensitivity of the relay. Furthermore, wear is reduced to a minimum since the only points at which wear is possible are between the rotary card and the movable contact springs. The rotary armature is pivoted without the conventional bearing and without introducing slide or wipe thereby eliminating variable friction and sticking.

What is claimed is:

1. An electromagnetic relay comprising a core, a magnetic circuit including fixed elements having pole-pieces,

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means comprising a coil carried by said core for establishing a difference of magnetic potential between said core and said pole-pieces, a rotatable armature controllable by the established magnetic potential, and means physically independent of said core for mounting said armature for rotation about its center axis in spaced relation to said core and to said pole-pieces comprising a plurality of spring members interconnecting said armature and said pole pieces and radially disposed with respect to the axis of rotation of said core.

2. An electromagnetic relay according to claim 1 in which said spring members constitute flexible couplings between said armature and the fixed elements of said magnetic circuit.

3. An electromagnetic relay according to claim 1 in which one end of each of said spring members is secured to a different point on said armature and the other end of each of said spring members is secured to a different point on fixed elements of said magnetic circuit.

4. An electromagnetic relay according to claim 1 which includes contact springs, and means carried by said armature for operating said contact springs.

5. An electromagnetic relay comprising a coil, a cup-shaped magnetic element having a base, a core mounted on said base and located within said coil, a magnetic sleeve contiguously associated with said cup-shaped element and having integrally formed pole-pieces, a ring-shaped armature disposed for rotation about one end of said core and having a centrally located collar portion circumscribing the said one end of said core, pole-pieces fixed to said armature, and means for maintaining said armature in fixed spaced relation to said magnetic sleeve, the collar portion thereof in fixed circumscribed relation to said core and the pole-pieces of said sleeve and armature in spaced proximity, comprising spring members fixed solely to and interconnecting said armature and said magnetic sleeve.

6. In a relay structure, a mounting for a rotatable ring-shaped armature having a collar disposed at right angles to the main body portion thereof and circumscribing one end of a fixed cylindrical core, comprising a punching of spring material having a center ring-shaped portion fixed to said armature in circumscribed relation to said core, and a plurality of integrally formed arms extending radially therefrom in a direction away from said core and anchored at their outer ends to the relay structure.

7. A mounting for a rotatable armature according to

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claim 6 in which the said ring-shaped portion of said spring material occupies a plane parallel to the plane of said armature and the said integrally formed arms occupy divergent planes at right angles to the plane of said ring of spring material.

8. In a relay, the combination of a cup-shaped housing of magnetic material having a closed end and an opening, a base of insulative material enclosing said opening, contact springs embedded in said base and extending in parallel array into said housing, means including an insulating card rigidly supported within said housing and fixedly terminating the inner ends of certain of said springs in spaced relation to each other, a second insulating card in juxtaposed position relative to said first card and having apertures therein to permit the inner ends of certain other of said springs to protrude therethrough in close proximity to the inner ends of said first springs and to the inner edges of the apertures in said second card whereby said second card, when rotated, functions to move the inner ends of said second springs relative to the inner ends of said first springs to control electric circuits, a cylindrical magnet core fixed to the closed end of said cup-shaped housing and projecting into said housing with its longitudinal axis coincident with the longitudinal axis of said cup-shaped member, pole-pieces magnetically associated with the sides of said housing, means comprising a coil circumscribing a portion of said core for developing a difference of magnetic potential between said core and said pole-pieces, an armature fixed to said second insulating card, and means mounting said armature for rotation about an axis coincident with the longitudinal axis of said core comprising a plurality of leaf springs each physically independent of said core having one end thereof fixed with respect to said housing and the other end of each thereof fixed to said armature.

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