

Sept. 24, 1957

F. FISCHER ET AL
ELECTROMAGNETIC RELAY

2,807,688

Filed Nov. 26, 1954

2 Sheets-Sheet 1

FIG. 2

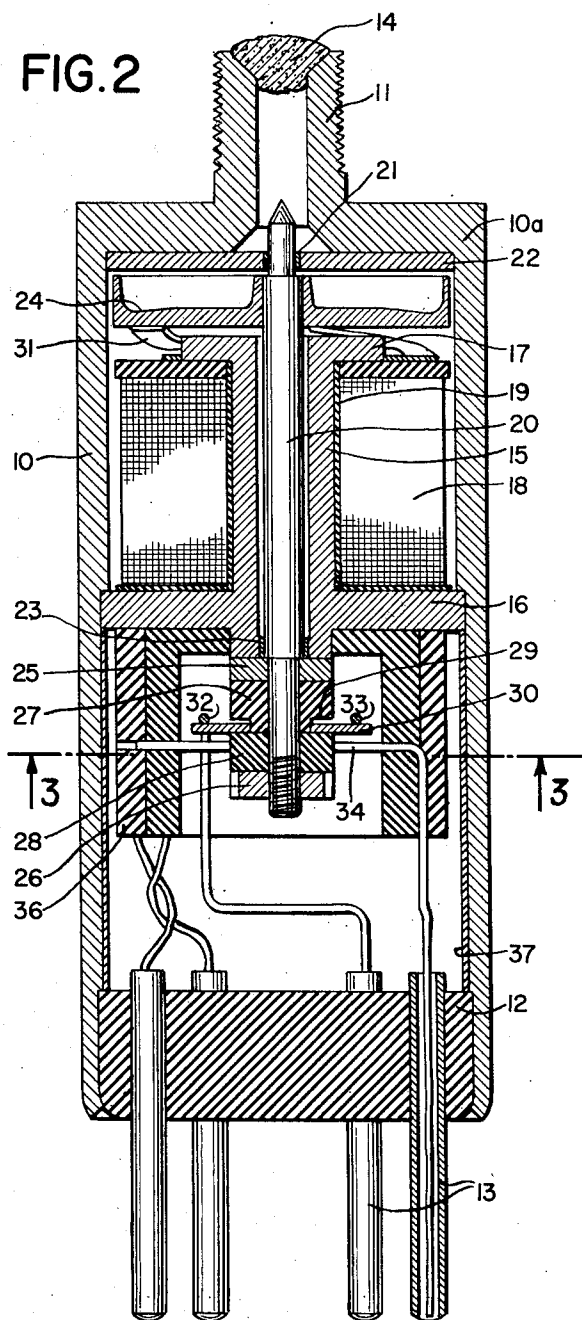
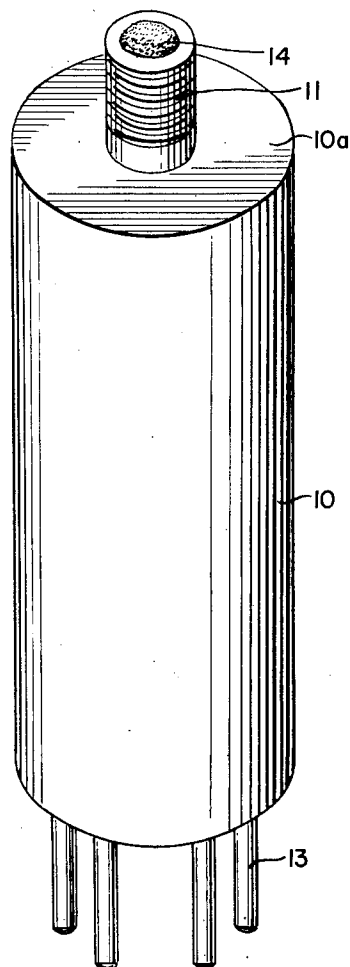


FIG. 1



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FIG. 3

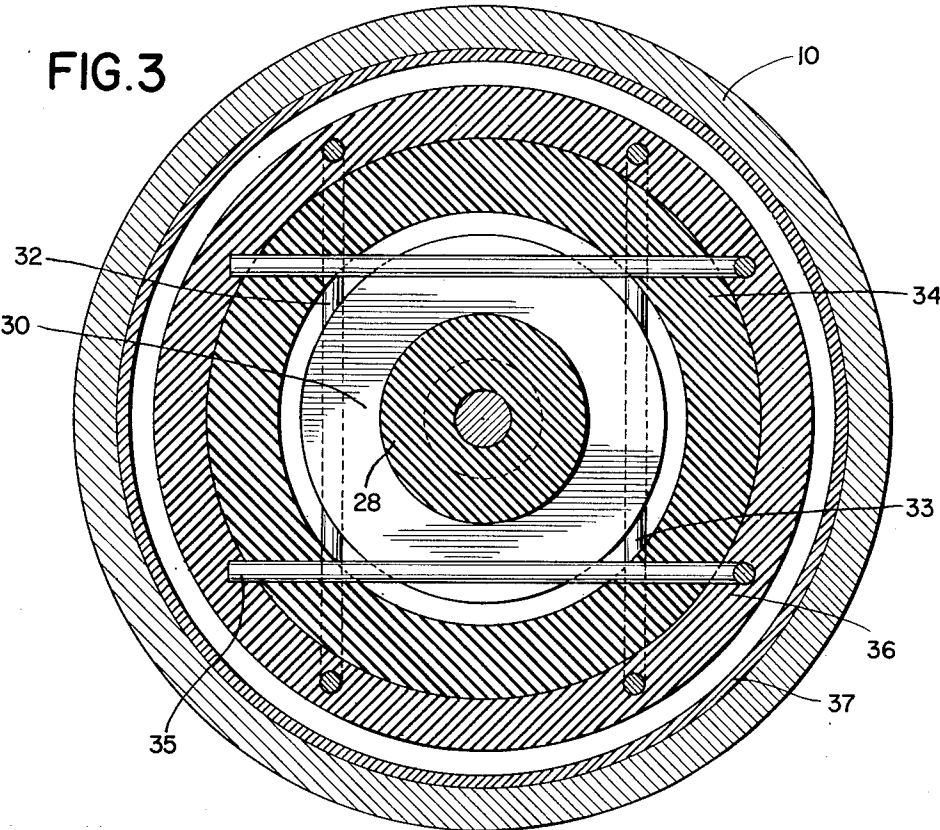


FIG. 4

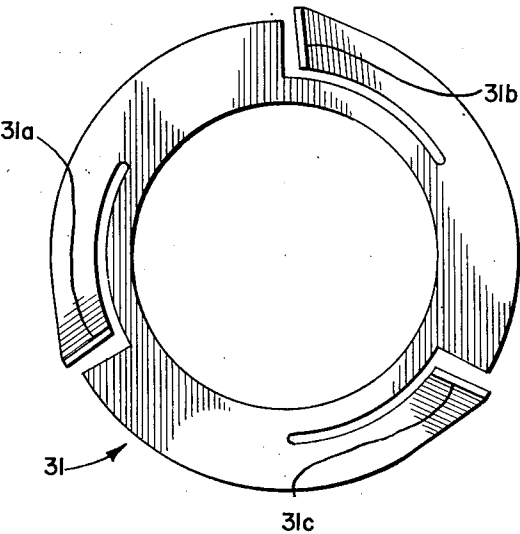
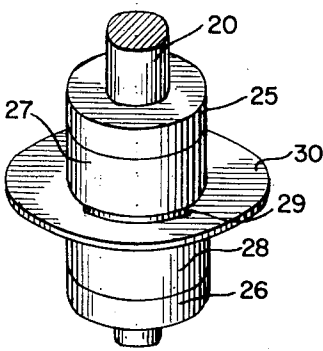


FIG. 5



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ELECTROMAGNETIC RELAY

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6 Claims. (Cl. 200—87)

The present invention relates generally to electromagnetic relays, and more particularly to an improved relay structure of high sensitivity adapted to control current flows of relatively large intensity.

In relays of conventional design, a movable contact is caused to engage one or more fixed contacts, whereby each time the relay is energized a predetermined area on the surface of the moving contact is urged against the fixed contact. As a consequence, with repeated actuation of the relay the engaging surfaces of the fixed and moving contacts tend to wear down and deteriorate, particularly when the switching action is accompanied by arcing phenomena. Thus, however well constructed the relay is in other respects, the short life of the relay contacts constitutes a distinct drawback.

Moreover, where the movable or bridging contact is adapted simultaneously to press against a pair of fixed contacts lying in the same plane, the movable contact tends to make a somewhat better electrical connection with one fixed contact than with the other. This condition arises by reason of the fact that the fixed contacts, unless very carefully adjusted, are not precisely in the same plane. In a conventional relay the movable contact is rigidly mounted and is unable to accommodate itself to variations in the positions of the fixed contacts. Other factors tending to impair the reliability of a relay are the presence of dirt and moisture which interfere with the proper functioning of the relay mechanism. Accordingly, it is the primary object of this invention to provide an efficient relay of simple construction and having a high order of reliability in operation.

More specifically, it is an object of the invention to provide a relay which is exceptionally compact in size and which will function in situations where available operating voltages or currents are materially limited. A relay in accordance with the invention may be made to match the size of a sub-miniature vacuum tube and yet have a large current-carrying capacity.

It is also an object of the invention to provide an electromagnetic relay having a movable bridging contact in cooperative relation with at least one pair of fixed contacts, the arrangement being such that with each actuation of the relay a different area on the surface of the bridging contact is caused to engage the fixed contacts. A significant feature of the invention resides in the fact that the bridging contact, with each actuation of the relay, is caused to shift angularly as well as to move axially in a direction effecting engagement with the fixed contacts.

Still another object of the invention is to provide a relay of the above-described type wherein the bridging contact is tiltable so as to make effective engagement with the fixed contacts despite variations in the positions of the fixed contacts relative to the bridging contact.

It is yet another object of the invention to provide a relay having an outer casing of magnetizable material which fully shields the relay structure from external mag-

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netic fields. Another important aspect of the invention is that the outer casing also forms part of the magnetic circuit of the relay.

A further object of the invention is to provide a relay structure which is gas-filled and hermetically sealed, whereby the relay mechanism is shielded from rust, dirt and moisture. A relay in accordance with the invention is formed of easily fabricated elements, which elements may be assembled with a minimum of difficulty and expense.

Briefly stated, a relay in accordance with the invention is constituted by a hollow core surrounded by a solenoid, a plunger extending through the core and supporting an armature at one end and a tiltable movable contact at the other end, whereby said armature effects an axial movement of said plunger and said movable contact when said solenoid is excited. Means are also provided to impart a rotational movement to said armature when said armature is displaced axially, whereby with each engagement a different area of the movable contact is active.

For a better understanding of the invention, as well as further objects and features thereof, reference is made to the following detailed description to be read in connection with the accompanying drawings, wherein like components in the several views are identified by like reference numerals.

In the drawing:

Fig. 1 is a perspective view of an assembled electromagnetic relay embodying the present invention.

Fig. 2 is an enlarged longitudinal cross-sectional view of the relay shown in Fig. 1.

Fig. 3 is a transverse cross-sectional view taken along the line 3—3 in Fig. 2.

Figure 4 is a plan view of the spring incorporated in the relay structure.

Fig. 5 is a perspective view solely of the bridging contact assembly.

Referring now to the drawings and more particularly to Figs. 1 and 2, there is shown an electromagnetic relay in accordance with the invention comprising a cylindrical outer casing 10, formed of magnetizable material, such as soft iron. The casing is closed at the upper end by a closure disc 10a integral therewith. The closure is provided with a tubular cap 11 formed centrally thereon, which is externally threaded. The lower end of casing 10 is enclosed by a cylindrical insulating base 12 having a plurality of terminal prongs 13 embedded therein and extending therefrom. The tubular cap 11 is sealed by a fusible plug 14 of tin or similar material through which a small hole has been drilled for the purpose of evacuating the casing and thereafter filling the relay with an inert gas under pressure. The externally threaded cap facilitates the union of the relay casing to a vacuum pump or to a container of compressed gas, and when the relay is filled the fusible plug may be sealed off by heat. The insulating base 12 is held in the casing 10 with a tight fit and rests against a suitable shoulder formed in the internal wall of the casing. The base may be secured in place by spinning over the lower end of the casing, or by the use of a suitable cement.

Concentrically disposed within the cylindrical casing 10 is a hollow magnetizable core 15 of ferromagnetic material, such as soft iron. The core is supported within the upper section of casing 10 by means of a disc-shaped flange 16 extending outwardly from the lower end of the core and abutting a shoulder formed in the internal wall of the casing, whereby the core and casing are magnetically associated. The upper end of core 15 is provided with a circular flange 17 constituting one pole piece of the magnetic circuit, the opposing pole piece

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thereof being defined by the closure 10a of the casing 10 which is magnetically connected to the lower flange 16 of the core.

Surrounding core 15 is a solenoid 18 which is wound about an insulating spool 19. Extending through the longitudinal bore in core 15 is a plunger shaft 20. The upper end of shaft 20 is journaled in a sliding-bearing 21 formed in a non-magnetic circular plate 22, mounted against the closure 10a of the casing, and preferably made of brass. The lower end of shaft 20 is journaled in a sliding-bearing 23 formed in the lower end of shaft 20. Thus, the plunger shaft 20 is slideable axially in the core and is also free to rotate.

Secured to the upper end of shaft 20 and operative within the air gap defined between pole piece 17 and closure 10a is an armature 24. Armature 24 is disc-shaped, the underside thereof being flat, the upper portion thereof being hollowed out to reduce the weight of the armature.

Attached to the lower end of shaft 20 is a bridging contact assembly consisting of two non-magnetic metallic rings 25 and 26, preferably of brass, between which are tightly clamped two collars 27 and 28 formed of insulating material. An annular recess 29 is cut into the lower end of the upper collar 27 in order somewhat loosely to accommodate a disc-shaped bridging contact element 30, fabricated of silver or any other highly conductive metal suitable for use as a switching contact. The small amount of play allowed contact element 30 in the annular recess 29 affords sufficient freedom to permit rotation or tilting thereof through a small angle.

Surrounding pole piece 17 and resting on the upper cheek of the insulating spool 19 is a spring member 31, which, as best seen separately in Fig. 4, is formed by a ring of flat, resilient metal having three equally spaced fingers 31a, 31b, and 31c. The fingers extend upwardly to engage the flat underside of armature 24. The spring member may be fabricated from the flat metal by cutting radial and arcuate slots therein at points spaced at 120° from each other and then bending the resultant fingers upwardly.

When the solenoid 18 is excited by an applied voltage, armature 24 is drawn downwardly against the pressure of the spring fingers. The downward movement of armature 24 is transmitted by plunger shaft 20 to the bridging contact element 30. The de-energization of the solenoid results in the upward movement of the armature, the armature being lifted by the action of the spring fingers. The underside of armature 24 is planar and normal to the vertical axis of plunger shaft 20, whereas the spring fingers, when fully raised, occupy an oblique angle relative to the surface of the armature. Hence, upon energization of the relay, as the armature is brought to bear against the spring fingers it tends to rotate as well as to shift in the axial direction. When spring member 31 is not compressed, the projection of its length on the plane of the armature is shorter than the projection of its length when it is compressed by the axial movement due to energization of the solenoid. The spring fingers therefore drive the armature by friction and act like a pawl. This complex movement is transmitted to bridging contact 30.

Two pairs of fixed contacts are provided, one pair being disposed above and the other below bridging contact 30. The upper pair is constituted by wires 32 and 33, and the under pair by wires 34 and 35. The fixed contact wires are supported transversely in a tubular insulation block 36, which depends from the lower end of core 15 and coaxially surrounds the bridging contact assembly. Wires 34 and 35, as best seen in Fig. 3, extend in parallel paths in a common plane on either side of insulation collar 26, the wires being suitably spaced to clear the collar. Similarly, wires 32 and 33 extend in parallel paths perpendicular to wires 34 and 35 and on either side of insulation collar 27. The position of wires 32 and 33 is such

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as to engage the movable bridging element 30 at the rest position of the element when the relay is de-energized. The position of wires 34 and 35 is such that when the relay is energized they are engaged by bridging element 30 in the downward or operative position.

Each contact wire is provided with an integral extension which passes longitudinally through the wall of insulation block 36 and terminates in a respective pin or prong 13, to which it is soldered. Thus, as shown in Fig. 2, contact wires 34 and 32 are provided with integral extensions 34a and 32a, respectively. If desired, the terminal prongs 13 may be eliminated entirely and the contact wire extensions brought directly out of insulation base 12 for connection to an external circuit. In a similar fashion the leads from solenoid 18 may be connected to suitable prongs or brought out directly to the base. Casing 10 is provided with an internal insulating liner 37 which extends from the underside of flange 16 to base 12 and acts to protect the switching circuit and to prevent the axial displacement of core 15.

In operation, when the relay is energized, contact element 30 is caused to engage fixed contact wires 34 and 35, the contact element 30 tilting to an extent which will accommodate the surface thereof to that of the fixed contacts. Thus, the position of the fixed contacts is by no means critical, and small changes therein which might occur with continued use of the relay will in no way preclude an effective electrical connection. Tilting of the contact element 32 will also occur when it is released to engage fixed contact wires 32 and 33. Furthermore, inasmuch as element 30 is displaced angularly by reason of the action of the spring fingers, each time the relay is energized a different area of the contact element will be brought into engagement with the fixed contacts, thus distributing the wear on the bridging contact and substantially lengthening the effective life thereof.

It is important to note that there are no soldered or screw joints for electrical connection to the fixed contacts, nor are there flexible leads connected to the movable contact. An electrical connection is completed between the wires in a given pair of fixed contacts when they are bridged and interconnected by the movable contact 30. It will also be appreciated that the magnetizable casing 10 serves not only to shield the mechanism of the relay from external fields, but also functions as a return path for the magnetic circuit.

The relay entails a minimum number of components and may be readily assembled on a mass production basis, for the position of the fixed contacts therein is uncritical and need not be carefully adjusted. The relay may be constructed entirely of tubular or cylindrical parts, which parts can be turned on a lathe with great accuracy and at relatively low cost. As none of the parts is made by bending sheet metal, the overall design may be miniaturized without difficulty.

While there has been shown what at present is considered to be a preferred embodiment of the invention, it will be manifest that many changes and modifications may be made therein without departing from the essential concept underlying the invention. It is intended, therefore, in the annexed claims to cover all such changes and modifications that fall within the true scope of the invention.

What is claimed is:

1. An electromagnetic relay comprising a cylindrical casing of magnetizable material, a tubular core concentrically mounted within said casing and having at the lower end thereof an outwardly extending flange abutting the internal wall of said casing to effect a magnetic connection therewith, a solenoid surrounding said core, a plunger extending through said core, an armature mounted at the upper end of said plunger, said armature effecting axial movement of said plunger upon energization of said solenoid, a movable contact element supported on the lower end of said plunger, a fixed contact element coop-

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eratively positioned relative to said movable contact element, and a compressible spring interposed between the upper end of said solenoid and the underside of said armature to impart a rotational movement thereto when said plunger is displaced axially said compressible spring including circumferentially arranged upwardly extending resilient fingers engaging the underside of said armature frictionally to apply a torque thereto when said fingers are compressed upon energization of said solenoid.

2. An electromagnetic relay comprising a cylindrical casing of magnetizable material, a tubular core concentrically mounted within said casing and having at the lower end thereof an outwardly extending flange abutting the internal wall of said casing to effect a magnetic connection therewith, a solenoid surrounding said core, a plunger extending through said core and slideable therein, a disc-shaped armature mounted at the upper end of said plunger, said armature effecting axial movement of said plunger upon energization of said solenoid, said armature having a flat underside, a movable contact element tiltably supported on the lower end of said armature, a fixed contact element cooperatively positioned relative to said movable contact element, and a compressible spring interposed between the upper end of said solenoid and the underside of said armature to impart a rotational movement thereto when said plunger is displaced axially, said spring including three circumferentially-arranged upwardly extending resilient fingers engaging the underside of said armature frictionally to apply a torque thereto when said fingers are compressed upon energization of said solenoid.

3. An electromagnetic relay comprising a cylindrical casing of magnetizable material, the upper end of said casing being closed and terminating in a tubular cap adapted for evacuation of said casing, a tubular core concentrically mounted within said casing and having at the lower end thereof an outwardly extending flange abutting the internal wall of said casing to effect a magnetic connection therewith, said core having a second flange at the upper end thereof constituting a pole piece, a solenoid surrounding said core, a plunger extending through said core and slideable therein, an armature mounted at the upper end of said plunger, said armature having a flat underside, said armature effecting axial movement of said plunger upon energization of said solenoid, a tiltable movable contact element supported on the lower end of said armature, a fixed contact element cooperatively positioned relative to said movable contact element, a compressible spring interposed between the upper end of said solenoid and the underside of said armature to impart a rotational movement thereto when said armature is displaced axially, said spring including circumferentially arranged upwardly extending resilient fingers engaging the under side of said armature frictionally to apply a torque thereto when said fingers are compressed upon energization of said solenoid, and an insulating block en-

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closing the other end of said casing and provided with terminal prongs.

4. An electromagnetic relay comprising a cylindrical casing of magnetizable material closed at the upper end thereof, a tubular core concentrically mounted within said casing and having at the lower end thereof an outwardly extending flange abutting the internal wall of said casing to effect a magnetic connection therewith, a solenoid surrounding said core, a plunger extending through said core, an armature mounted at the upper end of said plunger, said armature effecting an axial movement of said plunger upon energization of said solenoid, a movable contact assembly supported on the lower end of said armature, fixed contact elements cooperatively positioned relative to said movable contact assembly, and a compressible spring member interposed between the upper end of said solenoid and the underside of said armature to impart a rotational movement thereto when said armature is displaced axially, said spring including circumferentially arranged upwardly extending resilient fingers engaging the under side of said armature frictionally to apply a torque thereto when said fingers are compressed upon energization of said solenoid, said assembly comprising a pair of non-magnetic metallic rings and a pair of insulating collars clamped between said rings, one of said collars having an annular recess therein, and a bridging contact element received loosely within said recess whereby said element is tiltable.

5. A relay, as set forth in claim 4, wherein said spring member is constituted by a flat annulus of resilient material having three radial slits therein displaced 120 degrees relative to each other and three displaced arcuate slits terminating in said radial slits to define three spring fingers which extend to the underside of said armature.

6. A relay, as set forth in claim 4, wherein said fixed contact elements are constituted by a first pair of substantially parallel wires on either side of said upper collar and a second pair of substantially parallel wires on either side of said lower collar, said tiltable contact element accommodating its surface to said wires.

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