# United States Patent

**De Lucia**

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[54] **HIGH VOLTAGE MINIATURIZED RELAY**


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[52] **U.S. Cl.** .....**335/131,** 200/144, 335/170, 335/229

[51] **Int. Cl.**.....**H01h 51/10**

[58] **Field of Search**.....335/170, 179, 154, 229, 131; 200/166 BA, 166 BH, 144 B, 16 A



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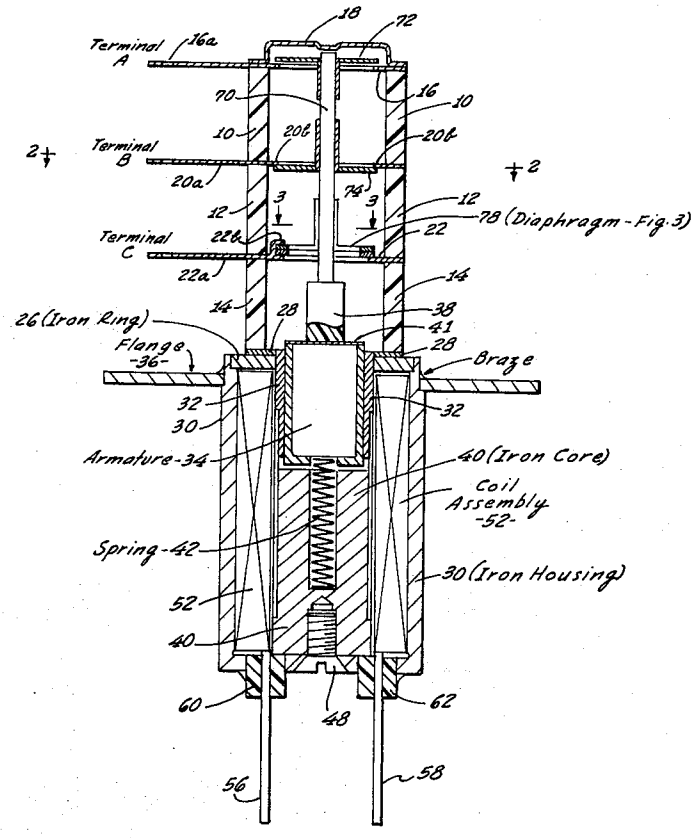
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[57] **ABSTRACT**

A high voltage relay is provided in which the operating components of the relay are enclosed in a sealed envelope which may be evacuated. The relay to be described is a miniaturized high voltage relay capable, for example, of operating at voltages up to 5 kilovolts, and in conjunction with relatively high frequencies. The envelope of the relay is composed of ceramic, and the relay is capable of efficient operation in wide extremes of ambient temperatures. The relay includes a linearly movable contact which makes connection with a fixed common electrical terminal through a resilient diaphragm which is constructed to permit free linear reciprocal movement of the movable contact and yet maintain a positive electric current to the common terminal.


**8 Claims, 4 Drawing Figures**



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SHEET 1 OF 2

Fig. 1

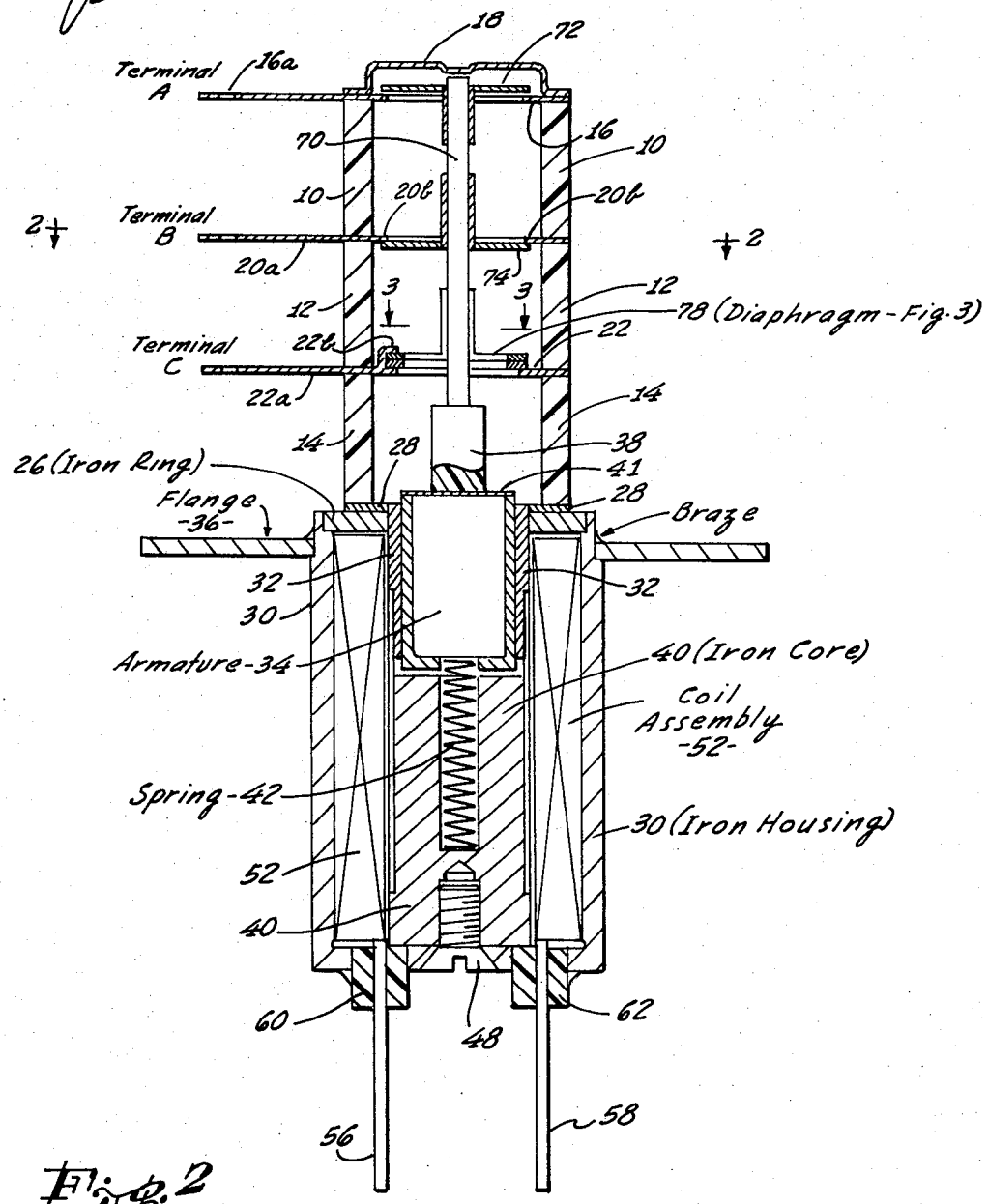
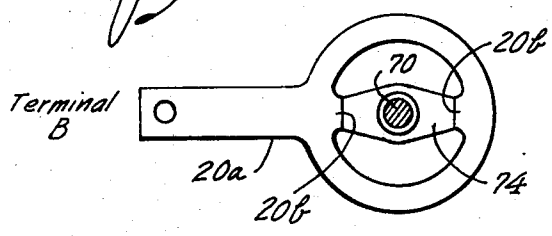



Fig. 2




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Fig. 3

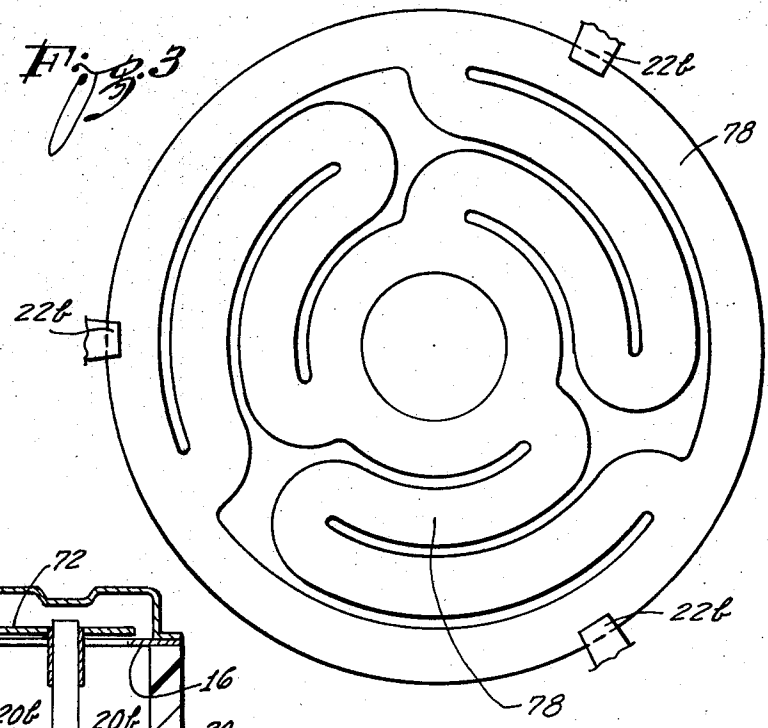
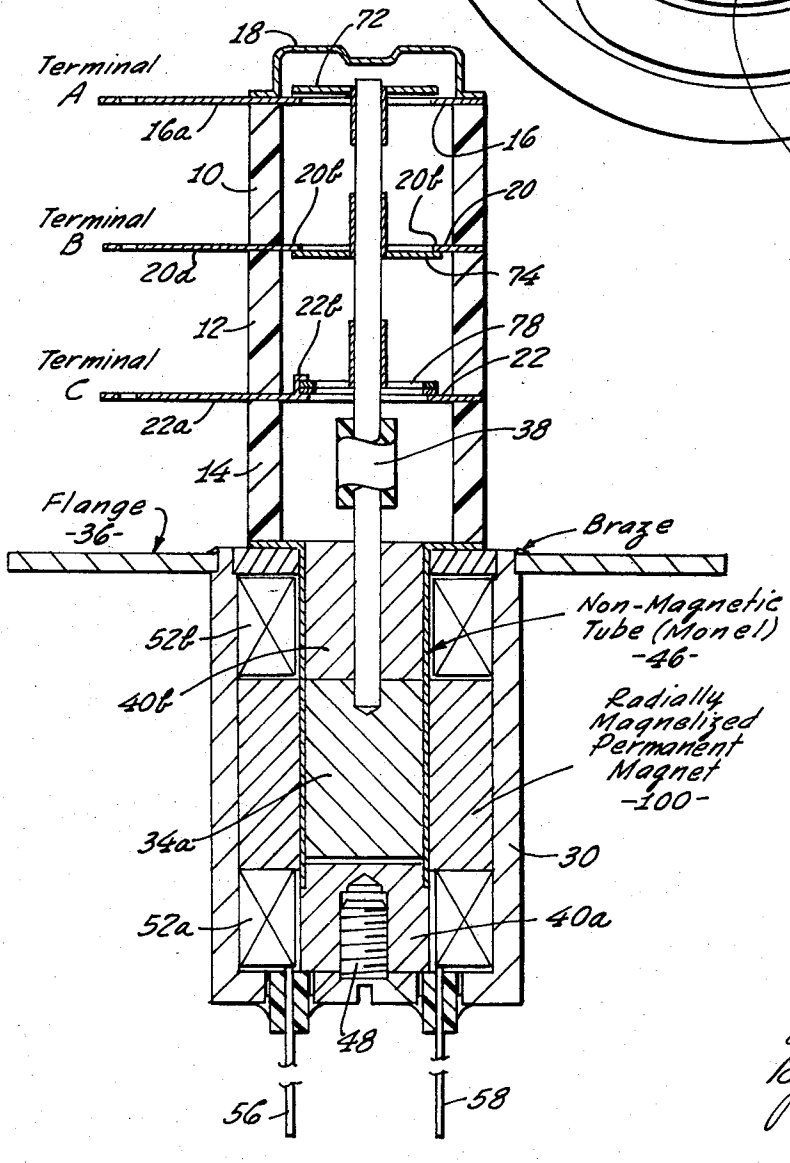



Fig. 4




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# HIGH VOLTAGE MINIATURIZED RELAY

## BACKGROUND OF THE INVENTION

Vacuum relays have achieved wide utility in the relay art, in that deterioration of the relay contacts is reduced to a minimum. This is because the absence of gases in the evacuated envelope of the relay obviates the formation of contact-eroding oxides to a material extent.

However, problems have been encountered in the prior art vacuum relays, including the problem of vaporized metal which is released by ion bombardment in the contact area and which has a tendency to weld the contacts together during the operation of the relay. Also, a problem has long existed in providing an adequate connection between the movable contact of the relay and the terminal connection to that contact, which connection is positive and continuous and not subject to arcing with a tendency to circuit discontinuity.

The relay of the present invention is constructed in an improved and simplified manner, and it has a reciprocally moving contact which establishes selective positive contact with the fixed contacts of the relay, and which also is connected to an improved resilient diaphragm to a common electrical terminal of the relay.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional representation of a relay constructed in accordance with one embodiment of the invention;

FIG. 2 is a cross-section, essentially along the line 2—2 of FIG. 1;

FIG. 3 is a cross-section, essentially along the line 3—3 of FIG. 1, on an enlarged scale, and illustrating a diaphragm element which is incorporated into the relay of FIG. 1; and

FIG. 4 is a side section of a relay representing a second embodiment of the invention, the relay of FIG. 4 incorporating a permanent magnet so as to constitute a latching relay.

## DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The relay of FIG. 1 includes a stack of cylindrical-shaped members **10**, **12** and **14** of electrically insulating material, such as ceramic, which are mounted in coaxial relationship with one another to constitute the envelope of the relay. The ends of each of the ceramic cylinders **10**, **12** and **14** are metallized. A first annular-shaped electrically conductive terminal member **16** is brazed to the upper end of the cylindrical member **10**, and a cap **18** is brazed over the top of the annular conductive terminal **16** to constitute an enclosing cover for the envelope. The cap **18** may be formed of nickel, or other appropriate material. The annular member **16** has an elongated portion **16***a* which extends out one side of the assembly to permit an electric connection to be made to the relay. The members **10**, **12** and **14** may, for example, be made of beryllium oxide which is a good electrical insulator, and yet is a good heat conductor for efficient heat transfer from the active elements of the relay.



A second annular terminal member **20** is brazed to the ends of the cylindrical members **10** and **12**, and it includes an elongated integral portion **20***a* which extends out from the side of the assembly, as shown, and which also forms a terminal connection for the relay. A third annular terminal member **22** is brazed to the ends of the ceramic members **12** and **14**, and it has an elongated portion **22***a* which, likewise, serves as an electric terminal for the relay. The members **16**, **20** and **22**, and their integral portions **16***a*, **20***a* and **22***a* may be formed, for example, of berylium copper, or other appropriate electrically conductive material.

The lower end of the envelope formed by the ceramic members **10**, **12** and **14** is affixed to a ring **26** formed of magnetizable material such as iron. The ring **26** is sealed to the lower end of the cylindrical member **14** by an appropriate material **28** composed, for example, of Kovar, which serves to provide an adequate seal between the ring **26** and the ceramic member **14** for wide ranges of temperature.

A tubular housing **30** which is formed of iron, or other suitable magnetizable material is brazed or otherwise attached to the ring **28**, the housing **30** extending coaxially with the body assembly of the ceramic members **10**, **12** and **14**, on the opposite side of the ring **26**. A mounting flange **32** is brazed or otherwise attached to the housing **30**, as shown.

An inner tubular member **32** composed of a non-magnetic material such as monel metal is supported coaxially within the housing **30**, and extends into the ring **26**. A movable armature plunger **34** is slidable in the tubular member **32**, the plunger **34** being formed, for example, of magnetizable material such as iron. A ceramic rod **38** which is affixed to a support bridge **40** extending across the top of the armature **34**. The armature **34** is shown as hollow so as to provide low inertia for the relay.

An iron core **41** is provided in the housing **30**, and a spring **42** is housed in a cavity in the iron core, the spring bearing against the underside of the armature **34** so as to bias the armature upwardly in FIG. 1. The core **41** is held in place by means of a screw **48** extending, for example, through the bottom of the housing **30**, and threaded into the core **41**.

An electric coil **52** is wound in the housing **30** around the core **41**, and when the coil **52** is energized, the armature **34** is drawn down into the housing **30** against the end of the core **41** and against the bias of the spring **42**. When the coil is de-energized, on the other hand, the spring **42** moves the armature back to its illustrated position in FIG. 1. Electrical connection is made to the coil **52** through a pair of terminals **56** and **58** which extend through bushings **60** and **62** in the bottom of the housing **30**.

An electrically conductive rod **70** extends upwardly from the ceramic rod **38** and through the various annular terminal members **16**, **20** and **22**. A first electrical contact **72** is welded or otherwise affixed to the rod **70** at the upper end thereof, the contact **22** being normally spaced from the annular contact **16**. However, when the relay is energized, the downward movement of the armature **34** causes the contact **72** to engage the annular contact **16** and establish electrical connection thereto from the conductive rod **70**.

A second contact 74 (FIG. 2), of the same shape as the contact 72, is welded or otherwise affixed to the rod 70, and the contact 74 normally makes electrical contact with the underside of the contact 20. However, when the relay is energized, the downward movement of the armature 34 and rod 70 causes the contact 74 to move away from the contact 20. A diaphragm 78 is also attached to the rod 70, and is crimped to the annular contact 22 by three lugs 22*b*. The diaphragm 78 is shown in an enlarged form in FIG. 3. The diaphragm is composed, for example, of a resilient material such as berylium copper, and it has the illustrated configuration in FIG. 2, so that when its central portion is attached to the rod 70, and its peripheral edge is attached to the terminal 22, free reciprocal movement of the rod 70 in a vertical linear direction is permitted, while maintaining a positive electrical connection with the terminal contact 22. The diaphragm 78 is formed, for example, by photo-etching techniques.

Therefore, the relay illustrated in FIG. 1 operates to establish an electric connection between the common terminal C formed by the protruding portion 22a of the terminal contact 22 and the terminal B formed by the protruding portion 20a of the terminal 20, when the relay is de-energized; and it establishes electrical contact between the terminal C and the terminal A formed by the protruding portion 16a of the terminal contact 16, when the relay is energized. The contact 74 has the form shown in FIG. 2, so that during assembly it may be turned and drawn down into the envelope through the contact 20 to be disposed below the contact 20, as shown in FIG. 1. The contact 74 is then turned back so that it will engage the ears 20*b* of the contact 20 (FIG. 2) when the armature moves upwardly as the relay is de-energized.

The structure shown in FIG. 1 is a small, sturdy and rugged unit, and one which may operate at relatively high voltages, as described above, and in conjunction with high electrical frequencies. Also, the relay unit shown in FIG. 1 is capable of operation through wide ranges of ambient temperature.

The relay of FIG. 4 is generally similar to the relay of FIG. 1, and like elements have been designated by the same numerals. A significant difference between the relay of FIG. 4 and the relay of FIG. 1 is that the relay of FIG. 4 incorporates a radially magnetized permanent magnet member 100 so as to constitute a latching relay. The magnet 100 is formed, for example, of barium ferrite. In the latter structure, the permanent magnet 100 is mounted in the housing 30 in coaxial relationship with a first coil 52*a* and a second coil 52*b* as an injection molded sub-assembly. The coil 52*a*, when energized, draws the armature 34*a* down against the end of a lower core section 40*a*, and the armature remains in that position due to the attraction of the permanent magnet 100, even after the coil 52*a* has been de-energized. Then, to return the relay to its illustrated position, the coil 52*b* is energized which draws the armature up and away from the core 40*a*, to the illustrated position against an upper core section 40*b*, the relay maintaining the illustrated position after the coil 52*b* has been de-energized, and until the coil 52*a* has again been energized. The armature 34*a* may be chromium coated and oxidized to prevent cold welding thereof with the upper and lower core sections.

In the construction of the relays described above, the cap 18 is brazed to the contact 16 as a final operation, and the relay is evacuated through holes in the depressed central section of the cap. The holes are then sealed by placing a pellet of copper/silver alloy, for example, in the depressed central section of the cap and melting the pellet by a high frequency electric current.

The invention provides, therefore, an improved miniaturized vacuum relay which has a strong and rugged construction, in which all its contacts are insulated from one another and from the housing, and which is capable of making and breaking high electrical potentials at high electrical frequencies. The relay also has the feature of operating through wide ranges of ambient temperatures.

While particular embodiments of the invention have been shown and described, modifications may be made, and it is intended to cover all modifications in the following claims which come within the spirit and scope of the invention.

What is claimed is:

1. A relay including: a housing; a plurality of annular contact members affixed to said housing at spaced positions therein; a movable element for the relay including an electrically conductive rod extending coaxially within said annular contact members; solenoid means attached to one end of said housing for selectively moving said rod in a rectilinear reciprocal manner between a first position and a second position with respect to said annular contacts; a resilient diaphragm composed of electrically conductive material attached to said rod and to one of said annular contacts and electrically connecting said rod to said one of said annular contacts, said diaphragm lying in a plane perpendicular to the axis of said rod; and at least one movable contact affixed to said rod for selective engagement with a further one of said annular contacts as said rod is moved between its first and second positions.

2. The relay defined in claim 1, in which said resilient diaphragm has a photo-etched pattern extending therethrough.

3. The relay defined in claim 1, in which said housing is formed of a stack of coaxially positioned open-ended cylindrical-shaped electrically insulating members separated by said annular contact members.

4. The relay defined in claim 3, in which said cylindrical-shaped members are ceramic.

5. The relay defined in claim 1, in which said solenoid means includes first and second electrical coils and a radially magnetized tubular permanent magnet interposed therebetween in coaxial relationship therewith; and a permanent magnet for latching said relay in each of the aforesaid first and second positions of said rod.

6. The relay defined in claim 5, in which said solenoid includes first and second magnetic core sections spaced axially from one another and disposed within said first and second coils, respectively; and in which said movable element includes a magnetic armature movable axially between said first and second core sections.

7. The relay defined in claim 1, in which said movable element includes a plunger formed of magnetizable material and received in said solenoid means, and a ceramic rod mounting said conductive rod on said plunger.

8. The relay defined in claim 3, in which said annular contacts each have an integral elongated portion protruding radially out from the external surface of said housing.

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