

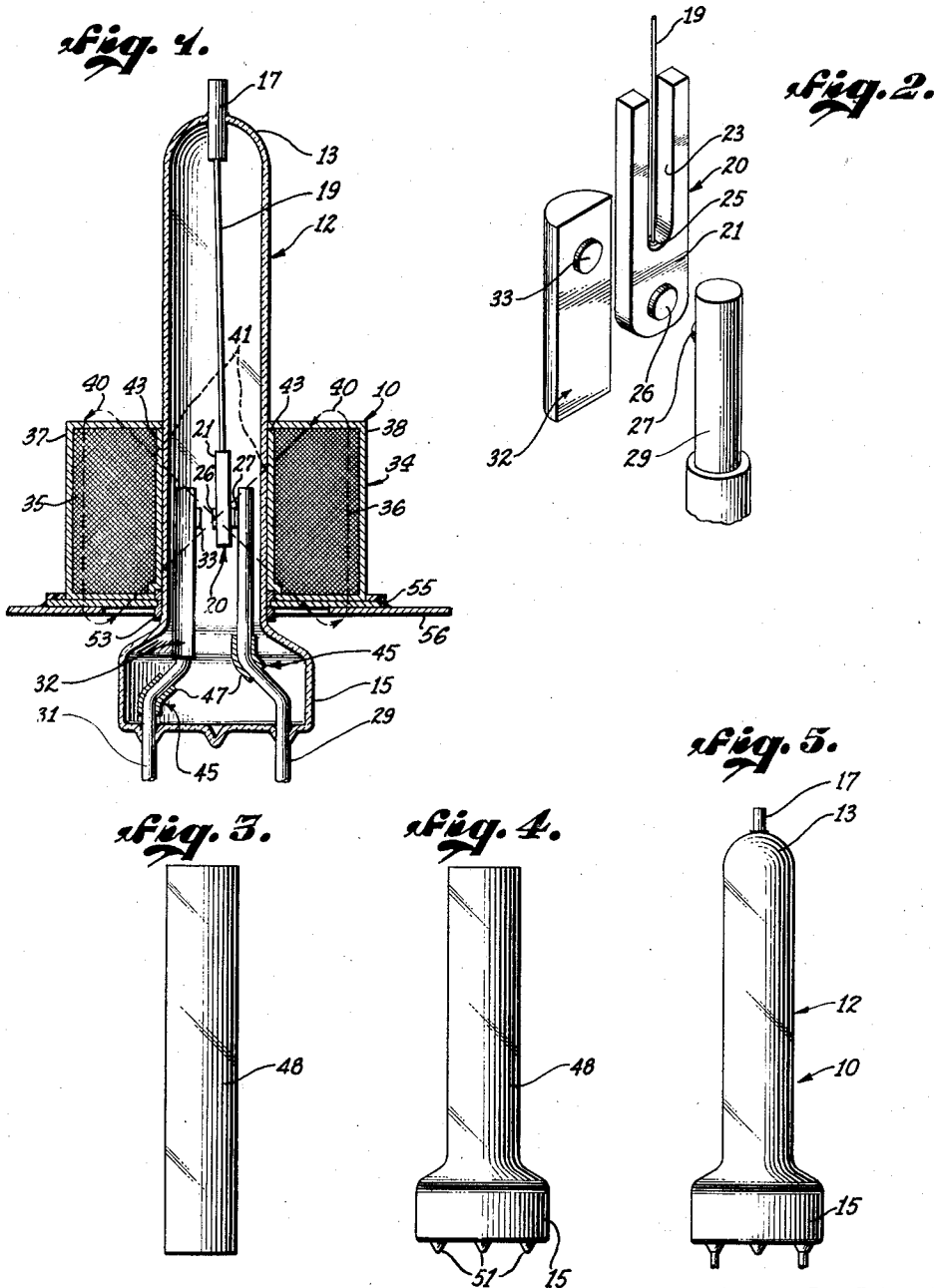
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HIGH VOLTAGE HIGH VACUUM RELAY

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This invention relates to a high voltage, high vacuum relay and, more particularly, to a relay of the aforementioned character which is simple in construction and which has eliminated many of the operating deficiencies of prior art relays.

Relays of the type under consideration usually include an evacuated envelope in which is located a plurality of leads. One of the leads has a movable armature operatively connected thereto by means of an elongated resilient arm, said armature being alternately movable between one or two associated contacts by means of a magnetizable core. One of the major disadvantages of prior art relays has been the fact that the length of the resilient arm upon which the armature must be suspended is necessarily limited by the over-all dimensions of the envelope in which the armature is disposed. The relatively short arms of conventional relays inhibit movement and the suspension of the armature on the extreme lower ends thereof subjects the armature to flutter by external vibrational stimulation.

It is, therefore, an object of the invention to provide a high vacuum relay which includes an armature mounted upon a resilient mounting arm adjacent its center of weight thus reducing the susceptibility of the armature to external vibratory stimuli and the consequent flutter and undesirable movement resulting therefrom.

Another object of the invention is the provision of an armature which includes a bifurcated body and which has the end of its associated mounting arm attached to said body at the base of the opening between the legs formed therein so that the length of the mounting arm is extended by the depth of the opening to impart to the armature greater freedom of movement when the armature is subjected to magnetic attraction by the action of the aforementioned core associated therewith.

Another advantage of the substantially longer resilient mounting arm achievable by the utilization of an armature constructed in accordance with the teachings of the invention is the fact that the greater length of the mounting arm eliminates the excessive flexing characteristic of shorter arms and thus materially prolongs the life of the mounting arm.

Another operational difficulty encountered in prior art constructions has been the vibration of the ends of the leads associated with the armature, said vibration frequently being on the order of fifty milliseconds. This is extremely undesirable since, in the design of a relay for use in high energy pulse circuits, it is necessary that the time of travel of the armature from one associated contact to another be extremely rapid and that, when such contact is finally made, chattering, bouncing or vibration of the leads associated with the armature be as small as possible.

A further object of the invention is the provision of vibration damping means associated with the leads alternatively engageable by the aforesaid armature, said vibration damping means in the present embodiment of the invention being constituted by sleeve members tightly fitted over the peripheries of the leads within the envelope.

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The sleeves encompassing the leads substantially reduce the chattering, bouncing and vibratory movements characteristic of prior art devices and thus constitute a material advance thereover.

It is extremely difficult in inductive devices of the character under consideration to reduce the spurious emission to a level which will not affect the other portions of an apparatus with which the relay is utilized and, more particularly, it is quite difficult to limit the flux field of a coil associated with the relay to the immediate area of the core mounted within the relay envelope.

Another object of the invention is the provision of a high vacuum relay in which the core of the relay is magnetizable by relay coils mounted in the immediate vicinity thereof and on opposite sides thereof, the windings of the coils being in planes substantially parallel to the longitudinal axis of the envelope in which the core is mounted so that the lines of flux intersect within the envelope in the region of the armature and its associated core, thus eliminating spurious emissions which have undesirable effects upon associated electronic components such as radar.

An additional object of the invention is the provision of a method of manufacturing the relay of the invention by a series of relatively simple, uncomplicated steps which eliminate many of the fabrication difficulties encountered in the utilization of prior art methods and result in substantial reductions in the cost of fabrication of the relay of the invention.

Other objects and advantages of the invention will be apparent from the following specification and the accompanying drawing which is for the purpose of illustration only and in which:

Figure 1 is a vertical, partly sectional view of a high voltage, high vacuum relay constructed in accordance with the teachings of the invention;

Figure 2 is an enlarged, fragmentary view showing the relationship and construction of the armature and its associated alternatively engageable contacts;

Figure 3 is a front elevational view of a tubing which constitutes the base structure from which the envelope of the relay of the invention is fabricated;

Figure 4 is an intermediate step in the formation of the envelope of the relay; and

Figure 5 is a front elevational view of the completed relay.

A high voltage, high vacuum relay 10 constructed in accordance with the teachings of the invention is best shown in Figures 1 and 5 of the drawing and includes an elongated, substantially cylindrical envelope 12 fabricated from a glass having the requisite dielectric and structural characteristics.

The envelope 12 is convex at its upper end 13 and is provided at its lower end with an expanded base 15, the words "upper" and "lower" being utilized in a descriptive, rather than in a limiting connotation.

Positioned in the upper end 13 of the envelope 12 is a tungsten lead 17 which is copper brazed or otherwise affixed to the envelope 12 and which has a depending lower end to which is affixed the uppermost end of an elongated, resilient, mounting arm 19 which is associated end of the lead 17 and which is slightly cocked is also copper brazed or otherwise affixed to its associated end of the lead 17 and which is slightly cocked off its vertical axis, as best shown in Figure 1 of the drawing, during its affixation to the lead 17 to bias it in a predetermined direction, for a purpose which will be made apparent in the discussion below.

The elongated, resilient mounting arm 19 is approximately two inches in length instead of the customary one and one-half inches which is normally the length to which the mounting arm of conventional relays is re-

stricted by the over-all length of the envelope in which the arms are incorporated.

The length of the envelope 12 utilized in the present invention is identical, or substantially so, with the lengths of the envelopes utilized in prior art devices, and, to achieve the greater length of the resilient mounting arm 19, an armature 20 of unique design is provided. The armature 20 includes a body 21 which is bifurcated to define an elongated opening 23 which receives the lowermost portion of the length of the arm 19 whose lowermost end is copper brazed to the body of the armature 20 as at 25. If desired, an elongated bore can be formed in the body 21 immediately below the elongated opening 23 therein to provide for the reception of the end of the elongated mounting arm 19.

It is readily apparent, therefore, that the additional length of the elongated, resilient mounting arm 19 is attributable to the provision of the elongated opening 23 in the body 21 of the armature 20. The increased length of the elongated mounting arm 19 achievable by this expedient materially reduces the flexing encountered in the use of shorter mounting arms in conventional relays and, thus, materially prolongs the life of the mounting arm 19.

Said elongated arm, because of its greater leverage action, can be controlled with a smaller magnetic force than in prior art devices, thus minimizing the current requirement in the external actuating coil. Furthermore, the armature 20 is suspended upon the lowermost end of the elongated mounting arm 19 at a point which is substantially coincident with its center of weight and thus the armature is maintained in static balance and resists vibratory movement induced by external stimuli. The elongated mounting arm 19 is secured to the lowermost end of the lead 17 with its longitudinal axis deviated from the vertical axis of the envelope 12. This maintains a molybdenum contact 26 in engagement with a similar contact 27 secured to the uppermost end of a tungsten lead 29 which constitutes one of a pair of leads located in the expanded base 15 of the envelope 12.

The contacts 26 and 27 are operatively secured to the armature 20 and the uppermost end of the lead 29 by copper or silver brazing. Thus, the normal bias of the elongated supporting arm 19 serves to maintain the contact 26 on the armature 20 in engagement with the contact 27 on the uppermost end of the lead 29.

The other of the pair of leads in the base 15 of the envelope 12 is indicated at 31 and is formed from tungsten wire. Fastened to the uppermost end of the lead 31, as by copper brazing, is a soft iron core 32, said core having a molybdenum contact 33 brazed to the uppermost end thereof.

The uppermost ends of the contact 29 and the soft iron core 32 are laterally spaced from each other to accommodate the lower portion of the armature 20 and to permit movement of said armature and its associated contact 26 between the contacts 27 and 33 provided, respectively, on the lead 29 and the core 32.

The soft iron core 32 is magnetizable by the utilization of a coil means 34, the halves 35 and 36 of which are disposed on opposite sides of the envelope 12, each half being contained in a soft iron box 37 and 38, respectively. The windings of the coil means 34 are disposed in planes substantially parallel to the longitudinal axis of the envelope 12, as generally indicated by the directional arrows 40 which indicate the direction in which the coil means 34 is wound and the effective flux passes, for example, from the upper right-hand corner of the half 36 of the coil means 34 to the lower left-hand corner of the half 35 of the coil means 34. The flux pattern is indicated generally by the dash lines 41.

In order to further localize the flux in the immediate region of the relay 10, non-magnetic shims 43 formed from copper or brass may be provided. By the above described expedients, the magnetic field is confined to

the area of the coil means 34 and the relay 10 itself and interference customarily encountered with prior art relays of the type under consideration is completely eliminated. This is a material advance over the prior art since it permits the relay 10 of the invention to be used in close contiguity to devices which would be susceptible to emanations from prior art structures.

Therefore, when the coil means 34 is energized, the magnetization of the soft iron core 32 occurs and the armature 20 is deflected to break the contact between the contacts 25 and 27 and urge the contact 26 into engagement with the contact 33 on the soft iron core 32. The provision of the longer, elongated, resilient mounting arm 19 permits the armature 20 to be more easily moved between the contacts 27 and 33 and materially reduces the force which must be exerted upon the armature 20 to cause said movement. This is an important feature resulting from the elongation of the mounting arm 19.

Since the armature 20 must move with great rapidity between the contacts 27 and 33, vibration and chattering of the leads 29 and 31 must be reduced to a minimum. In prior art devices, vibrations of the order of fifty milliseconds have been encountered which result in impaired current flow and improper operation of the relay 10. In order to overcome such undesirable side effects, vibration damping means 45 are provided in association with the leads 29 and 31, said vibration damping means being constituted, in the present embodiment of the invention, by soft, annealed, nickel sleeves 47 which encompass the leads 29 and 31 and sufficiently rigidify said leads to prevent excessive chattering or vibration thereof.

In actual test it has been found that the vibratory frequencies have been reduced from fifty to five milliseconds.

The method of fabricating a relay 10 is as follows:

A straight piece of glass tubing 48 having the same coefficient of expansion, or substantially the same coefficient of expansion, as the tungsten leads 17, 29 and 31, has its lower portion heated into plastic condition. It is then introduced into a carbon or other suitable mold wherein the base portion 15 is formed thereupon, together with the depending dimples 51. The dimples 51 are subsequently opened by means of a high temperature flame and the tungsten leads 29 and 31 inserted therein by means of a jig. The lower ends of the leads 29 and 31 are subsequently sealed in the associated dimples 51 by means of copper brazing or other conventional methods. Subsequently, the convex upper end 13 of the envelope 12 is formed by plasticizing the upper end of the tubing 48 and the tungsten lead 17 is mounted therein. By inserting the tungsten leads 29 and 31 in the above described manner, the oxidation of said leads at the upper ends thereof is eliminated since they are copper brazed adjacent the lowermost ends and are not exposed to heat in the areas where the contacts 27 and 33 are mounted.

After the complete fabrication of the envelope 12, the center dimple 51 is utilized as a tubulation to evacuate the envelope 12 or to gas fill the same by techniques common to the art of vacuum tube manufacture and is subsequently sealed. By the utilization of the method of my invention, it is possible to achieve a stronger housing of neat and uniform appearance.

After the relay 10 has been fabricated in the above described manner, a band 53 formed from silver, platinum, or other material, is applied to the periphery of the envelope 12 adjacent the base 15 thereof. Subsequently, a mounting disc 55 is soldered to the band 53 to provide a mount for both the envelope 12 and the coil means 34 associated therewith.

By this means it is possible to hermetically seal the relay into another container or case such as a transformer-containing case, in the manner shown in Figure 1,

by means of an "O-ring" gasket or by soldering directly into the top 56 of the case.

The relay 10 of the invention is thus characterized by absence of vibration due to external stimuli and the armature 20 of said relay is characteristically more easily moved between its associated contacts because of the provision of the elongated mounting arm 19. In addition, the elongated, resilient mounting arm being of greater length is subject to less flexing than a shorter arm. The provision of a U-shaped or bifurcated armature body permits the increase in the length of the elongated mounting arm and also suspends the armature at a point substantially coincident with its center of weight, thus reducing the susceptibility of the armature to vibration induced by external stimuli.

Furthermore, the relationship between the coil means 34 and the armature 20 and leads 29 and 31 materially reduces undesirable emission from the coil means 34 and the magnetic field is limited to the immediate vicinity of the relay 10. Moreover, the undesirable vibration of chattering of the leads 29 and 31 is substantially reduced by the provision of vibration damping means in association therewith.

In conventional relays of this type where high pulse currents are passed through the internal elements or contacts resistance welding of said internal members is not uncommon. Welding is prevented in the relay of my invention by selecting materials having poor weldability; namely, tungsten and molybdenum or a combination of both. The contacts of the relay preferably are made convex in shape so that extremely small areas touch each other when the contacts 26, 27 are in the positions shown in Figure 1. By this means the pressure per unit area is increased to a value proportional to the reduction in surface area, thus reducing the electrical resistance at the contact junction to a value proportional to the pressure per unit area. In addition to the above technique, the contacts are preferably given a superficial etch. This may be done, for example, in a 10 percent solution of potassium hydroxide in an electrolytic cell. In the cell the contact is used as one electrode and a stainless steel member is used as the other electrode. An alternating current density of two amperes per square centimeter is passed through the cell for a period of about three seconds to form the desired etch on the contact surface. The etch does not reduce the surface area when the contacts are together, but induces the current to divide and flow through a multiplicity of parallel paths having a low total resistance. These parallel paths are provided by the fine etch and can be seen under the microscope.

It will be understood that the specific embodiments of this invention described above are intended to illustrate and exemplify the invention and are not necessarily

intended as a limitation thereon and that modifications of this invention may be made within the scope of the following claims which define the invention sought to be covered by Letters Patent.

5 The invention as claimed:

1. In a relay, a generally elongated envelope, a pair of spaced opposed fixed contacts in said envelope adjacent one end thereof, a lead extending from each of said contacts through said envelope to the exterior thereof, one of said leads being nonmagnetic and the other having a paramagnetic portion adjacent its contact, a terminal at the other end of said envelope, a resilient arm having one end thereof fixed to said terminal and extending generally longitudinally within said envelope, a movable paramagnetic armature between said contacts, said armature having contact elements thereon alternatively engageable with said fixed contacts, said contact elements being closely adjacent the center of gravity of said armature, the other end of said resilient arm being secured to said armature closely adjacent the center of gravity thereof, said resilient arm being biased to normally hold said armature against said nonmagnetic contact, and coil means associated with said relay for actuating the same.

25 2. A relay as defined in claim 1 wherein said coil means comprises coils disposed outside said envelope on opposite sides thereof and generally aligned with said fixed contacts, the windings of said coils being disposed in planes generally parallel to the longitudinal axis of said envelope.

3. A relay as defined in claim 1 wherein said armature is a generally U-shaped member, said contact elements being mounted on the bight portion thereof and said other end portion of said resilient arm extending between the legs of said armature and being secured to said bight portion.

4. A relay as defined in claim 1 wherein said armature is provided with an opening extending inwardly thereof to substantially its center of gravity, said other end portion of said resilient arm extending freely into said opening with its end secured to said armature at the bottom of said opening.

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