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CERMET RESISTANCE MODULE

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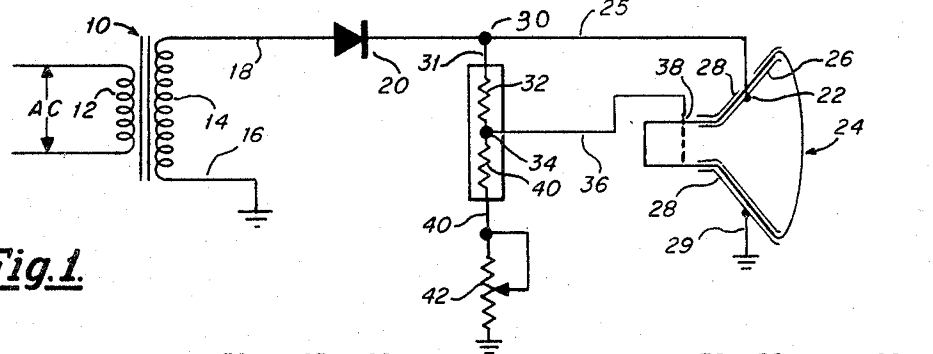

Fig.1.

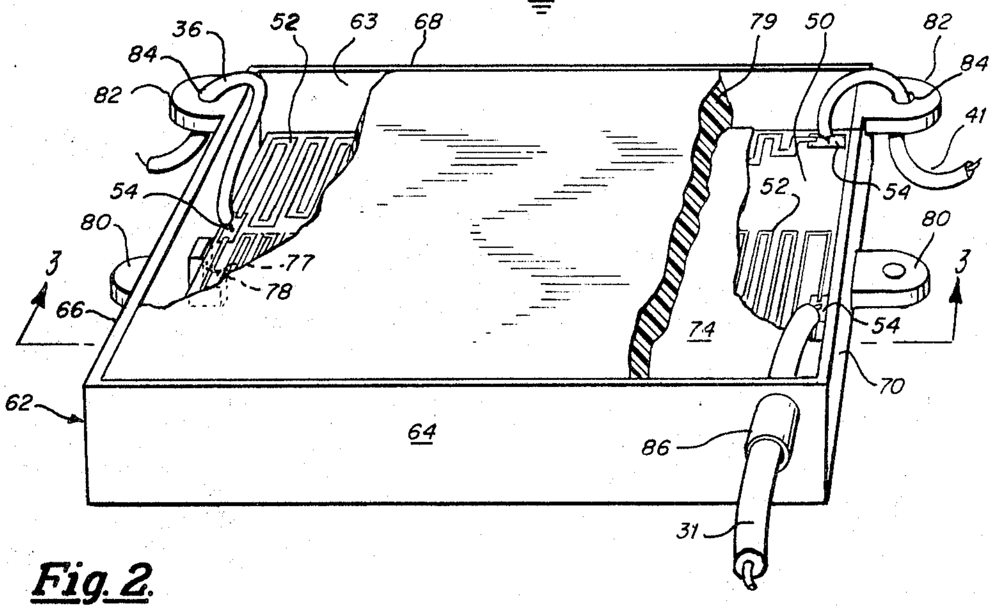

Fig.2.

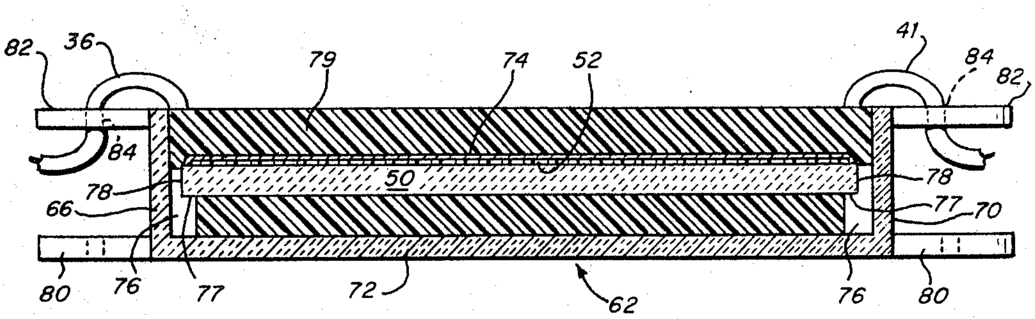

Fig.3.

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CERMET RESISTANCE MODULE

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ABSTRACT OF THE DISCLOSURE

A modular electrical resistor for use in high voltage circuits which is fabricated by encapsulating a cermet resistance element in a mold filled with high dielectric material. The mold becomes a permanent part of the module, and includes integral therewith, lead restraints and mounting tabs.

This invention relates in general to electrical resistors capable of operating in high voltage environments, and in particular, to electrical resistors housed in a module, which are capable of safely operating in circuits utilizing voltages of 25,000 volts or more. More particularly, this invention relates to a resistance module for use in the high voltage circuit of a color television receiver wherein it is desirable to provide a focus voltage from the output of the high voltage transformer which is proportional to the second anode voltage.

In television receivers it is well-known to maintain the focus voltage proportional to the second anode voltage to compensate for a decrease in second anode voltage and a consequent reduction of electron velocity as a result of increased beam current due to an increase in picture brightness. If the focus voltage were not maintained proportional to the second anode voltage, the bi-potential focus lens would not maintain the electron beam in focus as the picture brightness varied.

The second anode voltage is derived directly from the output of the high voltage transformer, and the focus voltage, which is always at a lower potential than the second anode voltage, is generally tapped from the transformer before the high voltage output. Obtaining the focus voltage in this manner requires a focus rectifier, capacitor, and load resistor for filtered high voltage DC, but since the resistor operates at a potential substantially below the second anode voltage, it does not require extremely high voltage insulation.

Another well-known method of obtaining the proportional focus voltage is to directly tap the second anode voltage and reduce it through a resistance network. The advantage of this latter method is the elimination of an extra rectifier and capacitor, since the picture tube capacitance is now utilized and the rectifier is the same as that normally used for the second anode voltage. The primary disadvantage of this arrangement is that the resistance network, for reducing the second anode voltage to a level suitable for the focus voltage, must be capable of withstanding the very high second anode voltage which is about 25,000 volts.

Heretofore, resistors capable of withstanding very high voltage were expensive due to exotic electrical insulation and methods of construction, and were also quite bulky since the electrical insulation was relatively thick. Many prior high voltage resistors were also difficult to secure to the chassis since no convenient mounting means were provided, and consequently, they often were merely suspended by their leads.

This invention pertains to the construction of an economical and compact resistance module capable of operating in high voltage environments. The resistance module generally comprises a nonconductive substrate having a resistance element, such as cermet, deposited thereon. Insulated conductors capable of withstanding high voltage are connected to the resistance element, and the entire assembly is encased in a high dielectric, hardenable material, forming the resistance module. The encased assembly is provided with mounting tabs for easily securing it to a chassis, and further includes conductor restraining means to reduce strain at the connection between the resistance element and the conductor. In addition, the resistance module is constructed to insure adequate dissipation of the heat generated due to the potential reduction therethrough.

Accordingly, it is the primary object of this invention to provide economical and compact resistance means capable of safely operating in a high voltage environment.

Another object of this invention is to provide a high voltage resistance module which includes means integral therewith for preventing strain at the connection between the electrical conductors thereof and the resistance element.

It is also an object of this invention to provide a high voltage resistance module which may be easily fabricated and includes provisions integral therewith for simplified mounting thereof to a chassis.

A further object of this invention is to provide a resistance module capable of operating in a high voltage environment, which has a higher than average heat dissipation characteristic.

Other objects of the invention will become apparent upon an examination of the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates a simple schematic diagram of the high voltage section of a television receiver wherein the invention may be employed.

FIG. 2 is a partially cutaway three dimensional view of a resistance module of the invention.

FIG. 3 is a cross sectional view of the resistance module taken along line 3—3 of FIG. 2.

Referring now to the simple schematic diagram of FIG. 1, there is shown a high voltage transformer **10** having a primary winding **12** connected to a suitable AC source, and a secondary winding **14**. A first end **16** of secondary winding **14** is grounded, and a second end **18** thereof comprises the pre-rectified high voltage output. This high voltage output is rectified by a simple half-wave rectifier **20**, shown as a semiconductor diode, although as is well-known a vacuum tube rectifier may be used. The rectified high voltage is connected to a high voltage or second anode connection **22** of a television picture tube **24**, by a well insulated high voltage lead **25**.

Picture tube **24** is fabricated of glass and includes an interior conductive coating **26** electrically coupled to second anode connection **22**, and an external conductive coating **28**, which is grounded at **29** in any convenient manner. As is well-known by those familiar with the art, the internal and external conductive coatings, with the glass dielectric therebetween comprises a capacitor of substantial magnitude.

The focus voltage, which is of substantially lower magnitude than the second anode voltage and which must be maintained proportional thereto, is obtained by tapping the rectified second anode voltage at **30** and conducting it via a high voltage lead **31** to a first drop down resistor **32**. Resistor **32** is serially connected to a second drop down resistor **40**, at a junction point **34**, and is serially connected to a grounded variable third resistor **42**, by a lead **41**. The current flowing through this resistance network establishes a potential at point **34** suitable for the focus voltage. A lead **36** couples junction point **34** to an anode terminal **38** of picture tube **24**.

In a typical color television receiver, the second anode voltage has a magnitude of 25,000 volts, while the voltage at point **34** may be in the range of four to six thousand volts. The magnitude of the focus voltage at point **34** is varied by changing the total resistance from point **34** to ground thereby changing the current flowing in the serial path of resistors **32**, **40**, and **42**, and by changing the ratio of resistances of resistor **32** to the serial combination of resistors **40** and **42**.

Resistors **32** and **40** are subjected to the very high, and moderately high voltages of the high voltage circuit, respectively. Consequently, they must be well insulated to insure safe and reliable operation of the television receiver. To this end, the resistance module of the invention is provided although it should be understood that a resistance module of the type to be described may be used in any high voltage environment.

The resistance module, clearly illustrated in FIGS. 2 and 3, comprises a flat, plate-like substrate **50** fabricated of a nonconductive material such as alumina. In the preferred embodiment, a resistance material **52**, such as cermet, is deposited on the alumina in narrow strips which have a specific resistance per unit length. The substrate is then heated, which permanently bonds the cermet thereto. The deposited resistance element may assume any desirable shape, although care should be taken to provide a maximum distance between the very high voltage input connected to lead **31**, and the low voltage output coupled to the variable resistor **42**.

In the embodiment shown, the deposited resistance element comprises two series connected fixed resistors having soldering pads **54** at their junction and at each end, for easily soldering conductors **31**, **36**, and **41** thereto. Conductor **31** connects the second anode voltage to the input of the resistance module, and is physically connected thereto at a soldering pad such as **54**, not shown. Conductors **36** and **41** are each soldered to their respective soldering pads **54** for deriving the focus and control voltage respectively, from the resistance module. The electrical insulation encasing these high voltage conductors preferably comprises silicone rubber which has excellent dielectric capabilities and is also resistant to moderate temperatures, although other types of insulation may be used.

A mold **62** having a cavity **63** formed of side walls **64**, **66**, **68**, and **70**, and bottom wall **72**, is provided. The length and width of the cavity is slightly larger than the similar dimensions of the substrate. Substrate supports are provided in the interior of the cavity adjacent the intersection of each side wall and the bottom wall, substantially at the center of said side walls. Each substrate support comprises a horizontal shoulder **77** which maintains the substrate a uniform distance from the mold bottom during manufacture. Each substrate support also has a side member **78** for maintaining a substantial clearance between the peripheral edge of the substrate and the inner edge of the mold. The substrate supports are provided to allow a flowable, high dielectric material to completely fill the cavity, thereby encapsulating the substrate, resistance element, and the soldered connections to the electrical conductors.

The cermet resistance material of which resistors **32** and **40** are fabricated, is protected before being encapsulated in the dielectric material by a covering which may comprise a layer of blue diallyl phthalate. The blue diallyl phthalate primarily protects the resistance material, but it is also an excellent electrical insulator.

During manufacture, the substrate, with the resistance material and blue diallyl phthalate thereon, is placed in the mold and supported by shoulders **77**. The mold is then filled with the flowable, high dielectric material, filled polyurethane resin being used in the preferred embodiment. Filled polyurethane resin is used because of its high dielectric strength, its ability to harden adequately, and its good heat conductive characteristics. The resin fills the mold, flowing beneath the substrate and occupying the volume defined by its bottom, the side walls, and bottom wall **72**. The resin enters the space between the substrate bottom and the bottom wall by flowing through the clearances provided by side members **78** of the substrate supports. After the resin cures, during which time it undergoes a slight exothermic reaction, a rigid mass is formed which provides a resistance module, mold **62** becoming a permanent part thereof.

Mold **62** includes two features which are integral therewith, in addition to the substrate supports. The first additional feature is mounting tabs **80** which extend from two opposing side walls, outwardly of the cavity. These mounting tabs provide convenient means for fastening the resistance module to a chassis or other member. When the module is secured to a chassis, its large bottom contact area provides rapid heat transfer thereto. The second feature of the mold is lead restraints which comprise ears **82** extending from two side walls adjacent the top edges thereof. Apertures **84** extend through ears **82** for passage of the two lower voltage conductors and an acute bend prevents the conductor from being pulled therethrough, eliminating undue strain at the electrical connection with the resistance element. The lead restraints are particularly important when silicone rubber insulation is used for the conductors, since most materials will not adhere to silicone products. If other types of insulation are used, the polyurethane resin adhering thereto may provide adequate strain relief. The lead restraint for lead **31** consists of a collar **86** integral with wall **64**.

What has been described is a resistance module capable of operating in a high voltage environment which is easily fabricated and economical to manufacture. The module includes integral therewith, means for mounting it to a chassis and lead restraining means for preventing strain at the connection between the insulated conductors and the resistance element.

It is obvious that upon study by those skilled in the art, the disclosed invention may be altered or modified both in physical appearance and construction without departing from its inventive concept. Therefore, the scope of protection to be given this invention should not be limited by the embodiments described above, but should be determined by the essential descriptions thereof which appear in the appended claims.

The embodiments of the invention in which an exclusive property or priviledge is claimed are defined as follows:

1. A resistance module comprising: a body of plastic insulating material defining a cavity; a plurality of small supports peripherally arranged about the interior of said cavity; a resistance element including a pattern of cermet resistance material bonded to a slab-like ceramic base, said base having dimensions smaller than the internal dimensions of said cavity and being supported within said cavity in spaced relation to all interior surfaces thereof by said plurality of supports; a pair of insulated electrical conductors connected to said resistance element; an encapsulating hardenable liquid plastic filling said cavity and completely engulfing said resistance element, said electrical conductors extending outside the confines of said cavity; and integrally formed strain relief projections on said body for engaging said electrical conductors and introducing an abrupt bend therein to firmly lock said conductors to said body.

2. A resistance module as set forth in claim **1**, wherein said body has a generally shollow rectangular configuration with the bottom of said cavity being formed by the largest surface; a pair of projecting mounting tabs integrally formed with said body to facilitate mounting of said module with said large bottom surface in intimate contact with a mounting surface for maximum mechanical stability and heat transfer.

3. A resistance module as set forth in claim **2**, wherein said encapsulating hardenable liquid plastic comprises a filled-polyurethane resin and wherein said pattern of cermet resistance material is covered with a coating of blue diallyl phthalate for protection prior to encapsulation.

4. A resistance module for use in a high voltage circuit of a television receiver which may be conveniently mounted in heat exchange relationship with any flat portion of the chassis of said receiver without danger of high voltage exposure comprising; a generally flat rectangular body of plastic insulating material defining a shallow, open cavity; a plurality of integrally formed supports in said cavity defining a supporting surface spaced from the bottom and side walls of said cavity; a resistance element consisting of a serpentine pattern of cermet resistance material deposited on a ceramic substrate of slab-like configuration, said substrate being supportable on said supporting surface in spaced relationship to said bottom and side walls of said cavity; connection points in electrical contact with the ends and an intermediate portion of said cermet resistance material; a corresponding plurality of insulated conductors soldered to said connecting points and extending outside said body for connecting said resistance element in said high voltage circuit; a plurality of apertured strain relief tabs integrally formed with said plastic body, said insulated conductors being distorted in passing through said apertures to firmly lock them to said body; a hardenable liquid filled-polyurethane resin, encapsulating said resistance element completely and extending to the top of said cavity for providing electrical insulation and hermetic sealing of said resistance element; and a pair of mounting tabs integrally formed with said flat rectangular body to

facilitate firm mechanical mounting thereof in heat exchange relationship with a flat surface of said chassis.

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174—52; 338—243, 308, 325