Sept. 14, 1965 B. F. HAY 3,206,704

ELECTRICAL RESISTOR

Original Filed Feb. 21, 1961

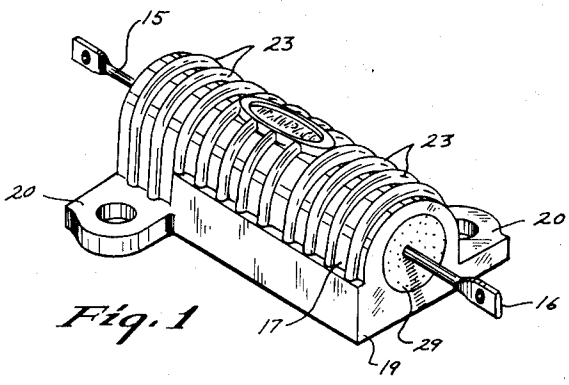


Fig. 1

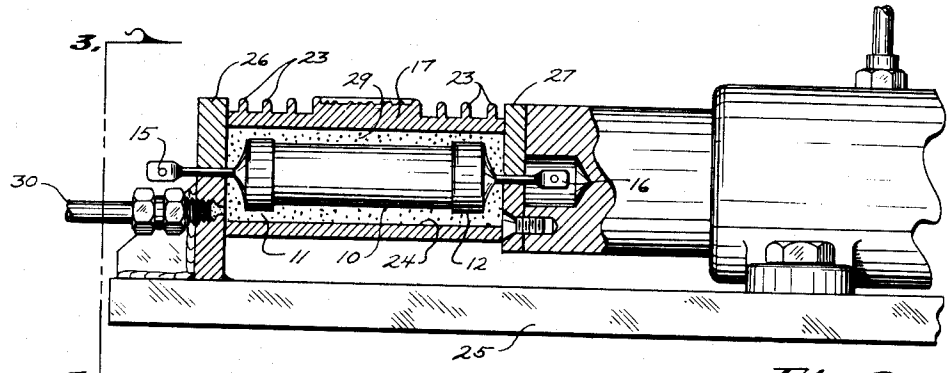


Fig. 2

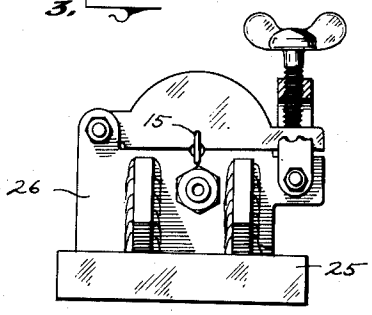


Fig. 3

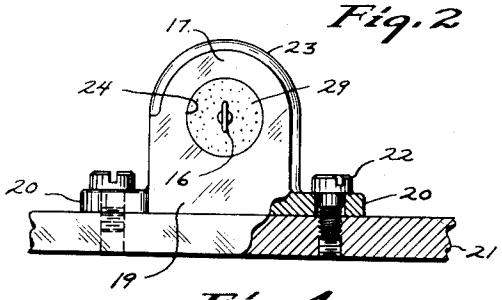


Fig. 4

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ELECTRICAL RESISTOR

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Original application Feb. 21, 1961, Ser. No. 90,794. Divided and this application Nov. 19, 1962, Ser. No. 238,657

1 Claim. (Cl. 338—250)

This is a divisional application of my co-pending application Serial No. 90,794, filed February 21, 1961.

This invention relates to electronic units that objectionably overheat, and more particularly to electrical resistors.

Electrical resistors are now being used in many types of electronic equipment, including aircraft of various types.

The most serious problem experienced in the use of resistors is their tendency to objectionably develop very high temperatures under electrical loads. Some effort has been made to reduce this heat factor by placing the resistor inside a metal housing and then securing the housing to a metal object whereby some heat could be transferred away from the resistor. Other objections to resistors are that they are relatively heavy, are poorly protected against shock and are difficult to manufacture if they are to be properly manufactured for high efficiency.

Therefore, one of the principal objects of my invention is to provide an electrical resistor unit of high efficiency that is easily and quickly manufactured in volume.

A further object of this invention is to provide an electrical resistor unit that is of light weight relative to its high voltage capacity.

A still further object of this invention is to provide an electrical resistor unit that is successfully protected against severe shocks.

A still further object of this invention is to provide an electrical resistor that is highly efficient in the dissipation of heat.

Still further objects of my invention are to provide an electrical resistor unit that is economical in manufacture, durable in use and refined in appearance.

These and other objects will be apparent to those skilled in the art.

My invention consists in the construction, arrangements, and combination, of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in my claims, and illustrated in the accompanying drawings, in which:

FIG. 1 is a perspective view of my resistor unit ready for use;

FIG. 2 is a side sectional view illustrating one method of introducing under pressure a solidifiable insulating and holding plastic material into the outer metal housing;

FIG. 3 is an end view of the injection plastic molding fixture taken from line 3—3 of FIG. 2; and

FIG. 4 is an end view of my resistor unit installed onto a supporting base.

As herebefore indicated, the preferred resistor is one that is light of weight, compact, and one that will withstand severe impacts, large electrical loads and high temperatures without fracture or malfunction. While this invention may be employed for other electrically heatable units, I am particularly concerned with the proper and desirable fabrication of electrical resistors. The physical features of ordinary electrical resistors consist of a cylindrical body or capsule **10** having therein the usual wire coil, and caps **11** and **12** at each end, respectively, of the body **10**. Such resistors have the usual two

lead conductors **15** and **16** extending outwardly through the two end caps **11** and **12**, respectively, as shown in FIG. 2.

Such a resistor is limited in the load it will carry depending on its size, and in order to accommodate the maximum loads required, it is necessary to employ much larger resistors than desirable in order to prevent excessive heating, fracture, or other damage. It is essential and important to provide for greater heat-dissipation than heretofore possible in order to employ a resistor of small size while carrying maximum electrical loads.

To produce a desirable resistor unit, my first step is to place, loosely around, the cylinder portion or body **10**, a hollow aluminum cylinder or housing **17**. This cylinder is open at both ends at this stage of assembly and the two leads **15** and **16** extend through these two open ends respectively. One side of the hollow cylinder is flat to form a base portion **19** for engagement with a supporting base, frame, chassis or like. The cylinder base portion has holed flanges **20** and the cylinder may be rigidly secured to a supporting base **21** by any suitable means such as screws **22** or bolt means extending through the hole of the flanges **20**. Cooling ribs or flanges **23** may be formed on the outer periphery of the hollow cylinder **17**. The bore **24** of the hollow cylinder is substantially greater than that of the diameter of the inserted resistor. Also, it will be appreciated that the bore of the hollow cylinder is of sufficient length to more than embrace the body **10** and caps **11** and **12** of the resistor. After the resistor is properly spaced and positioned within the bore **24**, my next step is to fill all spaces inside the bore and around the resistor by suitable castable insulation material. Obviously, for the operation to be successful, the castable material should be introduced into the bore under pressure. A congealing liquid plastic is not recommended. I recommend instead a transfer molding process which uses a powder or pellet type insulation which when introduced under pressure and heat first liquefies and then hardens into a very dense solid plastic insulation. By the use of the transfer molding process as compared to the liquid plastic, I have raised the operation of the resistor unit from approximately eighteen watts to twenty-five watts. This increased effectiveness is at least partly due to the increased density of the hardened plastic insulation which is more efficient in transferring heat from the resistor directly to the metallic hollow cylinder **17**, and which in turn dissipates heat to the atmosphere and the base support to which the unit is secured. Also, by the insulation being pressure molded in the bore, the resistor therein will not only be completely imbedded (except its leads) in the plastic insulation but will be supported properly in all directions and rigidly held against detachment from the housing **17**. There are high-temperature plastic insulation materials which are suitable and I recommend materials in the classifications of epoxys, phenolics or silicones. These three compounds with perhaps suitable mineral fillers are excellent for transfer molding. The use of powder or pellet material plastic casting is usually known as "pressure casting" or "plastic injection molding." Pressure plastic molding machines use both heat and pressure to solidify the powder or pellet plastic material within the cavity mold.

In the cast assembling of my unit, its own housing **17** acts as the mold cavity except for the two ends of such a mold cavity. Any suitable injection molding machine may be used. In the drawings I use the numeral **25** to designate the base of a molding machine. The numeral **26** designates a rigid block on the base **25** and which acts as one end of the mold cavity. The numeral **27** designates the slidable gate of the molding machine and which acts as the other end of the mold cavity as shown in FIG. 2.

The uncompleted resistor unit is placed between the two members **26** and **27**, and the member **27** slid into closed position. The two conductor leads **15** and **16** must extend through the two members **26** and **27**, respectively, and this may be accomplished by having the two members **26** and **27** detachably split as shown in FIG. 3. The end member block **26** engages the left end of the housing **17** and the gate block member **27** engages the right end of the housing **17**. By this arrangement of parts, the resistor housing **17** and members **26** and **27** form the mold cavity. The plastic material **29** is then injected into the mold cavity under pressure through the conduit **30** and which communicates with the inside of the mold cavity through the end member **26**.

After the molten plastic has hardened, the molding machine is opened and the entire resistors unit, such as shown in FIG. 1, is removed therefrom.

Some changes may be made in the construction and arrangement of my electrical resistor without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claim, any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

I claim:

In a device of the class described,

a rigid metallic housing having an elongated smooth cylindrical bore extending entirely therethrough with the opposite ends of said bore being completely open,

a self-contained rigid cylindrical resistor element positioned on the longitudinal axis of said bore,

said resistor element having a length and diameter substantially less than that of said bore so that said resistor element can dwell in substantial spaced relationship to both the ends and the interior surface of said bore,

said resistor having the properties of functioning electrically at relatively high temperatures,

a single dense hard cast homogeneous plastic insulation material comprised of high temperature plastic

in complete and direct engagement with the entire outer surface of said resistor element;

said plastic having the characteristic of remaining in a hard dense state during the sustained high operating temperatures of said resistor element, and completely filling the space in said bore around said resistor element to surround said resistor element with an insulative layer of substantial thickness, and to support said resistor element in all directions to rigidly hold said resistor element against detachment from said housing,

said insulation material extending completely to the plane of the open ends of said bore so that the outer shape of said casting material defines a cylinder that has the same internal volume as said bore,

said insulation material having a density greater than that of identical material formed into a solid under atmospheric pressure,

the plastic insulation material at the extreme ends of said bore being exposed to the atmosphere,

an electro-conducting lead element extending outwardly from said resistor element through said insulation material to a point outside said housing beyond the ends of said bore.

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