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METHOD OF MAKING INSULATED TERMINALS OF THE RECEPTACLE TYPE

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Fig. 1

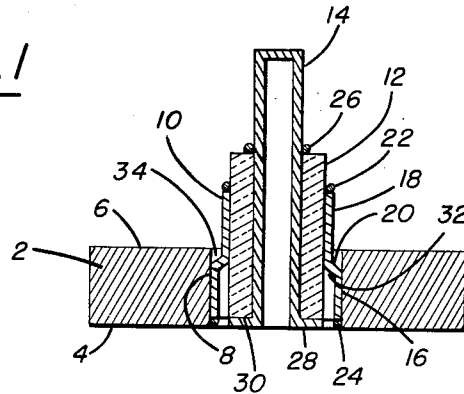


Fig. 2

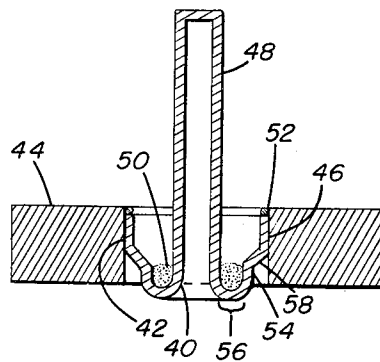
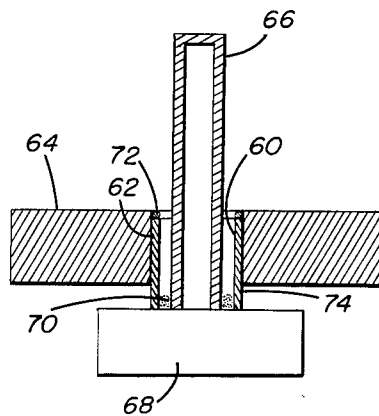


Fig. 3



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METHOD OF MAKING INSULATED TERMINALS OF THE RECEPTACLE TYPE

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3 Claims. (Cl. 29—155.55)

This invention relates to a method of making insulated terminals of the receptacle type, and more particularly, to terminals used in vacuum tubes or the like.

This application constitutes a division of my co-pending application, Serial No. 539,950, filed October 11, 1955, now abandoned.

In a variety of electronic devices, the need frequently arises to incorporate a number of electrical terminals which may serve either as internal collectors or current leads to internal parts of the structure. The terminals must necessarily be vacuum-tight when used in conjunction with a vacuum tube. In other applications, where the container is pressurized, the terminals must withstand the pressure differential. Many of the commonly-known terminals consist of a central lead sealed into an insulating sleeve which in turn is bonded to the wall of the tube envelope. Such tubes suffer from certain defects. For example, protruding leads are liable to be broken off and also, in critical cases, occupy additional space which may interfere with the most advantageous operation of the device. Furthermore, making connections to protruding rods is not always a simple matter. Where glass-insulated terminals have been used in the prior art, the relatively low softening point of the glass has involved a limitation in that it prevents baking the tube at temperatures higher than 450° C. Where ceramic-to-metal seals have been used in the prior art, they have required a careful matching of the thermal expansion coefficient in order to prevent objectionable strains from arising during fabrication and operation. Such matching is difficult if not impossible to obtain throughout the wide range of temperatures to which the tubes are subject.

An object of the present invention, therefore, is to provide an insulated terminal of the receptacle type which can be flush-mounted, if desired, and which is free of the prior art temperature limitation occasioned by the inopportune melting of glass or the occurrence of objectionable strains due to thermal expansion.

Another object of the invention is to provide methods of fabrication of insulated terminals free of the aforementioned prior art defects.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 shows a cross section of a preferred embodiment of a ceramic-insulated terminal made according to the present invention;

FIG. 2 shows a cross section of another preferred embodiment of the invention illustrating a glass-insulated terminal in the initial stage of its fabrication according to a preferred method of the invention; and

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FIG. 3 shows another preferred embodiment of a glass-insulated seal made according to the invention by another preferred method of fabrication contemplated by the invention.

Reference is now made to FIG. 1 wherein the numeral 2 indicates a portion of the wall of a vacuum tube or the like. This invention is particularly applicable to vacuum tubes or the like made as an all-metal structure, especially the variety where the envelope is required, for operational reasons, to have high electrical conductivity and wherefor the base of the tube, for example, as exemplified by part 2 in FIG. 1, is constituted by a heavy block of copper or similar metal. The surface 4 represents the exterior of the tube while the surface 6 faces the interior of the tube and is subjected to a vacuum, in the case of a vacuum tube, or whatever pressure may be desired in a pressurized type of device. The terminal lies within an opening 8 formed through the wall 2 and comprises an outer metal, generally cup-shaped member 10, a ceramic sleeve 12 and an inner metal member 14, generally in the shape of a thimble. The cup-shaped member or collar 10 is shaped to fit within the opening 8 in the block 2 and conveniently, although not necessarily, be in the form of a cylinder. The collar 10 has a first portion 16 of relatively large diameter, a second portion 18 of relatively smaller diameter and, intermediate between them, a transition portion 20. The collar is made of relatively thin metal, typically copper, and the transition portion 20 is of such a structure that, when the terminal is finally in place, the collar is flexible to yield so that thermal stresses imposed on it by expansion and contraction of the main body of metal 2 into which it is brazed will not be transposed to the ceramic seal. In general, this means that the portion 20 is relatively thin metal and is not in the form of a planar shoulder. Conveniently, it can be as shown in FIG. 1 of tapered cross section, although not necessarily conical. In manufacturing the whole assembly, the three main parts can be inserted in place and, by placing a brazing material such as a ring or brazing paste at 22 and at 24, the process of assembly can be accomplished all at once by simply baking the assembly in a neutral or reducing atmosphere at the desired brazing temperature. This temperature causes a brazed joint to form between the portion 18 and the exterior of the ceramic sleeve 12, the brazing material 22 running into the interface by capillary action. Similarly, a brazed joint is formed between the portion 16 and the opening 8 in the wall 2 by the brazing material 24 rising by capillary action. The third brazed joint is made by brazing material 26 running between the interface formed by the exterior of the thimble 14 and the interior surface of the ceramic sleeve 12. A preferred form of thimble shown in FIG. 1 has, for added structural strength and durability, a flange 28 which may also be bonded at 30 by the brazing operation to the end of the ceramic sleeve 12.

The location of the brazing material at 22 rather than, for example, at 32, and the location of the brazing material at 24 rather than in the depression at 34, accomplishes the desirable feature of providing brazed joints between the collar 10 and the ceramic sleeve 12 and the block 2 and ceramic sleeve 12 without causing a more or less solid, thick wall to be formed between the block 2 and the sleeve 12 in the region of the transition por-

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tion 20. Such a solid joint would defeat the very purpose of the invention, which is to allow flexibility in the region 20.

The bonding of the ceramic sleeve 12 to the thimble 14 and to the collar 10 is accomplished by well-known techniques described in the literature, a common technique being the use of previously-metallized ceramic sleeves. The thimble 14 is preferably made of oxygen-free, high conductivity copper. The final product, then, represents a flush-mounted ceramic-insulated terminal of the receptacle type which has the aforementioned advantages over pin-type terminals. Great advantages can be gained by submitting the tube envelope and its internal parts to thermal treatments at much higher temperatures than customarily achieved by glass-insulated terminals. Ceramic-insulated terminals permit outgassing as at as high a temperature as 600° C. and a better final vacuum and more stable emission from the oxide cathodes, which may be contained within the structure, will result.

Another advantage of the terminal of FIG. 1 is that it can be made in the form of a sub-assembly and then inserted into a larger structure after it has been tested for possible leaks. The terminal is particularly well adapted for crowded spaces where a large number may have to be inserted in close proximity and where the opening 8 may be of the order of 1/4" or even less.

FIG. 2 shows another preferred embodiment of the invention using a glass-insulated seal and made according to a preferred method of the invention. To make the seal of FIG. 2, a metal cup, generally indicated at 40, is inserted in an opening 42 in the block of copper or the like 44, constituting the base of a vacuum tube or the like. The cup 40 has a first portion 46 of such a shape and size as to fit closely within the opening 42 and has a re-entrant thimble portion 48 which will constitute, in the final product, a receptacle into which a prong connector can be inserted. To fabricate the assembly, glass, either in the form of powder or a ring 50, is inserted in the base of the cup, adjacent surfaces of the cup having been pre-treated in a manner well known in the art to insure bonding with the glass, and a brazing ring or paste 52 (only those parts in the plane of the cross section being shown for clarity) is placed in the position shown. The entire assembly is now heated as, for example, by baking in an oven, and the brazing material forms a joint between the portion 46 and the wall of the opening 42, while at the same time the heat melts the glass 50. The assembly is allowed to cool, forming a permanent brazed joint at the interface between 46 and 42 and forming a bond between the glass sleeve that results from solidification of the glass 50 and the base of the thimble 48 on the one hand and the portion 54 of the copper on the other hand. To complete the item, the annular portion of metal indicated by the bracket at 56 is removed by grinding or etching or other suitable process, leaving the thimble 48 insulated by the glass sleeve from what remains of the cup 40 and, if desired, providing a terminal flush with the lower surface of block 44. The transition portion 58 between the portion 46 and the portion 54 serves the function of providing flexibility under thermal stresses occasioned by expansion and contraction occurring upon heating of the relatively large block of metal 44.

In FIG. 3 there is shown another preferred embodiment of a glass-insulated seal made according to another preferred method of the invention. In the embodiment of FIG. 3, a copper or other thin metal collar 60 is inserted in an opening 62 in the relatively heavy metal wall 64 of a vacuum tube or the like, and a thimble 66 is placed within the collar 60. The open end of the thimble and the end of the collar are closed off by a closure piece 68 of graphite or other material to which glass will not bond. A supply of glass 70 is inserted in the annular space between the base of the thimble and the interior

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of the collar 60, being held against escape by the closure piece 68. A brazing ring or brazing paste 72 (only those parts in the plane of the cross section being shown for clarity) is placed in position to braze the collar 60 into the opening 62. To insure bonding of the glass to the base of the thimble and the collar 60, the regions of these two metal members in engagement with the glass are pre-treated by any convenient method well known in the art to provide an oxidized surface where the glass is to seal to the metal. The entire assembly can now be heated to accomplish the brazing and simultaneously melt the glass 70 to form, upon subsequent solidification, an insulating sleeve around the thimble. Upon cooling, the closure piece 68 is removed and the item is complete. The portion 74 of the collar 60, lying intermediate that portion of the collar bonded to the glass and that portion of the collar brazed to the wall 64 serves to provide the flexibility needed to withstand thermal stresses.

In all of the foregoing figures, the final terminals would appear as shown in each respective figure with the exceptions that the brazing ring or paste would have melted and disappeared in the interfaces between the members they were intended to braze and, in FIG. 2, the portion of the metal cup indicated by the bracket 56 would no longer be visible, having been removed.

While, as previously indicated, the terminals of the present invention can be made in relatively small sizes, of the order of 1/4" for the outer diameter or largest transverse dimension of the metal cup or collar, in which range of size the corresponding wall thickness of the metal cup or collar would be of the order of not more than about 10 mils, nevertheless, the terminals can be made in other proportions as long as the thermal strains are provided for by a relatively thin metal section on the collar or cup.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. The method of making an insulated terminal assembly, for use in a vacuum tube or the like having a metal wall with an opening therethrough, which comprises the steps of inserting in said opening in said wall a relatively thin metal cup having an outer surface shaped to fit within said opening and having an inner re-entrant thimble portion extending upward from the base of said cup, said cup having a supply of glass therein adjacent said thimble; retaining said glass in said cup with the free surface of said glass in contact with the interior of said vacuum tube by virtue of said cup being concave upward towards the interior of said vacuum tube, whereby said vacuum tube can be brazed at a temperature exceeding the melting point of glass while still so retaining said glass in position in said cup; brazing said cup to said wall within said opening, the heat of said brazing operation melting said glass to form a sleeve of glass around the base of said thimble; allowing said glass to cool, forming a bond to the exterior of said thimble and the interior of the outer wall of said cup; and removing the metal joining said thimble to the main body of said cup to leave said thimble insulated from said cup by said glass; the length of said cup being so proportioned relative to the amount of glass that there remains an intermediate portion of said cup between the portion thereof brazed to said wall and the portion thereof in contact with said glass.

2. The method of claim 1 wherein the brazing material is applied to said assembly at that end of the cup remote from said glass.

3. The method of making an insulated terminal assembly for use in a vacuum tube or the like having a metal wall with an opening therethrough which comprises the steps of inserting in said opening in said wall a metal

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collar shaped to fit within said opening, placing across the open end of said collar, to close off said end, a closure piece of a material to which glass will not bond, inserting a metal thimble within said collar with its open end bearing against and thus closed by said closure piece, depositing a supply of glass in the annular space between said collar and said thimble to be held therein by said closure piece; brazing said collar to said wall within said opening, the heat of the said brazing operation melting said glass to form a sleeve of glass around the base of said thimble, and allowing said glass to cool, forming a bond to the exterior of said thimble and the interior of

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said collar; and removing said closure piece from the terminal assembly so made.

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