Feb. 11, 1958 R. U. CLARK 2,823,251

TERMINALS AND METHOD OF MAKING SAME

Filed April 12, 1954 2 Sheets-Sheet 1

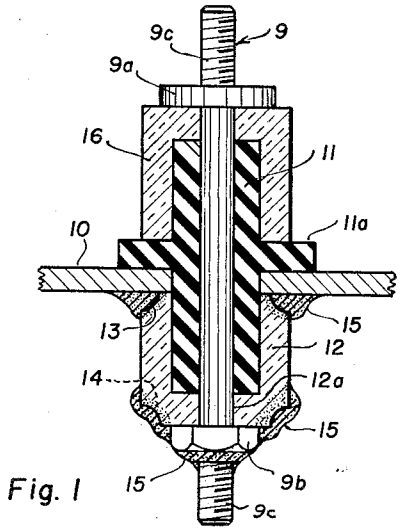


Fig. 1

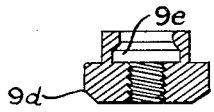


Fig. 2a

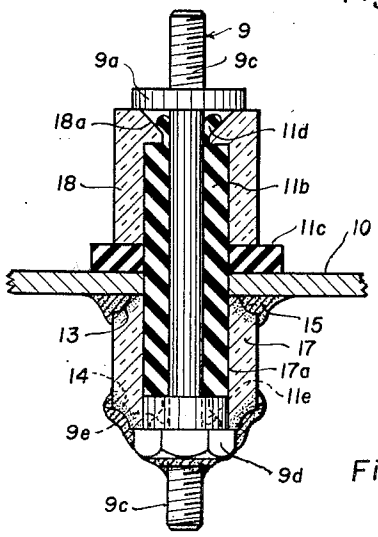


Fig. 2

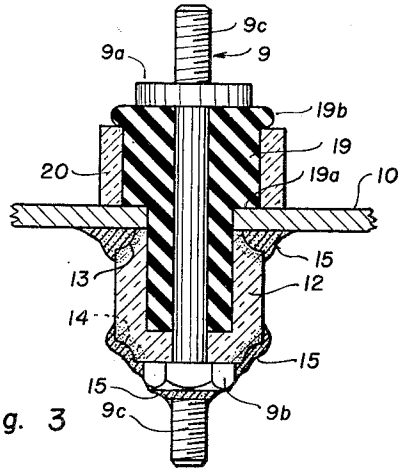


Fig. 3

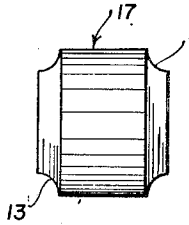


Fig. 5

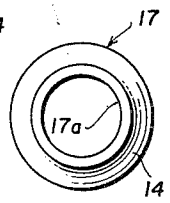


Fig. 5a

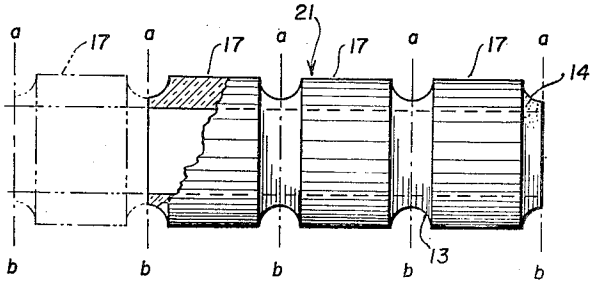


Fig. 4

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Feb. 11, 1958 R. U. CLARK 2,823,251

TERMINALS AND METHOD OF MAKING SAME

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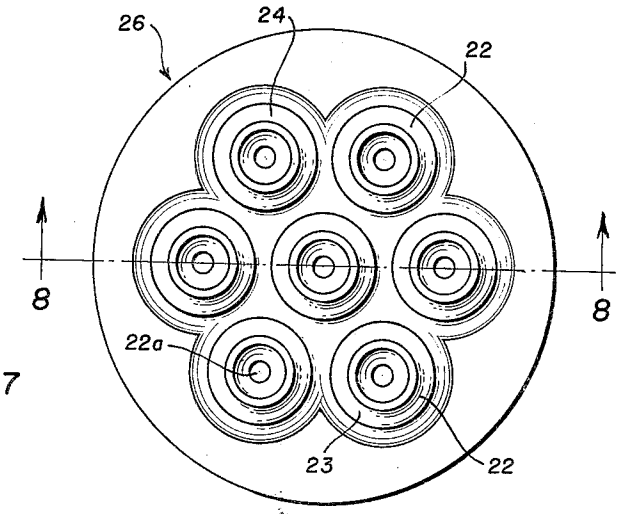


Fig. 7

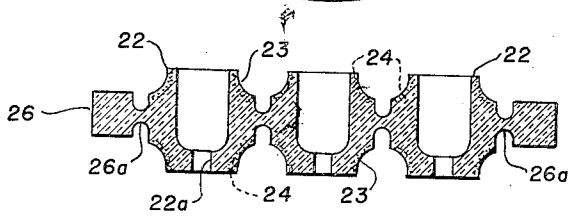


Fig. 8

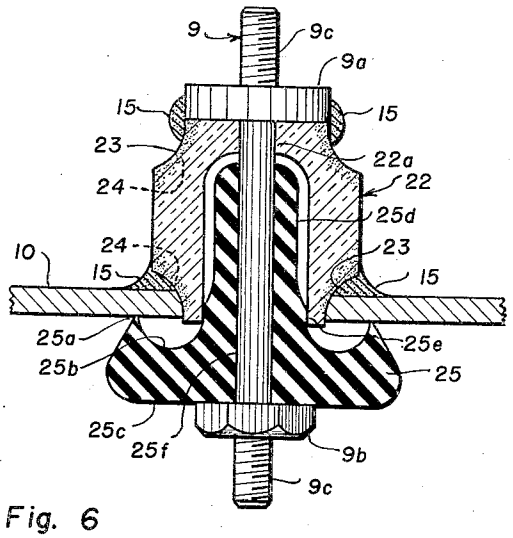


Fig. 6

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United States Patent Office

2,823,251

Patented Feb. 11, 1958

2,823,251

TERMINALS AND METHOD OF MAKING SAME

Richard U. Clark, West Acton, Mass.

Application April 12, 1954, Serial No. 422,315

8 Claims. (Cl. 174—153)

The present invention relates to electrical terminals and lead-in bushings and more particularly to improvements in such terminals and bushings which provide very high electrical insulation and vacuum tight characteristics for a conductor passing through a panel wall or housing, as well as improved methods of making the same.

This invention basically provides a construction and method of fabrication which results in a terminal that is not only an hermetic seal for an electrical conductor or conductors which carry current from without to within a sealed enclosure, but which also provides a vacuum tight seal. A vacuum tight seal may be defined as one that may be used successfully in either gas-filled or high vacuum electron tubes without danger of sufficient inherent leakage into the tube over a period of many years to materially affect the operational characteristics of the tube. In the past various types of hermetic seals have been developed which will readily exclude moisture and air from a sealed enclosure into which they may seal a terminal or conductor of electric current provided the enclosure is not exhausted to a high degree of vacuum. Under this high vacuum condition there will generally occur a very slow leakage, with so-called hermetic seals, which would prevent the enclosure from continually operating satisfactorily under high vacuum conditions.

Whereas terminals and lead-in bushings of the prior types, such as disclosed in my Patent No. 2,447,489 have provided very satisfactory hermetic seals and still find very wide use, the present improved terminal comprises an improvement thereover in that it is better suited to provide a vacuum tight seal over much longer periods and under more severe service conditions. In an increasing number of present day applications it is a prerequisite that the seal be completely vacuum tight over a period of years consistent with the life of the electrical equipment of which it forms a component part.

Soldered seals for terminals and the like have been used heretofore but have not proven fully satisfactory in that they have not withstood vibration and other disturbances, and particularly reheating temperatures to which they are necessarily subjected when closely adjacent terminals are soldered to the same panel or housing. There have also been developed various types of so-called solder seals wherein colloidal metal suspensions have been painted on as bands and subsequently fired into ceramic or glass, then the bands have been plated and tinned for solder sealing where the ceramic or glass passes through a panel or case, and also where a conducting member passes through the ceramic to provide a complete electrical terminal. Conventional solder seals of this type, although low in cost have not generally been adequate to provide a vacuum tight seal over a period of years. Prior types of hermetic solder seals depend upon their solder seal connection at the panel or case to provide all of the mechanical support to the terminal. This is poor practice since solder of the tin alloy type fatigues very easily, and also loses its physical strength rapidly as operating or use temperatures rise above 150 degrees

centigrade, although the same solder does not necessarily lose its sealing power unless ruptured. This rupture however is bound to take place if nothing is provided besides solder for the mechanical support to the terminal seal.

These and other disadvantages have been largely eliminated and overcome by my improved terminal construction and soldering technique, and my improved mounting arrangement and method of making the terminal components. In the present invention the aforementioned necessary mechanical support is provided to sustain the solder seal by means of clamping or truss mechanisms part of which also act as insert or baffle members to provide long internal electrical paths and give additional sealing ability to the assembly. In the combination of gasket or baffle members which offer a torsional support for the present invention, and the rigid solder sealed metal banded ceramic and through conductor electrode, which latter holds the parts under compression, there are also possible many variations or forms that make the device widely useful for a wide range of temperature and climatic conditions. My improved construction utilizes a ceramic element which is formed and fired by a novel method so as to provide metal bands or rings which facilitates its being soldered to adjacent metallic components to provide a vacuum tight solder seal. By this method gangs or multiple sections of the ceramic parts are pressed out in the form of break-out assemblies, leaving thin sections bounding or surrounding each discrete part, which latter can be readily cut, ground or grit blasted apart at the metal banded thinned out section, after banding and firing, thus providing, by halving each band, about one hundred percent increase in the number of actually applied bands at reduced handling and jigging costs. Various modifications of this improved method form a part of the present invention and serve to provide the metal banded ceramic parts, as well as the completed terminal, at relatively low cost of manufacture and assembly. I preferably solder the under-the-panel, or internal, ceramic element to the panel and to the metal stud and nut, and by using truss-like inserts or supplementary insulating members I thereby obtain a very robust seal by taking most of the mechanical shock, normally encountered in use, away from the soldered banded ceramics.

A further advantage of my improved terminal construction resides in the fact that the solder banded ceramic section may be kept relatively small and therefore low in cost. This is facilitated by its internal use wherein it is generally immersed continually in a highly insulative media, within the housing or case, such as wax, oil, resin or even a high pressure gas and its qualities are thus protected from high voltage flashover. A further advantage accrues from the construction of the external section which may be formed of two or more different materials and inserts or gasket means of novel form or configuration which break the surface continuity and thereby prevent surface tracking and other causes of terminal failure. Inasmuch as all of the terminal parts are first firmly bolted in place, a relatively large number of terminals can be soldered to the same panel without the danger of one terminal loosening other adjacent terminals. There is also provided an improved construction which allows for expansion of the gasket during high temperature operations of the terminal assembly.

It is accordingly a primary object of the present invention to provide a terminal of long-lasting hermetic and vacuum sealing qualities, which is low in cost, relatively small and readily handled and assembled. A further object resides in the provision of a highly insulative, vacuum tight terminal of improved shock-proof mechanically supported clamped or trussed construction. A still

further object lies in improved methods of forming, extruding and moulding a ceramic shell element of novel construction and form. Another objective includes the provision of such improved solder banded ceramic elements which are particularly adapted to providing improved solder sealing joints with adjacent components insuring durable tight seals which are long lasting and withstand re-heating, shock and vibration without leakage. A still further object resides in the manufacture and assembly of such improved ceramic elements by improved cutting and breaking apart methods and arrangements which eliminate prior jigging procedures and other costly manufacturing methods. Another object resides in an improved terminal assembly of elements of different materials which break continuity and provide long internal electrical paths which prevent surface tracking and exhibit other desirable characteristics of a satisfactory terminal. A corollary objective resides in an improved cooperative relationship of the respective gasketing inserts, baffle elements and other components which provide for expansion of the insulating material under elevated temperatures and other improved operating characteristics of the disclosed terminal construction.

Other objects and features of the present invention will be apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings forming a part hereof, in which:

Fig. 1 shows a longitudinal section through an improved terminal constructed in accordance with the present invention;

Fig. 2 shows a similar view of a modified form of terminal;

Fig. 2*a* is a cross-sectional view of the tightening means of Fig. 2;

Fig. 3 is a similar view of a further modification of the invention;

Fig. 4 is a view partly broken away depicting an extruded tube containing internal ceramic shells used in the above forms of terminals;

Figs. 5 and 5*a* show the side and end views, respectively, of the internal ceramic elements which appear in certain of the foregoing figures;

Fig. 6 shows a longitudinal section through a modified form of terminal in which the solder banded ceramic element is of a different form and is disposed externally of the mounting panel;

Fig. 7 is a plan view of a moulded disc containing a plurality of the ceramic elements of the type shown in Fig. 6; and

Fig. 8 is a sectional view of the same as taken along the lines 8—8 thereof.

Referring now to Fig. 1, the numeral **9** represents a metallic stud or electrode having an integral flange **9***a* adjacent its upper threaded terminal **9***c*. It preferably also has a lower threaded terminal **9***c* to receive a threaded metallic nut **9***b*. The panel or wall of the housing **10** is provided with a suitable hole or opening into which an integrally flanged single section insert or gasket **11** of a rubber-like or other suitable resilient insulating material may be inserted from the upper or external side of the panel with the integral insert flange **11***a* bearing against the panel external face. An outer or external tubular ceramic cup or shell **16** is placed over the insert **11**, and the shank of the electrode stud **9** is inserted through the central bores of both the insert and the outer shell to project below and internally of the panel **10**. The shell **16** externally protects the gasket or insert **11**.

The numeral **12** represents an improved ceramic shell which may be formed of steatite, alumina or other insulating material of similar properties. It is of a generally tubular shape, such as the outer shell **16**, having similar internal bores, such as at **12***a* to fit over and around the shank of the electrode **9**, and that portion of the insert **11** which projects through the panel **10**. It is, however, provided with concave chamfered peripheral edges **13** which are conditioned to adapt the chamfered and adjacent surfaces to be soldered to the adjacent metallic components of the terminal. Upon assembling the terminal, the nut **9***b* is tensioned or tightened to compress the insert **11** to the desired degree.

The improved ceramic shell **12** is initially formed with or has cut into it, the grooves or chamfers **13** which are painted with a material such as molybdenum oxide powder sintered into the ceramic which is applied as a coating prior to the firing of the ceramic body, which may preferably be accomplished by reduction in hydrogen at a temperature of 900° C. or higher with a reducing flame and is silver coated to provide a suitable soldering surface. This coating is applied in a suitable carrier such as amyl acetate and is brushed on, sprayed on or otherwise applied. This serves to impregnate the ceramic as at **14** with an integral metal band which terminates in a metal banded surface which forms a very good bond when forming an essential part of the soldered joint **15**. A first soldered joint **15** provides a vacuum-tight seal between the upper chamfer **13**, and its metal banding **14**, of the ceramic shell **12** to the undersurface of the panel **10**. The second soldered joint **15** provides a vacuum-tight seal between the nut **9***b* and the stud threads **9***c*, as well as between the nut **9***b* and the lower chamfer **13** and its metal banding **14** of the ceramic element **12**. The lower section of the insert **11** is completely encased by the ceramic cup **12** and its metal banded solder seal **15**. This results in an improved terminal which is completely vacuum-tight for exceedingly long periods, as determined by mass spectrograph test and the soft insulating material of the insert not only provides a very good cushioning effect to any shocks to which the terminal may be subjected but also serves to break the electrolysis path from stud to panel when excited under high humidity conditions.

The terminal modification in Fig. 2 is otherwise identical with that of Fig. 1 with the exception of the two-piece gasket **11***b*—**11***c* and the provision of expansion spaces at the ends of the straight tubular insert or gasket portion **11***b* into which the insulating material is caused to flow when the recessed bushing type nut **9***d* is tightened upon the lower threads **9***c* of the stud **9**. This also permits expansion of the gasket during high temperature operations of the assembly but tends to prevent the gasket from completely pulling back upon cooling. The bushing portion of the nut **9***d*, as shown in Fig. 2*a*, is provided with a conic bore or taper **9***e* which provides a recess or space by means of the countersunk oversize hole or bore into which the insert **11***b* flows as at **11***e*. The upper ceramic shell **18** is similarly formed with a conic bore or taper **18***a* which provides a recess or space into which the insert **11***b* flows as at **11***d*. In this modification of Fig. 2 the insert **11***b* may preferably be formed from tubular stock inserted within a tightly fitting compressible washer **11***c*, as distinguished from the integral flange **11***a* of the insert of Fig. 1. The lower ceramic shell or cup **17** has a straight or continuous bore **17***a* to closely fit over the outside diameter of the insert **11***b* and that of the bushing of the nut **9***d*. The terminal of Fig. 2 is otherwise similar to that of Fig. 1 in the formation of the ceramic element **17** and its vacuum-tight soldered seals **15** against the panel **10** and the nut **9***d*, as well as between the nut and the threads **9***c*, and will embody all of the same desirable characteristics thereof. Obviously the expansion spaces for the insert or gasket, as at **11***d*, can also be provided in the ceramic shells **12** and **16** of the terminal of Fig. 1.

The terminal of Fig. 3 utilizes a partly confined integral T-shape cross-section form of gasket or insert **19** which allows for partial gasket overflow at **19***b* adjacent the stud flange **9***a*, thereby differing in location from that considered in Figs. 1 and 2. This type of gasket is favored for materials having a memory type of flow characteristic

as with Teflon or other fluorocarbon resinous materials, rather than to be used with the more rubber-like resilient materials of the constructions of Figs. 1 and 2. It is however possible to use either type of gasket material in the terminals of Figs. 1, 2 and 3. The enlarged diameter portion of the insert **19** is formed with a shoulder **19***a* which bears against the outer face of the panel **10** by tensioning of the nut **9***b* of the electrode **9**, being constrained thereagainst by the previously assembled ceramic ring or tube **20** which closely fits over the large diameter portion of the insert. The ceramic ring preferably confines the height of the large diameter portion of the insert **19** for 80% of the height (plus or minus 10%) which I have found gives the best seal. This constraining effect of the ring **20**, being of slightly lesser height than the head of the insert, also cooperates with the stud flange **9***a*, from which it is spaced, to provide for the overflow bead or bulge at **19***b*. The stud **9** and the metal banded ceramic shell **12** of Fig. 3, may be otherwise the same as the corresponding components of Figs. 1 and 2, as well as the application of the improved vacuum-tight solder seals at **15** against the panel, the stud and the stud nut. While threaded terminals have been described and illustrated on each of the modifications it will be obvious that my invention is not limited thereto but that any of the conventional stud shapes and accessories such as the well known turret and slotted heads, eyelet, lug and other forms may be provided for making the conductor lead connections, as may be found desirable in any particular installation.

There is illustrated in Figs. 4 and 5 a method of extruding the ceramic elements such as the lower shell **17** of the terminal of Fig. 2, in the form of a long tube **21** having a uniform or straight internal bore **17***a*. Following the extrusion the tube **21** is grooved as at **13** with semi-circular recesses or serrations cut into the outer wall centered about and spaced at the transverse planes *a*—*b* defining the lengths, or heights, of the ceramic element. Each groove **13** is then banded, preferably by painting or otherwise applying to the ceramic, which may be steatite, alumina, or other material, a band of molybdenum oxide of very fine grain size. This coating may be applied in a sutiable carrier such as amyl acetate and may be brushed or sprayed upon the ceramic, or the basic band may be applied by other processes such as by the titanium hydride technique, or others. This oxide or other coating is then fired into the ceramic in and adjacent to the grooves **13**, preferably at a temperature at or above 900 degrees centigrade, in an atmosphere of hydrogen so as to reduce the metal oxide, while sintering or fusing it to the ceramic, into the parent metal, as indicated at **14**. This parent metal is then coated with a fused-on band of silver to which soft solder, or if desired, hard solder, may be applied in the final type of terminal assembly in which the part is to be used. The individual ceramic elements **17** are sawed or cut apart along the cutting planes *a*—*b* from the gang or multiple tube **21** and for this purpose I have found the dental type sand blast tool manufactured by one of the dental accessory manufacturers particularly adapted for accomplishing a smooth and accurate cutting operation and finish, to provide the completed unit of Fig. 5 ready for use. This method of making the ceramic elements, in forming the soldering bands in the grooves of a readily handled multiple gang tube, as distinguished from the difficulties in handling and separately coating the conventional small ceramic parts, provides a great saving in the cost of production as well as obtaining a better and more uniform product. In the final terminal assembly this facilitates making an extremely satisfactory vacuum-tight seal and I preferably allow the excess solder to flow and solder the ceramic over a generous area to the stud, panel and stud nut or retainer, upon heating.

In the modification of Fig. 6 the stud **9** is similar to that of the earlier forms, having an integral flange **9***a*, a retaining nut **9***b* and may have threaded terminals **9***c*. The ceramic cup or shell **22**, however, is preferably disposed on the outer side of the panel **10**, to which it is soldered as at **15**. It preferably has a small bore **22***a* to closely fit the stud shank and a larger internally rounded bore to receive the rigid plastic type insert **25** as at **25***e*. This ceramic cup or cap **22** has similar peripheral grooves **23** at its top and bottom which are metal banded at **24** as previously described to provide the improved soldered seals **15** to the stud flange **9***a* and to the panel **10**, respectively.

The rigid plastic insert **25** is generally T-shaped in cross-section and its central bore **25***f* is inserted over the stud shank from below the panel **10** with its stem or neck portion **25***d* extending up into the larger bore of the ceramic cap **22**, providing a long internal path with respect thereto. It may preferably bear thereagainst at the annular contact point or surface **25***e* and has an annular or circular contact edge **25***a* which bears in a truss-like manner against the lower face of the panel **10** to brace and support the ceramic cap **22** therein by the tightening of the nut **9***b* against the lower transverse face **25***c* of the insert **25**. The opposite face of the head of the insert **25** is annularly recessed as at **25***b*, terminating at the contact point or ring **25***a* and when tightened by the nut **9***b* it serves as a secure anchorage and support for the electrode stud **9** and the ceramic cap **22** in a simplified trussed solder seal arrangement in which the banded ceramic is soldered in position outside of the enclosure which it terminates. The ceramic of the terminal, as well as its solder seals, may be externally coated with an impervious coat of fluorocarbon resin material to prevent surface tracking or plating under conditions of high humidity, when electrically polarized, as outlined and claimed in my co-pending application Serial No. 239,906 covering an Hermetically Sealed Electrical Terminal, filed August 2, 1951. In the terminals of Figs. 1, 2 and 3, however, this coating is not required as the external path is broken so as to prevent tracking or plating. The trussed construction of the several disclosed terminal modifications prevents breakage in the event of mechanical shock. The terminal of Fig. 6 may be applied to the case or enclosure wall **10** to be terminated with hard or silver solder, if desired, provided the material of the baffle piece is a ceramic or other insulating material which will withstand the temperatures reached during the soldering operation. The flange part of the baffle or insert member **25** is ridged to the point-like construction at **25***a* to reduce electrical leakage to the panel in those cases where the insert material of high mechanical strength, but possibly of relatively low dielectric strength, is used.

In Figs. 7 and 8 there is shown an alternative method of manufacturing the banded ceramic elements used in the assemblies depicted in the modifications of Figs. 1, 3 and 6 to provide the same at a reasonably low cost of manufacture. A mould is made in the desired shape to form a disc of the desired ceramic material **25** containing a plurality of formed terminal elements **22**, which is in the form of the ceramic cap of Fig. 6, but which might alternatively be that of Fig. 1 or 2. Each cap element **22** is formed with the grooves or concave chamfers **23** at the peripheral edges of each element. Each ceramic element is connected to the other elements by a relatively thin web or intermediate disc portion **26***a* which provides a breakout means to separate the elements from the main body of the disc **25**. The elements **22** are similarly metal banded with the fired-in material at **24** as described in connection with the extruded ceramic units of Figs. 4 and 5 to prepare the same for the improved solder seals described above. The several elements **22** may alternatively be cut apart at the neck portions **26***a* by the sand or grit blasting tool and method heretofore described and by which their outer surfaces may be cut down or ground to the desired cylindrical shape acquired in the moulding process. While seven individual units **22** are illustrated in the moulded disc **26** it will be apparent that a greater or lesser number

may be formed depending upon the nature of the moulding equipment or other factors.

Other forms and modifications of the disclosed constructions and methods which will occur to those skilled in the art after reading the foregoing description are intended to come within the scope and spirit of the present invention as more particularly set forth in the appended claims.

I claim:

1. A vacuum-tight electrical terminal for the support of a conductor through an opening in a panel comprising a tubular resilient insert having an external flange disposed thereon, an outer cap element of apertured tubular form encasing an outer portion of said insert and bearing against said flange, an electric conducting stud disposed within said outer cap element and said insert, said stud and said insert extending through the opening in the panel, an inner cap element of apertured tubular form encasing the inner extending portion of said insert and an adjacent portion of said stud, said inner cap element having a first end surface in contact with said panel, means carried by said stud engaging a second end surface of said inner cap element for compressing said cap elements against said insert and the panel, said inner cap element formed from a ceramic material having metal banded fired-in chamfered grooves at its external peripheral edges adjacent said compressing end contact surfaces, and metal banded solder seals at said peripheral grooves arranged to seal said inner cap element to the panel and to seal said means to said stud and to said inner cap element in vacuum-tight joints, said inner cap element having disposed therein means carrying an outwardly divergent aperture surrounding the said electric conducting stud into which said resilient insert may flow under compression in a direction away from said panel when operated at an elevated temperature.

2. In an electrical terminal having a resilient tubular insert of insulating material adapted for mounting within an opening in a panel, an electrode stud axially disposed within said tubular insert, said stud having a threaded shank portion and a ceramic cap element encasing said tubular insert, the improvement comprising an internally threaded element threadedly engaging said threaded shank portion, said internally threaded element bearing against an end of said insert and having an adjacent annular recess of outwardly divergent configuration into which said resilient insert material is adapted to expand in a direction away from the panel when compressed by the threaded engagement of said threaded element with said electrode stud shank.

3. In a vacuum-tight electrical terminal including a metallic electrode, a resilient insert of insulating material arranged for insertion over the shank of said electrode and into an opening in a panel, an annular resilient member encircling said insert and disposed against said panel, a tubular ceramic element encasing a portion of said electrode and a portion of said insert, said ceramic element bearing against the said annular member on its face away from the panel, a second tubular ceramic element encasing a remote portion of the shank of said electrode and a portion of said insert on an opposite side of said panel, means to compress said insert and said annular member against said panel, and solder seals joining said second ceramic element to said panel and joining said compressing means to said second ceramic element and to said electrode in vacuum-tight joints, one of said ceramic elements provided with a tapered aperture adjacent said resilient insert and said electrode shank into which said resilient insert material may partially flow in a direction away from said panel when compressed by said means and when subjected to expansion of the insert material when the terminal is subjected to a higher temperature during its use.

4. The combination with an electrical terminal for the support of a conductor through an opening in a panel comprising a tubular resilient insert having an external flange disposed thereon, said flange bearing against the outer side of the panel, an outer cap element of apertured tubular form encasing an outer portion of said insert and bearing against said flange, an electric conducting stud disposed within said outer cap element and said insert, said stud and said insert extending through the opening in the panel, an inner cap element of apertured tubular form encasing the inner extending portion of said insert and an adjacent portion of said stud, means carried by said stud for compressing said cap elements against said insert and the panel, and metal banded solder seals arranged to seal said inner cap element to the panel and to seal said compressing means to said stud and to said inner cap element, one of said cap elements having a tapered aperture surrounding said stud and disposed adjacent an end of said resilient insert into which said resilient insert may be caused to partially flow in a direction away from said panel when subjected to expansion as said terminal is subjected to higher temperatures during its service operation.

5. An hermetic electrical terminal for the support of a conductor through an opening in a panel comprising a tubular resilient insert having an external flange disposed thereon, said flange bearing against the outside of said panel, an outer ceramic cap element of apertured tubular form encasing an outer portion of said insert and bearing against said flange, an electric conducting stud disposed within said outer ceramic cap element and said insert, said stud and said insert extending through the opening in the panel, an inner ceramic cap element of apertured form encasing the inner extending portion of said insert and an adjacent portion of said stud, means carried by said stud for compressing said cap elements against said insert and the panel, peripheral metal banded solder-coated seal means arranged to seal said inner ceramic cap element to the panel and solder seal means to seal said compressing means to said stud and to the face of the inner ceramic cap element most remote from said panel, said hermetic terminal characterised by one of said ceramic cap elements having a tapered aperture surrounding said stud and disposed adjacent to an end of said resilient insert into which said resilient insert may be caused to partially flow in a direction away from said panel when subjected to expansion due to a rise in its temperature.

6. A vacuum-tight feed-through electrical terminal comprising a metallic electrode arranged by means of enlarged end section elements to compress a complementary insulating assembly within an aperture in a panel, a tubular resilient insert encasing said electrode throughout most of its length, a resilient annulus positioned intermediate the ends of said insert, a counter-bored tubular ceramic member arranged to encase part of the electrode and one end of said insert up to said annulus, a second tubular ceramic member arranged to encase most of the remaining part of said electrode and the remainder of said insert after insertion of said insert into said aperture in said panel, means comprising an outwardly diverging opening partially closing the bore of said second ceramic member, said means being conductive at least in part but insulated from said panel, adherent metallic peripheral coating bands on each end of said second ceramic member, a compressive metallic element on the end of said electrode abutting the partially closed end of said second ceramic member and solder joining one peripheral band to said panel and the other peripheral band to said electrode and said compressive element thereof, said divergent configuration providing expansion and holding space for one end of said insert to thereby permit successful operation at elevated temperatures.

7. In a vacuum-tight electrical lead-through terminal for an opening in a panel including a metallic electrode having a shank, a resilient insert of insulating material having a central bore into which said electrode shank is arranged for insertion, a panel having an opening into

which said electrode shank and said insert are arranged for insertion, a ceramic element having a central bore adapted to closely encase said insert, said ceramic element bore formed with a reduced diameter outwardly divergent portion remotely spaced from the panel adapted to provide an expansion space adjacent an end of said insert and tightening means associated with said electrode arranged to compress said insert within said ceramic element bore whereby said resilient insert material may partially flow into said expansion space in a direction away from the panel when compressed by said tightening means and when subjected to expansion of the insert material when the terminal is subjected to a higher temperature during its use.

8. In a vacuum-tight lead-through terminal for an opening in a panel including a metallic electrode having a shank, a resilient insert of insulating material having a central bore into which said electrode shank is arranged for insertion, a panel having an opening into which said electrode shank and said insert are arranged for insertion, a ceramic element having a central bore adapted to closely encase said insert and tightening means arranged to engage said electrode shank, said tightening means having a recessed portion adapted to provide an internal expansion space adjacent an end of said insert, said tightening means engaging said electrode shank and said central bore of said ceramic element so as to compress

said insert within said ceramic element bore and into said recessed portion whereby said resilient insert material may partially flow into said expansion space in a direction away from the panel when compressed by said tightening means and when subjected to expansion of the insert material when the terminal may become heated to a higher temperature during its use, and a solder seal joining the adjacent portion of said ceramic element to said tightening means and to said electrode shank to thereby form a vacuum-tight joint therebetween.

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