May 18, 1965 B. L. WELLER ETAL 3,184,661

TERMINAL MEANS FOR ELECTRICAL COMPONENTS

Filed Oct. 18, 1962 2 Sheets-Sheet 1

Fig. 1

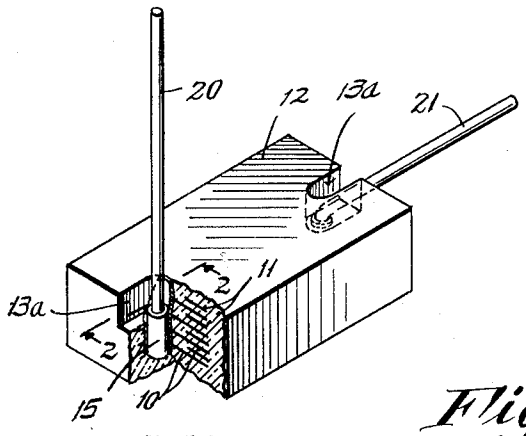


Fig. 3

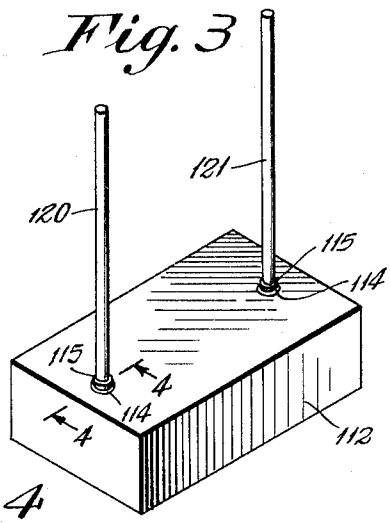


Fig. 4

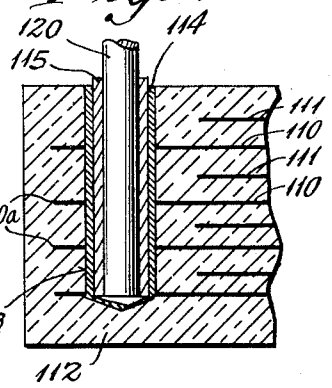


Fig. 2

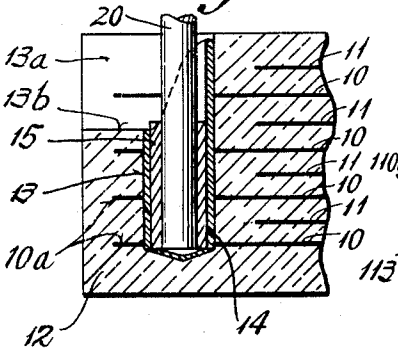


Fig. 8

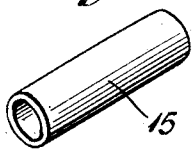


Fig. 5

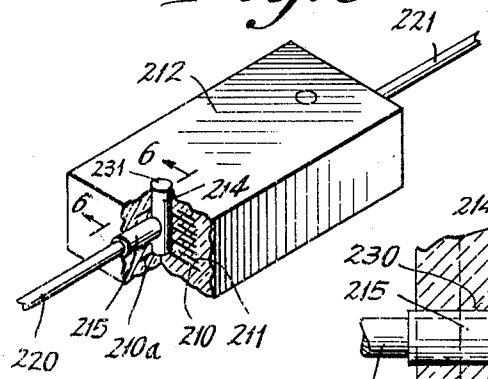
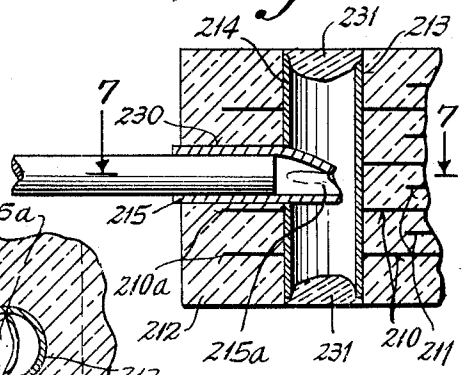


Fig. 6



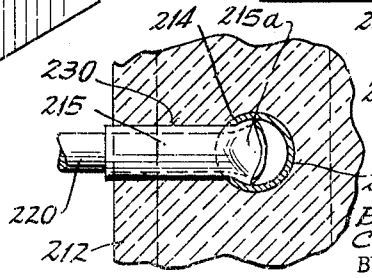


Fig. 7

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Fig. 9

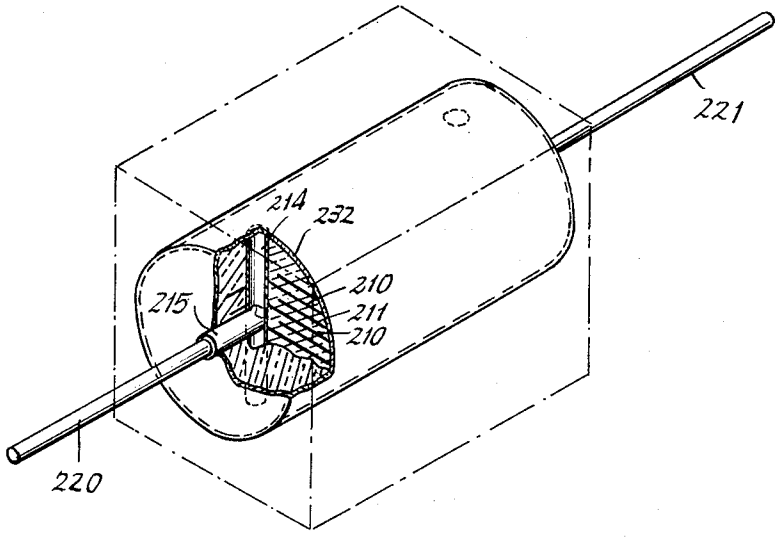


Fig. 10

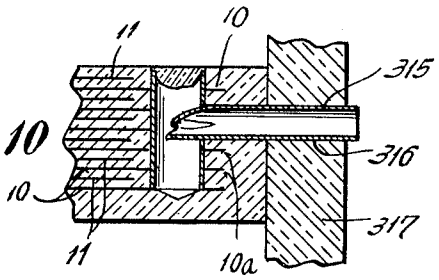
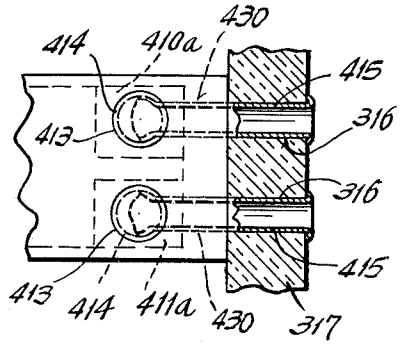


Fig. 11



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TERMINAL MEANS FOR ELECTRICAL COMPONENTS

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Filed Oct. 18, 1962, Ser. No. 231,344
8 Claims. (Cl. 317—261)

The present invention relates to terminal means for electrical components having bodies of thermo-shrinkable material and more particularly to a resilient sleeve adapted to be disposed within the body and electrically connected to elements therein and held in position in the body by the shrinking of the body around the sleeve and into holding engagement with the sleeve, which sleeve can constitute a terminal or a socket for receiving and holding a connector or a terminal lead wire.

Heretofore, it has been the practice to insert terminal wires into a recess in a component having a thermo-shrinkable body, such as a ceramic, vitreous, organic or other material requiring a firing or sintering operation, before the body has been fired or hardened. This has been explained in U.S. Patent No. 3,021,589. In order to make electrical contact with a conducting element located in the body and exposed in the recess a connecting medium, such as wet silver, has had to be used, because of the lack of resilience in the wire, with the attendant danger of the connecting medium being displaced or weakened incident to the insertion of the wire. The unit thus assembled is then fed through a furnace. The handling of the component with the wet silver, during lead insertion, and the projecting terminal wire leads during subsequent manufacturing operations has been difficult and time consuming. Further, firing of the body causes the body to shrink into gripping relation with the wire. In some instances, due to slight variations in the close tolerances between the lead wire and the recess, the body has cracked because of the pressure that is built up in the brittle fired body due to the lack of resiliency in the wire. After the firing, the handling and storage of the components having the wire extending therefrom requires great care and large amounts of space to prevent damage to the leads and their connection to the body and electrical elements therein as will reflect in the reliability of the component.

It is an object of the present invention to overcome these disadvantages by providing a component of high reliability and great versatility, which component lends itself to a simplification in the handling during the manufacture and storage thereof.

This is accomplished by providing the body with a thin resilient sleeve of high temperature conducting material, capable of withstanding the high firing temperatures, disposed in the recess in communication with electrical elements in the body, which sleeve can constitute a terminal or a socket for a terminal wire.

The sleeve when inserted into the recess, which is lined with a silver bonded in electrical connection with the electrical element in the component, will, due to its resiliency, conform to and be in intimate contact therewith so as to provide a more reliable electrical connection to the electrical element. Further the resiliency of the sleeve provides for a stronger anchorage of the sleeve in the recess as it permits the body to shrink and grip it tightly during the firing operation without setting up strain in the body, and thus increases its reliability with regard to terminal lead pull strength over that heretofore achieved by the insertion of the terminal wire into the recess.

The component of the present invention is highly versatile in that it can be made up in large quantities as a basic unit and, after firing, terminal wires may be readily secured in the sockets formed by the sleeves. The terminal

wires, many of which may have melting points lower than the firing point of the body, are selected to suit the particular style or material requirements, thus permitting a large number of different components to be produced some of which could not have heretofore been made because the material of said terminal wires would not have withstood the firing temperatures. Further, by extending the sleeve beyond the body, the sleeve can be connected directly by various means into circuits of a circuit board or the like.

The use of the terminal means in the present invention greatly facilitates the manufacture of the component in that it permits the component, before firing, to have a dry relatively non-distortable lining of silver or the like formed in the recess to connect with the electrical elements in the component, since the resiliency of the sleeve will permit the sleeve to conform to the material in the recess. When the component is fired the shrinkage of the body into gripping relation with the sleeve will secure the sleeve tightly in position and the resiliency of the sleeve will permit slight variations in the sleeve for accommodating variations in the recess resulting from shrinkage without setting up undue strain in the body.

The use of the sleeve embedded in the body greatly facilitates the handling of the component, in comparison with the situation wherein the component having the terminal wires projecting therefrom must be handled with extreme care in subsequent operations, since danger of applying undue force to the terminal wires with its inherent damage to the electrical connections in the body is eliminated. Also, the projecting terminal wires as the component passes through the firing tunnel produces, in effect, a baffle which in some instances alters the flow of heat thus varying the curing operation of the material of the body. Furthermore, when the components having the projecting terminal wires are handled in bulk, there is great danger of tangling of the units and unintentional damaging of the electrical or mechanical connection to the electrical elements in the body, thus increasing the danger of loss of reliability.

The components of the present invention also, because of their lack of projecting terminal wires, may be stacked and stored in a compact fashion and, as has been noted, can have the particular leads attached thereto as desired, thus requiring a smaller inventory of components in order to satisfy a wide variety of lead requirements.

The present invention is particularly well suited for use in capacitors wherein there is located within the body a plurality of separate electrical plates or electrodes which are exposed in the recess and are connected to a silver or similar lining in the recess, since the present invention provides for and insures a better electrical connection to the plates from the terminal means and provides a greater resistance to terminal pull than heretofore achieved.

Other features and advantages of the invention will be apparent from the specification and claims when considered in connection with the accompanying drawings in which:

FIGURE 1 is a perspective view, partly in section, of a capacitor having lead wires disposed for axial or radial extension.

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1.

FIG. 3 is a perspective view of another form of capacitor having radial lead wires.

FIG. 4 is a sectional view taken along line 4—4 of FIG. 3.

FIG. 5 is a perspective view, partly in section, of another form of capacitor having axially disposed leads.

FIG. 6 is a sectional view taken along line 6—6 of FIG. 5.

FIG. 7 is a sectional view taken along line 7—7 of FIG. 6.

FIG. 8 is a perspective view of the sleeve.

FIG. 9 is a perspective view, partly in section, of a cylindrical capacitor having axial leads.

FIG. 10 is a sectional view of a capacitor having an axially projecting sleeve adapted to form the terminal for the capacitor.

FIG. 11 is a view, partly in section, of a capacitor having terminal sleeves projecting from the same end and headed over into electrical engagement with the circuit of a circuit board.

While the present invention may be used in various electrical components, such as inductors, resistors, transistors, thermistors and combinations thereof to provide an electrical terminal for an electrical element disposed in a fired body of thermo-shrinkable material, it is herein illustrated in connection with capacitors. The capacitors are provided with cooperating spaced electrical elements 10, 11, preferably silver plates or the like capable of withstanding firing temperatures for the body material, each forming an electrode of the capacitor, which are embedded in a body 12 of thermo-shrinkable material such as a ceramic, vitreous, organic or other material requiring a firing or sintering operation. The plates 10, 11 have portions in offset relation such as shown at 10*a* in FIG. 2. Recesses 13 are formed in the body before it is fired so as to pass through the offset portions, and connector means are positioned in the recess to connect said plates to form the electrodes of the capacitor. In the preferred form of the invention the connector means is a lining 14 of silver.

In accordance with the present invention a resilient sleeve 15 of silver or the like material which is resistant to firing temperature of the body is inserted into the recess to form a terminal means for the body. While the sleeve can be provided with slits or the like to make it resilient, it is at present preferred to form the sleeve with a thin resilient wall, such as shown in FIG. 8 which can yield when inserted into the lining 14 to prevent scraping of the silver from the walls of the recess and can be gripped by the body as it shrinks during firing to be securely held in the recess without placing undue strain on the body which becomes brittle as an incident to the firing operation. The sleeve is also held in good electrical connection with the lining and thus provides good electrical reliability for the capacitor at this point.

With the sleeve thus securely held in the body a connector plug can be inserted therein to make connection therewith or as illustrated terminal lead wires of various styles and materials which might not withstand the firing temperature can be secured in the sleeve, after firing of the body, by brazing, soldering or the like. When thus securely connected to the sleeve, the leads have great strength to withstand substantial pulls as may be applied thereto and thus have great reliability with respect to the lead-pull factor.

Preferably, the sleeve extends to the surface of the component or slightly beyond so that any bending of the lead wire will be against the edge of the sleeve and not against the body which might tend to damage the body or the electrical connection at this point.

This construction not only improves the reliability of the component but also greatly simplifies the manufacture thereof. For example, with the use of the resilient sleeve the liner material which had to be in a wet condition in the prior processes in order to accommodate itself to the substantially rigid terminal lead wires can now be permitted to dry and the sleeve inserted into the recess at a later time since the sleeve, being resilient, can accommodate itself to the recess without the danger of wiping the lining material from the walls thereof and destroying the electrical connection between at least some of the plates.

Furthermore, since the terminal lead wires do not have to be inserted until after the firing operation, it simplifies the handling of the units before and during the firing operation because they can be stacked or otherwise handled without interference from the lead wires projecting from the body. Also, during the firing operation it has been found that the lead wires tend to produce a baffle above the units which affects the flow of air during the firing operation and affects the curing of the bodies.

After the firing operation care must be employed in handling the units with the wires projecting therefrom to avoid damaging the brittle fired body. An additional advantage of the present construction resides in the fact that test jacks or leads can be inserted into the sockets formed by the sleeves to permit testing of the components prior to connecting of lead wires thereto.

Not only does the present invention simplify the handling during the manufacture, but it also increases the versatility of the component and simplifies the matter of storage and inventory since a supply of tested component bodies having predetermined electrical characteristics can, without the lead wires, be readily and safely stored in a compact arrangement. When an order of a predetermined specification is to be filled, the component bodies having the required electrical characteristics can be withdrawn from storage and provided with lead wires of the desired configuration and of a material which may be brazed, soldered or otherwise secured to the sleeve. This, therefore, permits a minimum inventory of component bodies to provide a large supply of various types of finished components.

As will be clear from the drawings herein, the invention lends itself well to various types of capacitors. For example, in FIGS. 1 and 2 the capacitor is one in which the bendable terminal lead wires 20, 21 are secured in the sleeve and may be extended either in a radial or axial direction.

In this form of the invention a plurality of cooperable electrical elements 10, 11 forming the plates for the capacitor are disposed in the body of thermo-shrinkable material 12 in spaced relation. A recess 13 is formed in each end of the body to extend transversely thereof. As shown in FIGS. 1 and 2 the recess passes through the offset portions 10*a* of the plates 10. Also, a notch 13*a* is cut in the upper portion of the body adjacent each end to communicate with the recess 13 so as to permit the lead wires 20, 21 to extend radially as shown at the left of FIG. 1 or to be bent to extend axially of the body as shown in the right-hand lead in FIG. 1. The recess is lined with a liner 14 of a silver or the like material capable of withstanding firing temperatures which functions to connect all of the projecting portions of the plates 10*a* together to form an electrode for the capacitor.

The sleeve 15 which is of thin resilient silver or the like material capable of withstanding firing temperatures is inserted into the recess and within the liner prior to the firing of the body. Preferably the sleeve is of such a length that its end terminates at, or slightly above, the shelf 13*b* formed by the notch 13*a* in the body. It will be seen that the edge of the sleeve will support the lead wires as they are bent to the axial position to form a sharp bend therein and to prevent damage to the brittle body if subjected to the bending force.

As an incident to the firing of the body, the liner will bond to the body and to the plates 10*a* and the sleeve will be gripped by the thermo-shrinkable material which will firmly anchor it in place and secure it in good electrical connection with the plates to form the terminal means for the electrode.

If desired, the terminal lead wires 20, 21 can be inserted and secured to the sleeve after firing, or, if the body is to be stored, the leads can be inserted when the fired body is withdrawn from storage and ready for shipment.

In the form of the invention shown in FIG. 3, it is desired to have the terminal lead wires 120, 121 extend

radially of the body at both ends. As shown in FIG. 4, the electrical plates **110**, **111** are disposed in spaced relation in a thermo-shrinkable body **112** and a recess **113** is formed in the body extending through the projecting portions **110***a*. The recess is lined with a lining of silver **114** connecting the plates **110** together to form one electrode of the capacitor. A thin resilient sleeve **115** is disposed in the recess **113** and within the liner **114** so as to be held in good electrical and mechanical engagement therewith by the shrinking of the body during firing. A similar arrangement is provided at the other end with the sleeve passing through similar projecting portions (not shown) of the plates **111** to form the other electrode of the capacitor.

As will be noted in FIGS. 3 and 4, the sleeves **115** extend to or slightly above the surface of the body so that the terminal wire when inserted in position and connected to the sleeve, will apply any force incident to the bending of the lead to the end of the sleeve rather than to the brittle body.

In the form of the invention shown in FIGS. 5–7, a capacitor with axial leads is provided. In this form of the invention the sets of plates **210**, **211** are disposed in offset spaced relation in the body **212** with projecting portions **210***a* of one set of plates offset from the ends of plates **211**. A hole **213** is drilled completely through the body and through the projecting portions **210***a* of the plates **210**. An axial hole **230** is drilled in the end of the body to intersect the transverse hole **213**. A lining **214** of silver is inserted in the hole **213** and a sleeve **215** is inserted in the axial hole **230** with its inner end projecting into the transverse hole **213** and into electrical connection with the liner **214** which connects the plates **210** together, thus forming the electrode of the capacitor.

If desired, the gripping action of the body on the sleeve can be augmented by deforming the portion of the sleeve **215***a* projecting into the transverse bore **213** to form an interlock therewith. This is done by introducing an anvil (not shown) into the lower end of the hole **213** and a hammering tool or the like driving element (not shown) in the upper end of the hole **213** and deforming the end **215***a* of the sleeve, as shown in FIG. 7, so that it is completely interlocked with the transverse hole **213**.

After this is completed, a filler **231** of ceramic or other material can be inserted in each end of the hole. The unit is then fired and the terminal sleeve is locked in electrical and mechanical connection with the plates forming the electrode. The component body can then be stored or the lead wires **220**, **221** can be inserted in the sleeves and securely fastened in position.

Should a cylindrical capacitor be desired, the body of FIG. 5 is trimmed into cylindrical form, as shown in FIG. 9 wherein the body of FIG. 5 is shown in dot and dash outline. After the body has been trimmed, a wash or coating **232** of insulating material compatible with the body material is applied over the outer surface of the body and, as the body is fired, this becomes an integral part of the component of the body to protect the exposed edges of the plates **210**, **211** in the surface thereof.

Under some circumstances it may be desired to utilize the sleeve as the means for connecting the component unit into a circuit. As shown in FIG. 10, a longer sleeve **315** is inserted as previously described and located so as to project beyond the end of the body a distance sufficient to permit it to pass through an aperture **316** in a circuit board **317** or the like having the usual circuit (not shown) on the surface thereof after which it can be headed over, welded or otherwise secured in position and connected in the circuit.

In some instances it may be desirable to have both terminal means for the capacitor at one end thereof. This is acomplished by having projecting portions **410***a*, **411***a* of the plates in lateral offset relation as shown in FIG. 10 and each projecting portion is provided with terminal means. As herein illustrated, holes **413** are formed through each of the extensions **410***a*, **411***a* and are lined with silver or the like **414**. The axial holes **430** are drilled into the end of the body and into the transverse holes **413**. Sleeves **415** are positioned in each of the axial holes **430** and connected to the liner preferably in the manner as shown in FIG. 10. Thereafter the body is fired. If desired lead wires can be secured in the sleeves or, as illustrated, the capacitor may be connected into a circuit board by the sleeves **415** being passed through apertures **316** in the board **317** and headed over, as shown in FIG. 11 or otherwise secured to the circuit on the board.

Thus it will be seen that the foregoing invention provides terminal means for electrical components which result in high reliability both as to electrical connection and against lead pull out, increases the versatility of the component in that it permits various types of lead wires to be used therewith, and greatly simplifies the manufacture and storage of the components.

Thus, among others, the several objects and advantages of the invention as aforenoted are achieved. Obviously numerous changes in the structure may be resorted to without departing from the spirit of the invention as defined by the claims.

We claim:

1. In an electrical component comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable material having at least one electrical element embedded therein, said body being formed with a recess extending at least to said electrical element, and a terminal means disposed in said recess in said body for communicating said electrical element outwardly thereof; the improvement wherein said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body disposed in said recess and having electrical connection with said electrical element, said sleeve being held in said recess by the shrinking of the body therearound when said body is fired.

2. In an electrical component comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable material having at least one electrical element embedded therein, said body being formed with a recess extending at least to said electrical element, a liner of electrically conductive material in said recess and bonded to said element, and a terminal means disposed in said recess in said body for communicating said electrical element outwardly thereof; the improvement wherein said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body, said sleeve being disposed in said recess in electrical engagement with said liner and having electrical connection therethrough with said electrical element, said sleeve being held in said recess by the shrinking of the body therearound when said body is fired.

3. In an electrical component comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable material having at least one electrical element embedded therein, said body being formed with a recess extending at least to said electrical element, a connector of electrically conductive material in said recess and bonded to said electrical element, and a terminal means disposed in said recess in said body for communicating said electrical element outwardly thereof; the improvement wherein said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body, said sleeve being disposed in said recess and held therein in electrical and mechanical engagement with said recess and connector by the shrinking of the body therearound when said body is fired, said sleeve projecting beyond said body a dis-

tance to enable said sleeve to be directly connected to an electrical circuit.

4. In an electrical component comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable material having at least one electrical element embedded therein, said body being formed with a recess extending at least to said electrical element, a liner of electrically conductive material in said recess and bonded to said element, and a terminal means disposed in said recess in said body for communicating said electrical element outwardly thereof; the improvement wherein said terminal means comprises a thin sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body, said sleeve being disposed in said recess in electrical engagement with said liner and having electrical connection therethrough with said electrical element, said sleeve being held in said recess by the shrinking of the body therearound when said body is fired and forming a socket, and a terminal lead wire secured in the anchored sleeve to project therefrom, whereby electrical and mechanical reliability of the component is increased.

5. In an electrical component comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable material having at least one electrical element embedded therein, said body being formed with a recess extending at least to said electrical element, a liner of electrically conductive material disposed in said recess and bonded to said element, and a terminal means disposed in said recess in said body for communicating said electrical element outwardly thereof; the improvement wherein said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body, said sleeve being disposed in said recess in electrical engagement with said liner and having electrical connection therethrough with said electrical element, said sleeve forming a socket and being held in said recess and in engagement with said liner by the shrinking of the body therearound when said body is fired, and a bendable terminal lead wire having one end secured in said socket and the other end projecting from the component to be connected into an electrical circuit, said sleeve extending at least to the surface of said body, whereby the edge of the sleeve forms a means about which the bendable lead wire can be bent without damaging said brittle body.

6. In an electrical capacitor comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable dielectric material having a plurality of spaced electrically conductive plates embedded therein, said body being formed with recesses extending into said body, said recesses each communicating with a group of alternate plates, an electrically conductive connecting means in each recess for electrically connecting the plates communicating therewith for forming an electrode of the capacitor, and a terminal means disposed in each of said recesses in said body for communicating said electrodes outwardly thereof; the improvement wherein each of said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body disposed in said recess in engagement with said connecting means and having electrical connection therethrough with said electrode, said sleeve being held in said recess by the shrinking of the body therearound when said body is fired.

7. In an electrical capacitor comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable dielectric material having a plurality of spaced electrically conductive plates having offset portions embedded therein, the offset portions of alternate plates corresponding to form two electrode groups, said body being formed with a recess for each electrode group extending into said body and communicating with said respective offset portions, a liner of electrically conductive material in each of said recesses and engaging the offset portions communicating therewith for connecting the same to form an electrode of the capacitor, and a terminal means disposed in each of said recesses in said body for communicating said electrodes outwardly thereof; the improvement wherein said terminal means comprises a resilient sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body disposed in said recess in engagement with said liner and having electrical connection therethrough with said electrode, said sleeve forming a socket for a lead wire and being held in said recess by the shrinking of the body therearound when said body is fired, and a terminal lead wire having one end disposed in and secured to said socket and the other end projecting from said body for connection into an electrical circuit.

8. In an electrical capacitor comprising a substantially rigid brittle monolithic fired body of thermo-shrinkable dielectric material having a plurality of spaced electrical plates embedded therein with alternate plates having offset portions, said body being formed with a recess for each group of alternate plates extending into said body and communicating with the offset portions of its respective plates, a liner of electrically conductive material disposed in each recess and engaging the offset portions communicating therewith for electrically connecting the same to form a electrode of the capacitor, and a terminal means disposed in each recess in said body for communicating said electrode outwardly thereof; the improvement wherein said terminal means comprises a thin sleeve of electrically conductive material open at both ends and having a melting point higher than the firing temperature of said body disposed in said recess in engagement with said liner and having electrical connection therethrough with said electrical element, said sleeve projecting beyond said body to form a terminal for connection into an electrical circuit and being held in said recess by the shrinking of the body therearound when said body is fired.

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