Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 1

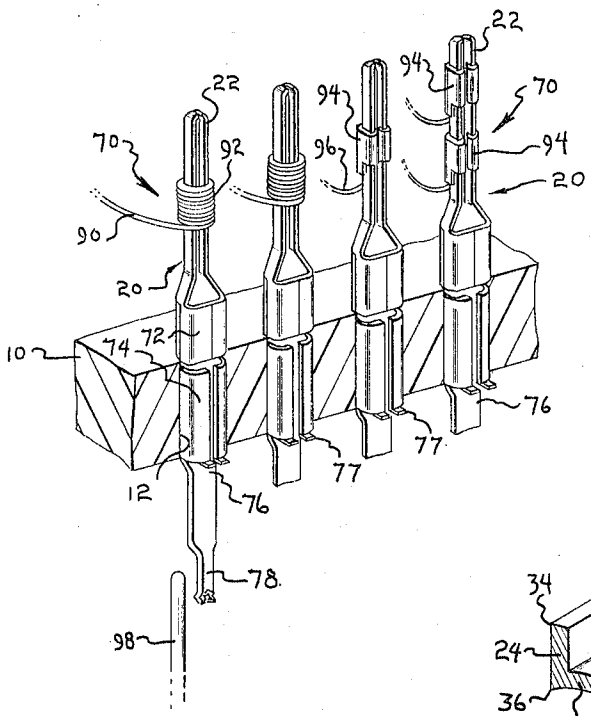

Fig 1

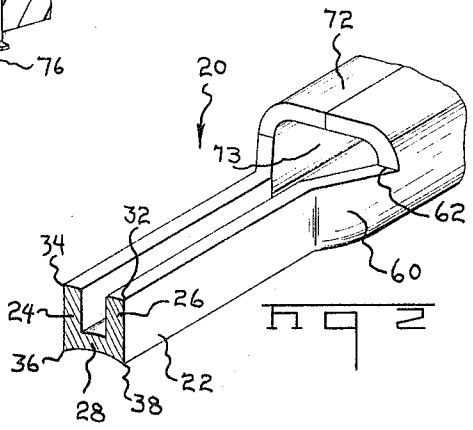

Fig 2

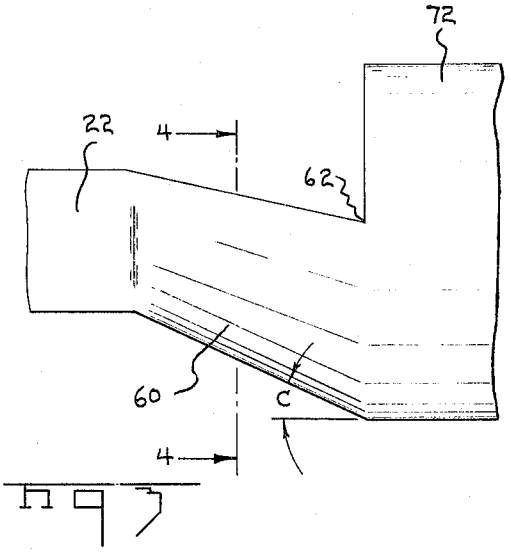

Fig 3

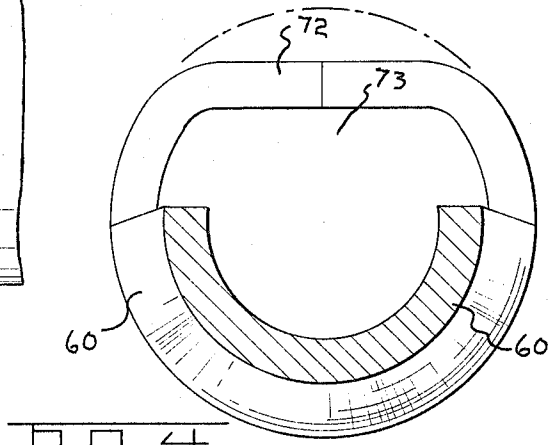

Fig 4

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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 2

FIG 5

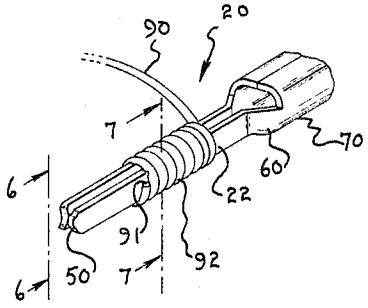
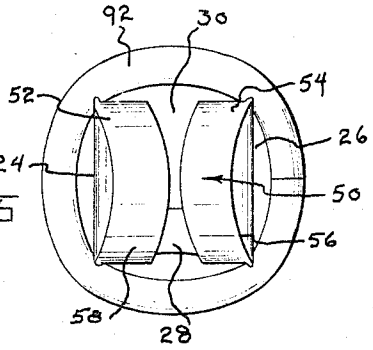


FIG 6



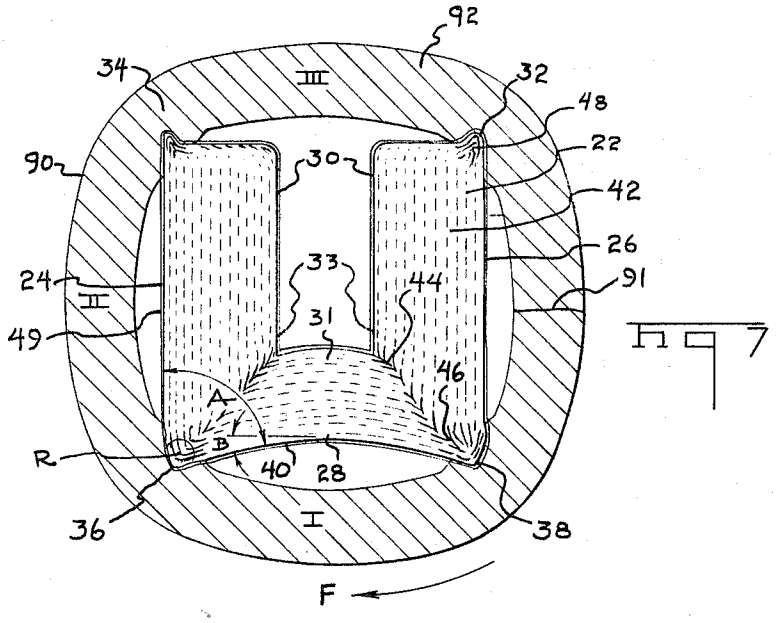


FIG 7

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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 3

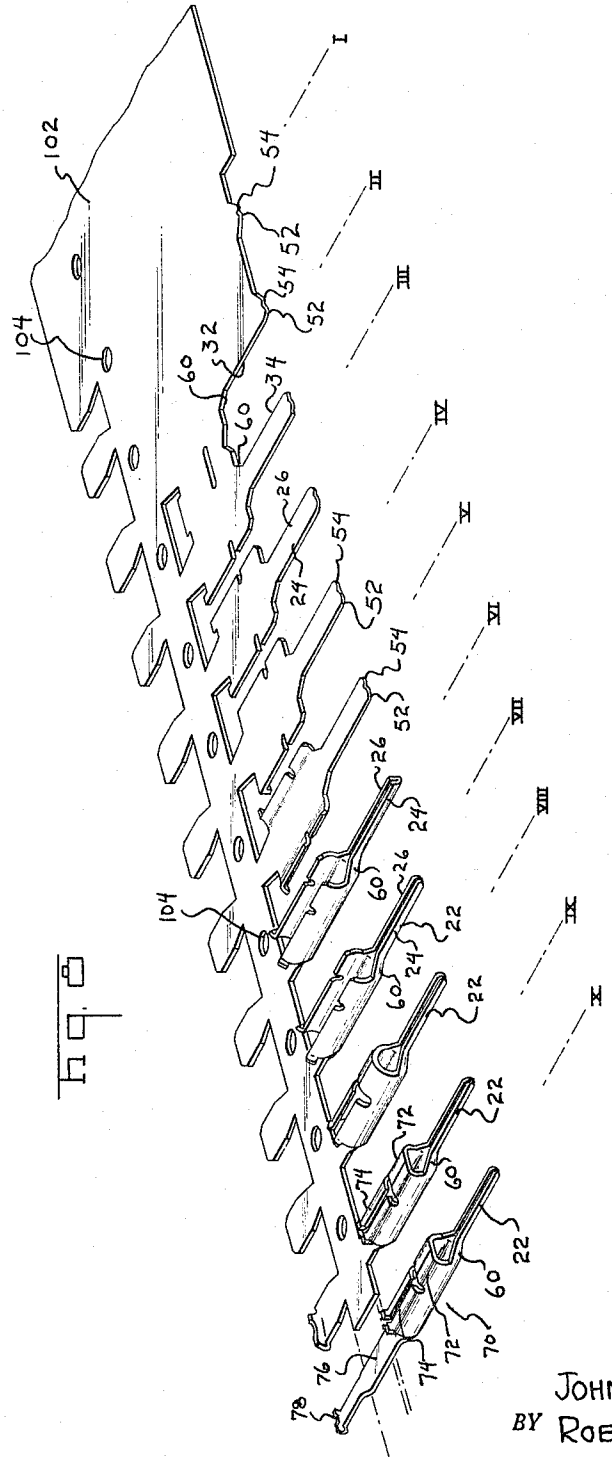

Fig. 6

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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 4

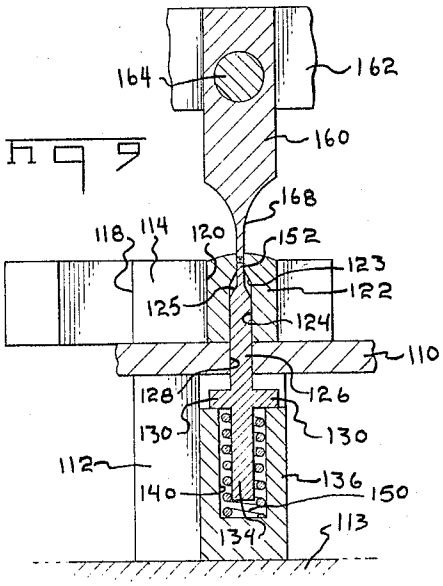

Fig 9

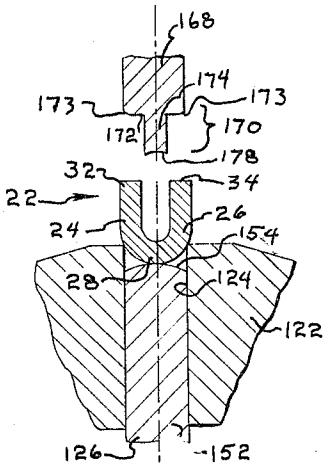

Fig 10

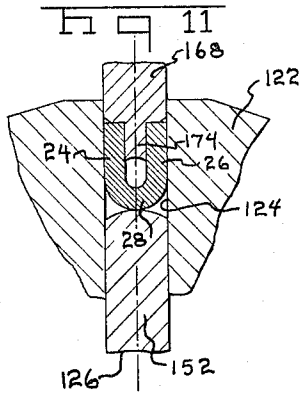

Fig 11

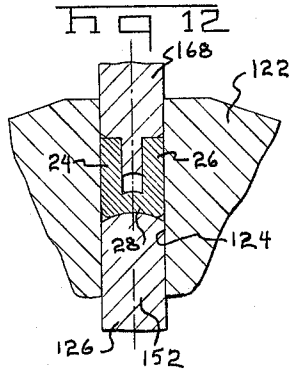

Fig 12

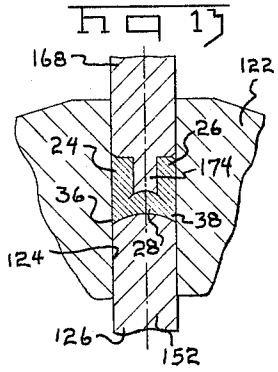

Fig 13

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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 5

FIG 14

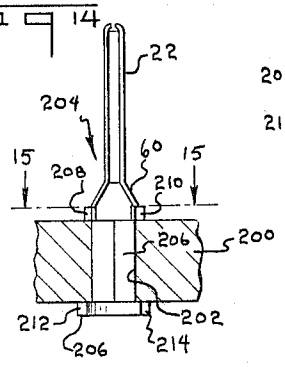


FIG 15

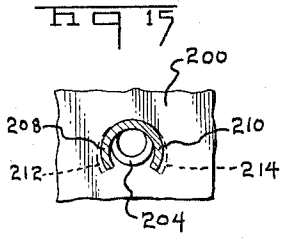


FIG 16

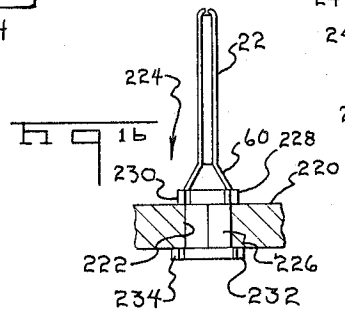


FIG 17

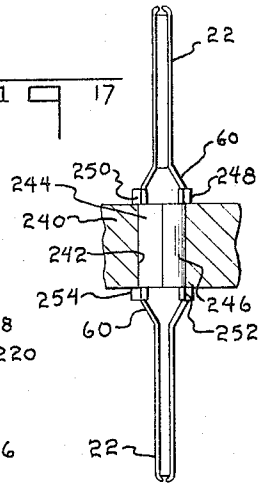


FIG 20

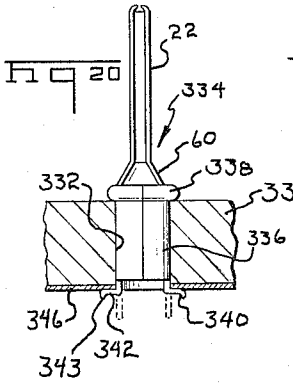


FIG 21

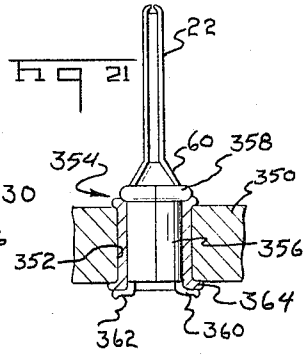


FIG 18

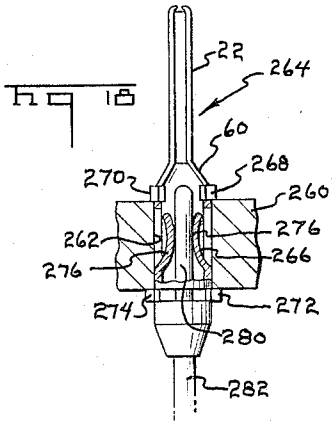


FIG 19

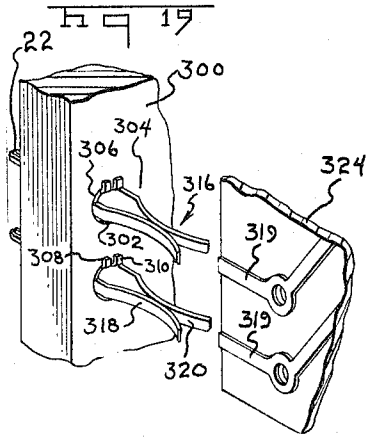


FIG 22

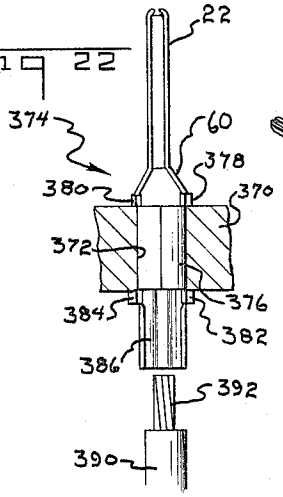
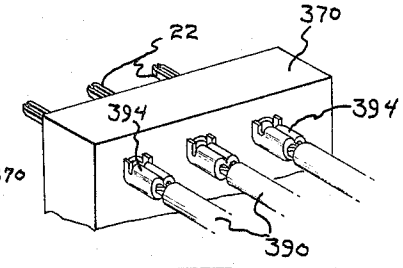


FIG 23



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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 6

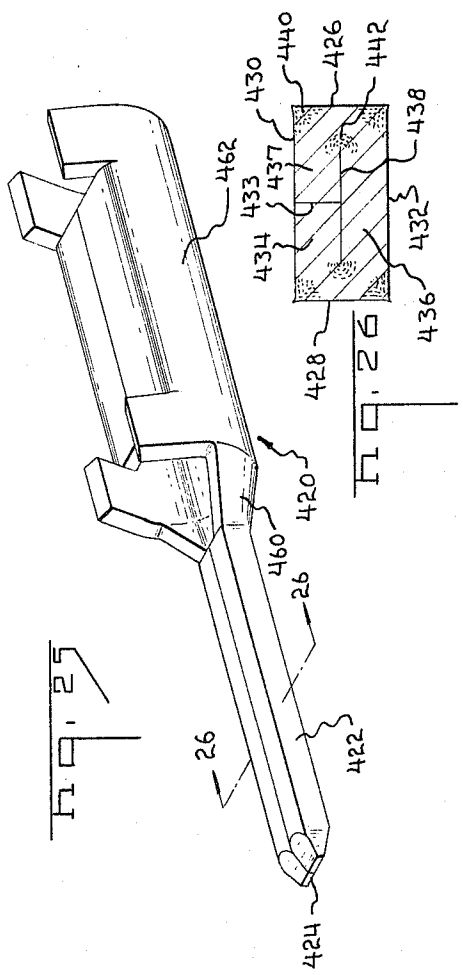

FIG. 25

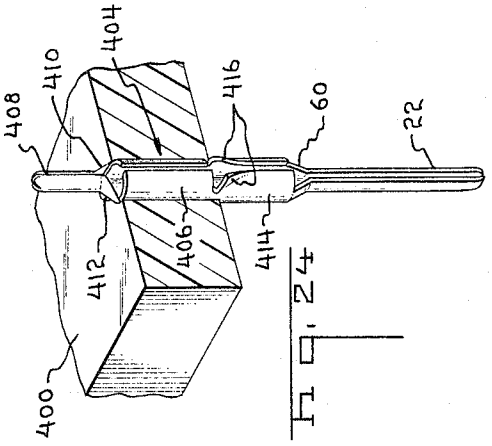

FIG. 24

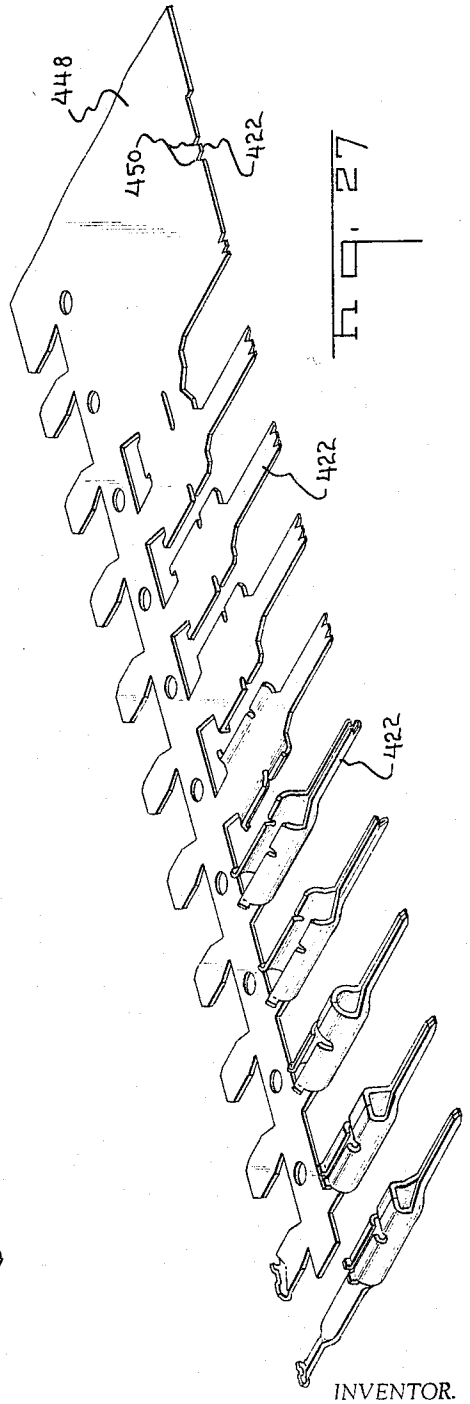

FIG. 27

FIG. 26

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Nov. 29, 1966 J. G. HATFIELD ETAL 3,288,915

ELECTRICAL TERMINAL MEANS

Filed July 25, 1963 7 Sheets-Sheet 7

Fig. 28

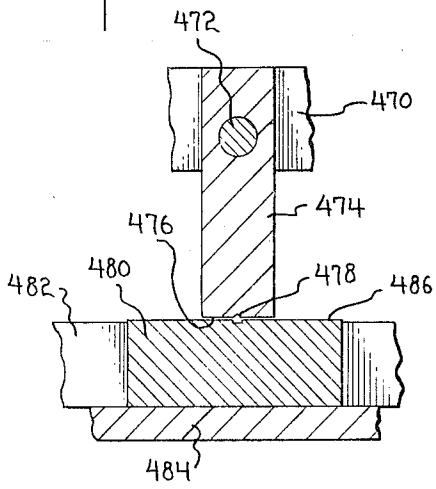


Fig. 29

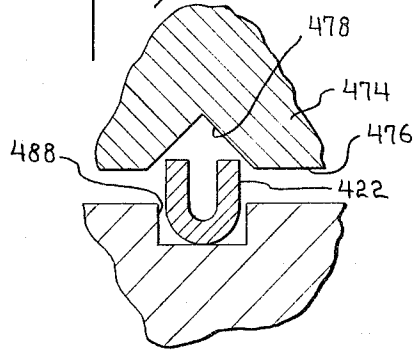


Fig. 30

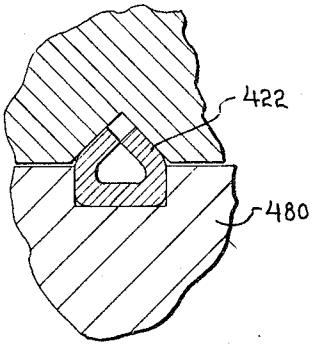


Fig. 31

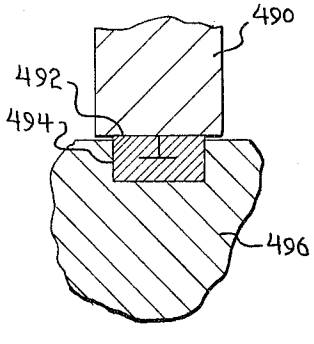
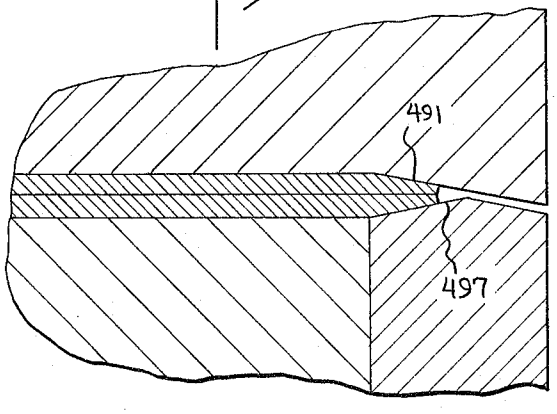


Fig. 32



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BY ROBERT M. MURRAY

United States Patent Office 3,288,915 Patented Nov. 29, 1966

3,288,915

ELECTRICAL TERMINAL MEANS

John G. Hatfield, Camp Hill, and Robert M. Murray, Elizabethtown, Pa., assignors to AMP Incorporated, Harrisburg, Pa.

Filed July 25, 1963, Ser. No. 298,002
5 Claims. (Cl. 174—94)

This application is a continuation-in-part of an application Serial No. 259,192, filed February 18, 1963, now abandoned.

This invention relates to an improved electrical connector and to a method for manufacturing such connector. More particularly, this invention relates to means and method of manufacture of an electrical connector of a type having characteristics suitable for use in point-to-point wiring applications and at the same time having characteristics suitable for use in other types of connections calling for either resiliency or formability of connector metal material.

As with solder, weld or crimp type electrical connections in general, the object of the point-to-point wiring connection is broadly to provide a stable, low resistance, conductive path between electrical circuits. The conductive path generally utilized is a length of relatively small insulated electrical conductor mechanically and electrically secured to distinct and separate points most commonly represented by conductive metal post members held in an insulating board and interconnected through such board to other individual connector means in turn connected to the electrical circuits sought to be interconnected.

Qualifying this general objective of point-to-point wiring applications are further factors related to the type of connection being made at each point which in turn dictate other requirements including possible high connection density (related to size and shape), reliability of connection, longevity, and cost, both of connector and of making the connection. The particular type of connection utilized sets up further requirements. For example, the wire-wrap connection adds specialized criteria related to radial forces which the connector must withstand during the application of wire-wrap turns and to the resistance against cold flow of the connector during the life of the wire-wrap connection. As a further example, there exist newly developed clip-on type connections which demand that any point-to-point wiring terminal post must be capable of supporting axial application forces and provide a certain mechanical resistance to assure a proper maintenance of conductor interface.

As described in detail in U.S. Patent No. 2,759,156 to R. F. Mallina, one specialized requirement relates to the material characteristics of a terminal post utilized in conjunction with wire-wrap techniques which operate to set up radial sheering and tensioning forces exerted by the wire during and after its application upon the terminal post. The material characteristics of the post must be such that the post dimensions will not be altered by cold flow under the forces developed by the wire under tension to an extent permitting an ultimate relaxation of the wire-wrap thereby resulting in the loss of the potential energy or elastic reserve stored in the wire-wrap turns and in the post to cause a failure in continuity between wire and post. As further noted in the Mallina patent, a second basic requirement for wire-wrap termination relates to the presence of an abrupt edge enabling the locking-in of the tensional forces of the wire to the post with a resulting stable interface contact area therebetween.

Further specialized requirements for satisfactory wire-wrap connections may include the factors described by W. P. Mason in U.S. Patent No. 2,870,241 wherein use of

particular surface materials incorporated into a terminal post in conjunction with a sufficient force of contact are utilized to provide a diffusion between wire and post material resulting in an improved connection. Yet a further desirable feature for terminal posts being used for wire-wrap applications is outlined in U.S. Patent No. 2,998,590 to F. G. Buhrendorf wherein there is described a method of making wire-wrap connections which involves pre-stressing the terminal post by twisting or rotational movement as the wire is being wrapped in tension about such post.

In U.S. patent application Serial No. 171,074, filed February 5, 1962 in the name of Robert F. Cobaugh there is described a different type of electrical connector having a capability analogous to that of the wire-wrap technique with respect to point-to-point wiring applications. This approach features a terminal post adapted to receive a clip member driven with considerable force thereover to wedge an electrical conductor into a stable, low resistance interface contact with the post member. The Cobaugh type clip has the further advantage of being capable of use with insulated conductors without a formal step of insulation stripping; the clip in being driven onto the terminal post operating to break and separate the insulation exposing the conductor material for contact. As will be appreciated from a review of the above-mentioned application, the use of the described clip involves a wedging operation wherein considerable longitudinal or axial forces are applied to the post. When the Cobaugh clip is applied by hand tools or even by automatic point-to-point wiring machines, slight oblique forces may result operating on the terminal post resulting in shearing forces being applied to the post. During the life of Cobaugh type connections the terminal post must be capable of maintaining its cross sectional configuration to an extent sufficient to provide an elastic reserve between clip and post holding the conductor therebetween in a stable interface contact.

Thus it is with both wire-wrap and clip type connections that the particular terminal post construction utilized must withstand certain forces during the application of a particular connection and thereafter during the life of such connection. The prior art answer to the foregoing requirements has been to provide a relatively thick solid post member as, for example, a post 30 thousandths of an inch or greater. Because of this, the material characteristics of the post member utilized have prevented the use of the post material for anything but the most limited additional functions such as providing the post mounting means. In even this use, it has been found necessary to emboss or further reduce the post material thickness to form mounting tab members which can be practically bent or deformed to lock the terminal post within an insulating board aperture. Further due to the relatively thick post material utilized in the prior art, it has heretofore been necessary to provide other and distinct connectors in applications wherein the connection made to the post must lead to a connection of the disconnect type. In addition to the multiplication of parts to perform a given number of connections, this practice inherently reduces the reliability of a given connection by increasing the opportunity for connection failure.

Accordingly, an object of the present invention is to provide an improved electrical connector having material qualities complementary to wire-wrap, clip type and other terminations and to a method of forming such connector from relatively thin, flat metal sheet material.

A further object of invention is to provide an improved terminal post construction having geometrical and material characteristics which enhance the electrical and mechanical connection formed by standard point-to-point wiring procedures.

Another object of the invention is to provide a uni-

versal terminal post and method of manufacturing such post permitting economy of use and manufacture.

Still another object of invention is the provision of a connector including a post section and a mounting section interconnected by a transition section adapted to hold the post section against substantial deformation during the application of conductors thereon.

A still further object of invention is to provide an improved terminal post construction of relatively thin, flat metal sheet material having qualities suitable for use in other types of electrical connectors.

Still another object of invention is the provision of a connector having as an integral structure a post section suitable for wire-wrap or other type connections and a further section having material characteristics desirable for securing the connector in a mounting board.

Yet another object of invention is the provision of a connector having as an integral structure a terminal post section and a further section formed to provide a locking feature to secure the connector in an insulating board.

Another object of the invention is the provision of a connector having as an integral structure a post section suitable for wire-wrap or other type connections and a further section of suitable resiliency to accommodate a spring engagement in a disconnect type connection with a further connector.

Yet another object of the invention is the provision of a connector having as an integral structure a terminal post section and a further section adapted to be crimped to provide an electrical and mechanical connection with a conductor.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the condition of a particular use.

These and other objects are achieved in a preferred embodiment of the means of the invention by providing a one piece connector body having a post section channeled to define sharp conductor contact edges and a contact surface with the post section being secured through a transition section to a tubular support section adapted to be mounted or embedded in an insulating board member. The particular post construction utilized by the invention provides a post cross-sectional configuration and material strength suitable for use in standard wire-wrap applications as well as clip type applications with a relatively thin post material having qualities suitable for forming other types of connectors including those demanding spring qualities. The improved method of manufacture contemplated by the invention embraces steps of a shearing, bending and impact, extruding operating on the terminal post section to provide qualities of hardness and slope to post corners which result in an improved electrical and mechanical connection between conductor wire and post with respect to wire-wrap applications. The improved method of the invention further results in a post construction capable of bearing the forces imparted by both wire-wrap and clip type procedures and furthermore of a construction capable of maintaining a substantial dimensional integrity to provide the necessary elastic reserve demanded by wire-wrap and clip type connectors. In further embodiments of the invention there is included integral with the post and transition sections of the invention connector, extended portions of distinctly different characteristics adapted for use in mounting the connector or in configurations suitable for use in other types of connectors of disconnect or crimp type.

In the drawings:

FIGURE 1 is a perspective showing part of a point-to-point matrix incorporating the connector of the invention mounted in an insulating board member with examples of wire-wrap and clip type connections;

FIGURE 2 is an enlarged perspective, partially sectioned, of an embodiment of the connector of the invention including the structural features of post, transition, and latching sections thereof;

FIGURE 3 is a fragmentary elevation of the transition seection of the structure shown in FIGURE 2;

FIGURE 4 is a cross section taken along lines 4—4 of FIGURE 3;

FIGURE 5 is an enlarged perspective showing an embodiment of the terminal post construction contemplated by the invention integrally formed with a transition section and a mounting section and further showing a typical wire-wrap positioned on the terminal post section;

FIGURE 6 is an enlarged and elevation of the device shown in FIGURE 5 as viewed from lines 6—6;

FIGURE 7 is an enlarged section of the device shown in FIGURE 5 as viewed from lines 7—7 therein included to show geometrical and metal characteristics achieved in one embodiment of the terminal post of the invention along with the particular contact interface achieved between conductor wire and terminal post corners;

FIGURE 8 is a perspective of an actual progression showing the various forms during manufacture of one embodiment of the invention including one preferred embodiment of the post section;

FIGURE 9 is a section of the tooling utilized to practice the method of the invention in achieving the novel post construction contemplated;

FIGURES 10, 11, 12 and 13 are enlarged elevations of the die faces of the tooling shown in FIGURE 9 depicting the impact extrusion step utilized by the method of the invention;

FIGURES 14 and 15 show elevational and cross sectional views, respectively, of an embodiment of the invention including the novel post section integrally formed with a mounting section having spring tab members for mounting and locking a connector within an insulating board member shown in section;

FIGURE 16 shows an elevation of an embodiment similar to that of FIGURES 14 and 15 adapted for use in thin board members shown in section;

FIGURES 17 shows an elevation of an embodiment similar to that of FIGURES 14 and 15 including dual post sections oppositely oriented with respect to an insulating board member shown in section;

FIGURE 18 shows a partial section of elevation of yet a further embodiment of the invention including the novel post construction and integrally formed therewith a spring section adapted for accommodating a disconnect connector of the pin type;

FIGURE 19 shows a perspective of an embodiment of the invention including the novel post construction integral with a leaf type connector spring;

FIGURE 20 shows an elevation of a further embodiment including the terminal post of the connector in connection with a mounting section having a different locking feature;

FIGURE 21 shows an elevation of the embodiment of FIGURE 22 with a further feature to accomplish connector mounting in conductive mounting members;

FIGURE 22 shows an elevation of a connector embodiment featuring the post construction of the invention in combination with a crimp type wire barrel;

FIGURE 23 shows a perspective of a number of devices of the type shown in FIGURE 22 crimped to a number of conductors;

FIGURE 24 is a plan view of yet a further embodiment including a terminal post section and an integral mounting

section carrying a barrel tip for use in the movable board of a patchboard device;

FIGURE 25 is a perspective of an alternative embodiment of terminal post especially adapted for use with clip-on type connections;

FIGURE 26 is a section of the post of FIGURE 25 taken along lines 25—25;

FIGURE 27 is a perspective of an actual progression showing the various forms during manufacture of the device of FIGURE 25; and

FIGURES 28–32 are fragmentary sectional enlarged views of the steps of manufacture preferred to achieve the post configuration shown in FIGURE 25.

The above outlined general objectives and specialized criteria of wire-wrap and clip type point-to-point electrical connectors should be kept in mind in order to more fully appreciate the advantages inherent in the means and method contemplated by the invention. An additional consideration not heretofore appreciated should be also kept in mind involving the connector of the invention relative to its capability to perform a connection of a distinctly different type; namely, a connection having requirements of geometry and material characteristics basically incompatible with those of wire-wrap or clip type connections. FIGURE 1 showing one embodiment of the invention mounted in an insulating board member to form a point-to-point wiring matrix demonstrates the foregoing. The insulating board member **10**, only a corner of which is shown, represents for illustration the rear bay of a standard plugboard assembly of the type shown and described in U. S. Patent No. 2,975,395, issued March 14, 1961, in the name of G. C. Sitz. Fitted in apertures **12** of board **10** are connectors **70** different from those shown in Sitz having upper sections **20** defining a point-to-point wiring matrix and lower sections **76** extending on the other side of board **10** defining flexible contact spring members **78**. Each connector **70** is integrally formed of relatively thin conductive sheet material as for example, brass, to provide an electrical path through board **10**. An integral latching section **72** at mounting section **74** having locking tabs **77** is included in the connector structure to hold or secure the upper section **20** and the lower section **76** against axial movement. The upper section **20** includes a post **22** having characteristics which will be described in detail hereinafter accommodating standard wire-wrap or clip type applications to achieve an electrical connection between a given connector **70** and an electrical conductor from some external circuit on other structure. An example is depicted in FIGURE 1 wherein a conductor **90** is shown having wire-wrap turns **92** forming a connection with the post **22** of **20** and thereby with a connector **70**. The post **22** further includes features accommodating the application of other types of point-to-point wiring devices such as the clip **94** serving to interconnect conductor **96** to a connector **70**. It is, of course, to be understood that in the usual case one type of wiring interconnection, wire-wrap, clip or other will usually be employed throughout for a given point-to-point wiring application relative to the same wiring matrix.

With the various post sections **22** wired to define electrical circuits on one side of board **10** as indicated in FIGURE 1, the board **10** may be inserted in a plugboard assembly of the type above referred to and driven into a position wherein contact pin members such as **98** are driven to engage, deform and hold, under spring pressure as indicated, the contact spring members **78** of the sections **76** of connector **70**. From the foregoing it should be apparent that connector **70** provides a connector for point-to-point wiring application capable of directly accommodating distinctly different types of connections without resort to a number of separate connectors as in Sitz and the problems of reliability inherent in the additional connection necessitated thereby. While the connector structure depicted in FIGURE 1 includes a resilient spring member, the relative thinness of the material employed permits other connector constructions of a type capable of being formed during connector installation in an insulating board, such including integral metal tab portions to lock the connector into position into the board or perform other spring functions and, in certain instances, to contact printed circuit paths in a manner suitable for "dip" or other type soldering procedures. Yet other uses include a connector structure having a terminal post on one end and a rounded barrel tip on the opposite end to provide the contact surface for members mounted in the front bay or board of an assembly having the use and function of the assembly described in the Sitz patent, above mentioned. Embodiments of the invention exemplifying these uses will be described with respect to FIGURES 14–24 hereinafter.

As a differently expressed brief summation of the foregoing, connectors having spring, crimp, or folded tab or barrel features are more easily manufacturable to have desirable characteristics if the wall metal material utilized be relatively thin initially, while other types of connectors serving wire-wrap or clip connections demand a certain dimensional thickness most readily answered by the prior art use of relatively thick metal stock. The present invention solves this problem by a post construction of relatively thin metal stock having a configuration and hardness suitable to support both wire-wrap and clip type connections and at the same time answer the needs of other connectors.

Turning first to the aspect of the invention relating to the terminal post construction of the invention, reference may be had to FIGURES 2, 3, and 4. In FIGURE 2 member **20** will be recognized as the upper portion of connector **70** shown in FIGURE 1, including a post section **22** and integral therewith a transition section **60** and a portion of latching section **72**. As further apparent from FIGURE 1, section **22** is useful to mechanically support and electrically connect a conductor with connector **70**; while section **60** operates to support and electrically connect post **22** with section **72**, which in turn serves to latch the post and **70** within an insulating board.

Member **20** is formed of relatively thin metal stock such as brass to include post sections **22** defining wall members **24** and **26** interconnected by a wall member or web **28** with the post axially projecting from transition section **60** and section **72**. The relative planar disposition of the integral wall members **24**, **26** and **28** serves to resist rotational or radial as well as axial force moments in the same manner as the well respected I beam structure; both being efficient alternative to solid beams with respect to strength. As a further feature, post section **22** includes sharp corners or edges **32**, **34**, **36** and **38** as establishing the abrupt edges necessary for wire-wrap. Wall surfaces of **24**, **26** and **28** are also utilized for accommodating a conductor driven thereagainst by clip type connectors; the surface of wall **28** being preferred. It is contemplated that the interior surfaces of the post **22** may, in certain instances, be utilized to accommodate conductors fastened thereto by clip members.

Transition section **60** includes a flared or tapered, curved configuration of the same thickness of post **22** which is gradually increased in width to join at **62**, the generally tubular latching section **72**. As shown in FIGURES 3 and 4, the transition section is rounded in cross section to include a general taper of angle C as measured between planes parallel to a longitudinal axis of post **22** and parallel to the surface of **60**. The object of transition section **60** is to resist relative rotational, transverse or axial post displacement relative to the section **72**. As will be appreciated by those skilled in the art, an angular disposition of transition wall **60** with angle C approximating 30° operates to provide support of post section **22** in an efficient and reliable manner. The enlargement of the surface area of section **72** achieved by the increased diameter of **60** operates to facilitate mount-

ing of the connector structure against rotation or other movement relative to the insulating board member and, additionally, provides an available space 73 capable of accommodating the insertion of contact pin members as in certain embodiments of the invention to be described hereafter. Section 72, which may include a variety of different configurations, is shown in FIGURE 4 as D-shaped to complement the mounting section, which fits in an interlocking relationship the D-shaped apertures of a standard plugboard.

The particular geometry and material characteristics of the post section 20 may be more fully explained by drawing reference to the wire-wrap installation procedure, which subjects the assembly to greater stresses than any other point-to-point wiring application including the clip type. Turning then to a more detailed description of the post construction, reference may be had to FIGURES 5, 6 and 7. In FIGURE 5, the section 20, described with respect to FIGURE 2, is shown with a conductor 90 applied through a number of turns 92 to the post section 22 thereof in a typical wire-wrap application. The functional objective of the connection shown in FIGURE 5 is, of course, to provide a path of electrical continuity through conductor 90 and the conductive material of section 22; which path has characteristics of low resistance in the presence of time, vibration, humidity, and other environmental effects. In this manner an electrical circuit path is completed from 90 to another circuit connected to structure 70 as indicated in FIGURE 1. The particular wire-wrap shown in FIGURE 5 may be considered as applied by standard wire-wrap tooling in the manner urged by Mallina, Mason or Buhrendorf, above mentioned.

The provision of end 50 on post 22, more clearly shown in FIGURE 6, serves to accommodate the entry portion of standard wire-wrap tooling. The end 50 includes two rounded portions 52 and 54 turned inwardly and radiused so as to reside within the area defined by the four corners of the post as viewed in cross-section. This feature operates to prevent the wire held in a wire-wrap tool, or portions of the tool itself, from snagging on what otherwise might be sharp corners extending beyond the main body of the post at an end thereof.

In FIGURE 7 an enlarged detailed section of the post construction contemplated by the invention is depicted showing the post 22 to have a peripheral configuration which is substantially square with respect to the corners thereof. The side walls 24 and 26 interconnected by bottom wall or web 28 of the post are each substantially the same width to define an open section or slot between the side walls shown as numeral 30. At the upper corners of side walls 24 and 26 are further wall surfaces which intersect to define edges 32 and 34. At the lower corners of walls 24 and 26 and integral with wall 28 are further edges 36 and 38. It will be noted that each pair of surfaces adjoining edges 32, 34, 36 and 38 define an interior angle of approximately 90°. This is indicated by angle A with respect to the surfaces of 24 and 28. More specifically, with regard to describing the sharpness of post edges, reference may be made in terms of edge radius R shown with respect to corner 36. In a preferred embodiment of post construction, radius R is held to three thousandths of an inch with any tolerance leeway being taken up by having the radius less rather than greater than three thousandths. The control of angle A and radius R is important to wire-wrap applications for the reasons to be discussed more fully hereafter.

A further aspect of the post construction contemplated by the invention is indicated from the small lines within the interior portions of the post cross section shown in FIGURE 7. These lines are based upon microphotographs of an actual sectioned post and represent areas of worked metal, which provide a controlled metal hardness. Based upon a Vickers diamond pyramid hardness test (15 grams), a survey of post 22 indicates a hardness range of approximately 170 to 190 in the less densely lined areas, such as 42, and a hardness range from approximately 190 to 225 in the more densely lined areas such as 44, 46, and 48. It is to be observed that the post material defines relatively hard areas at each post edge 32, 34, 36 and 38 as well as in areas or zones surrounding the interior U portion of the post 22. The edge hardness serves to provide a biting edge of sufficient strength to permit a proper penetration of the conductor 90 by each edge, thus operating to increase area of contact with the post at each edge. The hardness zones such as 44 operate to strengthen the post construction and resist collapse of side walls 24 and 26 under the forces of the wire-wrap imparted thereto.

A further material feature of post 22 is indicated as shown with respect to bottom wall 28. The curvature is in a preferred form, in the range of from 10° to 17° with respect to angle B measured from a horizontal line to a line tangent to exterior surface 40 of wall 28. This curvature has been found to be highly desirable in maintaining the dimensional integrity of the post 22 under the force of wire-wrap turns as well as providing strength with respect to transversely developed forces tending to bend the post.

The advantages inherent in the post construction above described may be brought better into focus by reviewing the steps involved in the application of conductor wire 90 to accomplish a wire-wrap connection. Considering that the end 91 of conductor 90 is held fast and the wire is drawn around post corner 36 and corner 38 in the manner indicated under a considerable force F, it will be apparent that a clockwise torque will be generated tending to twist post 22. The geometry and material hardness of post 22 is such as to permit a slight twisting without relative displacement of walls 24, 26, and 28 which at the same time offers a positive resistance such that post edges 36 and 38 will bite into 90. The hardness of the edges of the post is such that the standard force applied by wire-wrap procedures will not unduly crumple or shear off such edges. The slope or sharpness of the post edges as measured by R is such as to provide a controlled penetration without severing 90 under the forces involved. As is understood, the sharpness of the post edges in conjunction with angle A of wall surfaces determines the depth of penetration, which in turn determines the contact area per edge per turn. Additionally, the sharpness of the post edges and the angle A of wall surfaces determines the interior wire face areas engaging the post edges to hold the wire against movements which could destroy the elastic reserve developed when the wire is stretched. Thus, as a turn of wire 90 is applied to the post, the section I is placed in tension held by the surface areas of the wire in contact with vertical surfaces of edges 36 and 38 respectively. A section of wire II will be similarly held between the horizontal surface areas of edges 38 and 32, and a section of wire III will be similarly held between the vertical surface areas of edges 32 and 34 as indicated. It will be realized that the application of leg III of the wire to edges 32 and 34 must not operate to collapse the sidewalls 24 and 26 closing space 30, thus destroying the post geometry necessary to maintain the elastic reserve between wire and post. The location of the cold work structure indicated by lines 44 as well as the curved configuration of the bottom wall 28 conjointly serve to resist any force tending to bring post walls 24 and 26 together.

As an additional point worth noting, the relative stiffness of walls 24 and 26 against closure is much greater than if the post were merely U-shaped, thus tending to bend about a longer moment arm.

It is preferred to provide a plating 49 to the exterior surface of the post 22. Such plating may comprise a first layer of nickel approximately 1.0 thousandth of an inch in thickness with an overlayer of gold approximately 60 millionths of an inch in thickness.

During and after the application of clip type connections as shown in the above mentioned patent application to Cobaugh, the post construction shown in FIGURES 5, 6, and 7 operates to resist both axial and transverse forces of application and to provide a constant dimensional geometry holding the clip in position. The relative thickness of sidewalls **24** and **26** taken in conjunction with their position relative to the disposition of a clip serves to maintain the post integrity. The surface **40** is preferably utilized to accommodate the wire being terminated by the clip type procedure, although as above mentioned, any of the surfaces, interior or exterior, may be so utilized.

While the post construction and material characteristics of the post heretofore shown and described may vary dependent upon the diameter and the material characteristics of the wire employed, the following dimensions of an actual post construction are included not to restrict, but to aid in indicating relative dimensions and characteristics found satisfactory for a type of commonly used wire identified as No. 22 AWG Solid Strand.

Dimensions in thousandths of an inch:

Post length from end **50** to transition section **60**	600
Post height, walls **24** and **26**	49.0
Post width, leg **28**	49.0
Wall thickness, leg **24** and **26**	17.0
Wall thickness, leg **28**	15.0
Material employed	Brass
Angle A	77°
Angle B	13°
Angle C	33°
Radius R	3.0
Transition section **60**, length	75.0
Mounting section **74**, largest dimension	375.0

With the geometry and material characteristics of one preferred embodiment of the novel post construction of the invention thus described, the method of the invention utilized to achieve such will now be treated.

FIGURE 8 depicts a progression including ten steps representing steps utilized in producing the post above described as integrally formed with the particular embodiment shown in FIGURE 1. A further step may be considered as that of plating and may be performed in a standard manner. While it is fully contemplated that each of the steps shown in FIGURE 8 may be performed in a non-automatic fashion, the perferred mode includes an automatic operation wherein a series of die stations I–X are arranged to be driven in a step-by-step fashion to perform shearing-punching, coining, extruding and shearing operations on a continuously fed strip of joined connector members. Production techniques of this type are generally well known.

Beginning with a spool or other supply of flat sheet metal stock as indicated by numeral **102**, stations I–X operate to transform sheet **102** into a separate connector member **70** as indicated at station X. It is contemplated that stations I–X are fixed and that sheet **102** and the progression formed thereof is moved by carrier **103** driven by pin members adapted to engage pilot holes **104** punched therein prior to station I. It is further contemplated that in a manner well understood by those skilled in the art the die operations at each station are synchronized by means of the pilot holes **104** operating pin members driving a die drive initiating means.

Based upon the progression shown in FIGURE 8, the operation at each die station I–X with respect to forming the connector shown at station X, exclusive of the post section **22** and the transition section **60** should be generally understood. The operations pertinent to the method contemplated by the invention are performed particularly at stations VI and VII and to a degree at stations II and IV. The only significance of station I with respect to the post and transition sections is that ends **52** and **54** are defined by the first shearing operation. At station II post edge **34** and the adjoining edge of transition section **60** are formed on one connector member while the adjacent post edge **32** and the adjoining transition section **60** thereof are formed. The operation at station II serves to work-harden to an extent consistent with a shearing operation, edges **32** and **34** of each post wall **24** and **26**. At station IV ends **52** and **54** are turned upwardly, which operation assures that such ends will be turned inwardly for the purposes heretofore described during the bending operation performed on the post section at station VI. The operation performed at station VI serves to form transition section **60** into its final shape; the die faces for forming such shape being of the general shape of the interior and exterior surfaces of such section as shown in FIGURES 3 and 4. The bending of the post section **22** at station VI results in a degree of work-hardening occurring in the portions of metal bent and proportional thereto. The die configurations for forming the post section **22** in the geometry shown at station VI are generally as the interior and exterior surfaces indicated in FIGURE 10; namely, U-shaped.

At station VII the critical part of the method of the invention is carried out with the geometry of the post section including the material characteristics heretofore outlined being achieved. At stations VIII–X further operations are carried out to progressively form the remaining portions of the connector embodiment chosen to exemplify the method of the invention.

Turning now to FIGURES 9–13, there is shown a preferred form of the tooling utilized at die station VII with the die members thereof in closure against post section **22** in the center of the figure. As a part of station VII and common with the remaining stations there is provided a stage **110** of relatively heavy metal stock positioned and held by stage support **112** seated and anchored on a tooling base **113**. Stage support **112** is, of course, duplicated along the various stations under portions of stage **110**. Supported and secured to stage **110** is die guide plate **114** having a number of apertures therein **118**, **120** to support and position die members appropriate for each station. Secured in aperture **120** is member **122** forming part of the lower die of station VII. Member **122** includes a centrally disposed die guide-way **124** having interior sidewalls adapted to maintain in sliding engagement a central die member **126** having a tapered extension defining die portion **152** with face **154**, better apparent in FIGURE 10. The lower movable die member **126** is further supported for vertical movement by the wall surfaces of an aperture **128** in stage **110**. Secured to the lower portion of die member **126** and beneath stage **110** are flange members **130**; the horizontal surfaces thereof serving as stops against vertical movement of die member **126** by engaging the lower surface of stage **110** and the upper surface of die stop member **136** respectively, on upward and downward movement. As will be apparent from FIGURE 9, the die member **126** is shown in its driven or bottomed position. Die stop member **136** includes a central bore **140** of a diameter sufficient to house a compression spring **150** coaxial with a spring guide member **134** which is part of the movable die **126**. With the dies in the position shown in FIGURE 9, spring **150** is in compression to develop a force tending to drive the die member **126** upwardly.

Aligned with the center-line of lower die half **126** and the upper slot portion of guide-way **124** of die guide member **122**, upper die **160** is carried in vertical movement by die carrier **162** and secured thereto by pin member **164**. The lower portion of die **160** includes a tapered extension **168** having a die face **170**.

Reviewing now the operation of the tooling shown in FIGURE 9, upper die **160** may be considered as initially in an upward position indicated by the dotted line while lower die **126** is in the upward position with the tapered face **125** of die member **126** resting against the tapered face **123** of die guide **122** under the force of spring **150**. The progression shown in FIGURE 8 may be considered

as being stepped along the progression support 114 with the upper die 160 being actuated to be driven downwardly as the centerline of each post section 22 arrives at the centerline of the dies 160 and 126 and comes to rest as shown in FIGURE 10

At this point, die 160 is operated to force the post section 22 down into the upper portion of slot 124 of member 122 with die surfaces 172 engaging edges 32 and 34 and the apex of the die surface 154 of portion 152 engaging the bottom surface of post wall section 28. The downward motion of die 160, post 22 and die 126 continues until flanges 130 of member 126 bottom against the upper surface of member 136 as shown in FIGURE 9. The continued downward motion and force of die 160 drives die face 170 working against die face 150 to perform a coining operation upon the post section 22. Thereafter, die carrier 162 will move die 160 upwardly to its rest position indicated by the dotted line with die member 126 under force of spring 150 acting through die portion 152 to drive the post section upwardly and out of slot 124; the post section being released for movement to adjacent station VIII.

Considering the final extrusion step of the method of the invention which achieves the novel configuration and material characteristics of the post section of the invention, FIGURES 10, 11, 12 and 13 show in detail the operation of dies 160 and 126 as heretofore described. FIGURE 10 represents the initial position of post 22 just prior to the initiation of downward movement of upper die 160 carrying tapered end 168 and upper die face 170 in a downward direction to engage post edges 32 and 34. Post section 22 nests within the slot portion of 124 against the interior edges of die guide 122 being driven to such position as the connector progression is driven along 114. The preferred shape for die face 170 is shown in FIGURES 10–13 to include a central projection 174 having a concave surface 178, faces 172 with the outer edges 173 thereof having a slight radius. The lower die portion 152 includes a face 154 defining a convex surface. From the description given relative to FIGURE 7, the characteristics and function of die faces 170 and 154 should be understood.

FIGURE 11 shows the next step wherein upper die 168 is driven downwardly and within the die guide 124 to depress post section 22 along the path of travel defined by slot 124. From FIGURE 11, it may be noted that the length of projection 174 is substantially less than the depth of the post section at this degree of forming. FIGURE 12 shows the next step wherein the travel of lower die portion 152 is stopped by reason of die 126 bottoming through flanges 130 against member 136. At this point, the post section, including walls 32 and 34, is in compression in the vertical sense with the post metal being driven and extruded. During the transition of post between the positions in FIGURES 11 and 12, outer edges 36 and 38 are driven downwardly and extruded into an extending contact with the surface 154 of lower die 152. FIGURE 13 shows the final stage of forming wherein die 168 has reached the bottom of its travel and the post section 22 is fully compressed into the volume then defined by die surfaces 170 and 152. At this point it will be observed that the rounding of edges 173 of die surfaces 172 results in relatively sharp edges 32 and 34; a similar result occurring with respect to edges 36 and 38 by means of the convex surface of 154.

During the downward stroke of die 168 and particularly at the point of travel indicated in FIGURES 12 and 13, a considerable working of the metal located in the areas 44 occurs (FIG. 7). This working is in addition to, and in a transverse sense, with respect to the initial working of these areas occurring at the preceding station V wherein the post section was formed into the U-shape shown in FIGURE 10. The areas proximate the post edges 32, 34, 36 and 38 each receive double working; edges 32 and 34 having been worked during the initial shearing operation and edges 36 and 38 having been worked during the shearing operation at station VI. The center wall 28 also receives a double working; first in the bending at station VI, and second in the forming as indicated in FIGURES 12 and 13. The hardened areas proximate the junction of wall 28 and walls 24 and 26 provide a spine-like structure performing a stiffening function with respect to the post.

As a result of the foregoing, the geometrical and material characteristics above described with respect to post section 22 are produced from a relatively thin metal sheet. The post construction includes characteristics of hardness at necessary points with resiliency elsewhere to serve in supporting the application of both wire-wrap and clip type connections. An adequate concept of the relative dimensions of die faces above described may be obtained from dimensions given with respect to the post section of the invention. Relative to the particular sample dimensions previously recited the force applied to die member 160 was approximately twenty tons through a stroke of approximately 1.5 inches.

It will be recognized that the method of bending and extruding above taught may be utilized to achieve a wide variety of post constructions. For example, and as to the post itself, sidewalls 24 and 26 may be additionally extruded in a radial sense inwardly to provide a generally X shaped cross-section. This may be accomplished by reshaping the wall surfaces of guide way 124 proximate the post wall position at the bottom of die travel. An alternative further example, sidewalls 24 and 26 may be additionally extruded from the shape shown in FIGURE 13 to define axially disposed indentations of part of the wall width to even further strengthen the post. As yet another alternative example, other shapes than the square shape recognized as the standard wire-wrap shape by certain segments of the industry may be formed by altering the relative width of sidewalls 24 and 26, and wall 28. Thus, a generally rectangular post shape may be obtained by decreasing the relative width of walls 24 and 26, and increasing the relative width of wall 28. These and many other equivalent structures may be obtained by following the method of the invention above outlined. In an alternative form of the invention to be hereinafter given, yet another type of post is contemplated using certain essentials of the above method.

It should be appreciated by those skilled in the art that, because of the relatively thin sheet material utilized in the post construction of the invention, a considerable number of integral mounting and associate connector configurations having widely different functions are possible. The more significant connector shapes considered as part of the present invention are included in FIGURE 1, previously described to introduce the advantages of the invention, and in FIGURES 14–24 to be now described.

Turning to FIGURES 14, 15 and 16, an embodiment of the invention is shown adaptable for use in point-to-point wiring applications of the type wherein a matrix of terminal posts are variously interconnected on the same relative side of an insulating board with one or several wire-wrap or clip-on type connections made per post to join conductors and thereby complete signal paths. In this type of application, one termination might be made to one post with wire laid in coordinate fashion between the matrix of posts to another post with separate further conductors being wire-wrapped or clipped to each of the posts. In FIGURE 14, 200 represents an insulating board apertured as at 202 to receive a connector 204, including a terminal post 22 integral with transition section 60, identical to the post described above with respect to FIGURE 2. Further integral therewith is a post mounting section 206 similar to the mounting section 74 above described, including spring-like tab members 208 and 210 at the end adjacent transition section 60, and similar members 212, 214 at the opposite end thereof, similar to latching section 72 above described. With this construction,

connector 204 may be fitted and latched or locked into board 200 by depressing the tab members at either end inwardly toward the center of mounting section 206 and inserting the mounting section 206 within aperture 202. Thus, if a rearward mounting is called for, wherein the post section 22 must enter aperture 202, spring tabs 208 and 210 may be depressed inwardly, the connector 204 inserted to a point wherein spring tabs 212 and 214 block further movement by contact with the bottom surface of board 200; the tabs 208 and 210 then being released from confinement within aperture 202 to spring outwardly to their normal position to lock 204 within the board. With the construction shown in FIGURES 14 and 15, connector insertion from either side of board 200 is possible. As a further advantage inherent in the embodiment of FIGURES 14 and 15 and with slight modification, the construction of the connector may be utilized for, or with, insulating boards of different thickness. This is shown in FIGURE 16 wherein insulating board 220 is approximately half the thickness of board 200. A connector 224 similar to that shown in FIGURES 14 and 15 may be inserted from either side of board 220 by an appropriate depression of spring tabs 228–230 or 232–234. It will be noted that the only difference in the structure of 224 lies in the relative axial thickness of the spring tabs. The only substantial limitation on the thickness or thinness of board which may be accommodated is that mounting section 226 must be left with a sufficient bearing area to properly support 224 in the presence of stresses placed thereon upon application of a conductor to post 22 and the tab members must be of a material width sufficient to perform the latching function.

A further embodiment of the invention is shown in FIGURE 17 wherein the now familiar post section 22 and transition section 60 are duplicated on each side of an insulating board 240. In this embodiment, connector 244 is provided with a mounting section 246 having at one end spring tabs 248 and 250 identical in structure and function to the spring tabs above described with respect to FIGURES 14–16, and at the other end, further identical spring tabs 252 and 254. Connector 244 may, of course, be inserted from either end through aperture 242 of board 240 to accommodate point-to-point wiring application on both sides of board 240.

FIGURE 18 depicts another highly useful connector assembly incorporating the post construction of the invention with an integrally formed spring section having a disconnect function somewhat different from the type of spring embodiment shown in FIGURE 1. Thus, in FIGURE 18, an insulating board 260 is shown having a connector assembly 264 secured in an aperture 262 therein capable of accommodating point-to-point wiring terminations on one side and a pin type disconnect on the other side thereof. Connector 264 includes at the upper end post section 22, transition section 60 and a central mounting section 266 having spring tabs 268 and 270 adjacent section 60 and spring tabs 272 and 274 at the opposite end thereof to latch 264 within aperture 262. As shown in FIGURE 18, section 266 includes further, struck out spring tab members 276 axially disposed within mounting section 266. The disposition of spring members 276 is such as to make contact with a pin member 280 inserted within the mounting section 266. As indicated, the insertion of pin member 280 will form a contact path from a conductor 282 to one or several conductors, not shown, wire-wrapped or clipped to post 22. This embodiment is preferred in application wherein there are height limitations in conjunction with disconnect requirements.

FIGURE 19 depicts a further embodiment of the invention featuring an integrally formed spring portion suitable for performing disconnect functions of a different type. Secured in insulating board 300 through aperture 302 thereof is a connector 304 having a mounting portion 306 and spring tabs 308, 310, similar to those above described, cooperating to support and latch 304 within board 300. On one surface of board 300 and extending from 306 is the post section 22 and transition section 60 as above considered. On the opposite side of board 300 is an integrally formed spring structure 316 including opposing, curved cantilever spring arms 318 and 320, which are relatively flat as is shown in FIGURE 19. The connector embodiment shown in FIGURE 19 is well suited to accomplish a direct connection from conductors mounted on post 22 to the circuit connected to a conductor path such as 319, which may be part of printed circuit paths on a printed circuit board 324 housing a number of components. With embodiments of this type, an insulating card carrying printed circuit paths connected to resistors, transistors, capacitors or the like may be made common to one row of terminal posts or to several rows of posts in both the X and Y directions of the post matrix; the card being both mechanically supported and electrically connected by means of spring arms 318 and 320. With arrangements of this type for a given matrix board, it has been found useful in certain applications to install several piggy-back component insulating cards such as 324 through mechanical and electrical connections with an appropriate number of connectors 304; the remaining and majority of the connectors assemblies of the matrix being one of the types shown in FIGURES 14–16.

In FIGURES 20 and 21 there is shown yet a further embodiment of the invention specialized to provide an even more secure mounting than provided by the embodiments heretofore described, and additionally, a further capability with respect to direct connections to planar conductive paths disposed on one side of a matrix board. The embodiments shown in FIGURES 20 and 21 have considerable utility in situations wherein a number of wire-wrap or clip type terminations are to be made at relatively separated locations, as, for example, the use in the connections formed on a television chassis. The particular embodiment shown in FIGURE 20 is mounted in an insulating board 330 and held within aperture 332 thereof by means of mounting section 336, a peripheral bead 338 and folded tab members 340 and 342. The bead portion 338 disposed adjacent transition section 60 represents a slight enlargement of the diameter of mounting section 336. Tab members 340 and 342 having an initial disposition as indicated by the dotted lines in FIGURE 20 are folded inwardly against the lower surface of board 330 to latch 334 against displacement. The use of tab members 340 and 342 may be desirable as an alternative to the lower spring tabs shown and described with respect to the embodiments in FIGURES 14–17 due to the built-in advantage of accommodating tolerance variations in board thickness. Thus, considering the embodiment shown in FIGURE 20, the connector 334 could be made to accommodate a considerable variation in the thickness of the board 330 larger than that shown; the thickness difference being taken up by merely bending a relatively shorter length of tab members 340 and 342. As yet a further advantage of the construction shown in FIGURE 20 is the possible use of tab members 340 and 342 for soldering tabs to a plated or printed circuit conductive path such as 346. To this end a small turned down portion 343 of one or both tabs 340 and 342 may be provided to accommodate "dip" solder techniques utilized in a manner well understood by those skilled in the art.

The embodiment shown in FIGURE 21 is quite similar to that shown in FIGURE 20 including in a connector structure 354, a mounting portion 356, bead 358 and tab portions 360, 362 all integral with a transition section 60 and post section 22. The use shown in FIGURE 21 differs with respect to the board member 350 which may be of steel or other conductive material. An insulating washer 364 is provided comprised of nylon, Teflon or similar materials, sufficiently pliable to be snapped within aperture 352 and yet sufficiently stable with respect to material flow to hold the connector 354 in position anchored by the over-

lap of bead 358 over the top portion of 364 and tab members 360 and 362 turned inwardly against the bottom surface of 364. To further assure 354 being locked within board 350, it is preferred to have the outer diameter of bead 358 and the length of tabs 360 and 362 such that there is an overlap as shown in FIGURE 21 with respect to the diameter of aperture 352.

Turning now to a further useful embodiment utilized to disclose the preferred mode of practicing the invention, FIGURES 22 and 23 depict an arrangement for interconnecting conductors utilizing wire-wrap or clip-on type connections to conductors having different characteristics such as those of stranded or relatively large diameter wire. A considerable problem calling for a connector of this functional capability has developed from the use of large and relatively expensive wire-wrap and clip-on type automatic machines which cannot perform a splice between conductor wires and which must invariably work through a terminal post interface. In FIGURE 22 a section of insulating block material 370 is shown apertured at 372 to receive a connector 374 having at one end a terminal post 22 secured by a transition section 60 to a mounting section 376 interlocked into board 370 by spring tabs 378, 380, 382, and 384 of the type heretofore described. Further integrally formed with mounting section 376 is an extended wire barrel portion 386 defining a volume capable of receiving conductor strand 392 of an insulated conductor 390 therein. The relatively thin material utilized for the upper portion of the connector 374 is ideally suited for use in forming wire barrels having characteristics suitable for crimping techniques. With respect to barrel portion 386, the relative thinness of the connector material permits the use of a number of types of crimps. For example, an "F" crimp may be applied to electrically and mechanically secure conductor 390 to form an electrical path to some other path connected to post 22 through either wire-wrap or clip-on type connections. FIGURE 23 shows an extension of block 370 to accommodate a plurality of connectors 374, each in turn crimped through the wire barrel section 386 by an "F" crimp 394 to conductors 390. The particular "F" crimp illustrated is more completely described in U.S. Patent Reissue No. 24,510, issued August 5, 1958, to James C. Macy. Blocks such as 370 containing one or dozens of connectors 374 are quite useful in conjunction with large point-to-point wiring circuits having one or dozens of auxiliary or associated circuit paths connected to auxiliary equipment via stranded or enlarged diameter cables.

In the embodiment shown in FIGURE 1, the novel terminal post of the invention is incoporated with a contact spring member adapted for use in the rear bay of a plugboard assembly. It is also contemplated that the invention may include a connector construction featuring a terminal post on one end and on the opposite end a barrel tip member having the function of member 98 as shown in FIGURE 1. A device of this type is used in the front bay or movable board of a pluboard assembly with the barrel tip being driven through the movement of the board to engage conductive spring members in the manner described in the Sitz patent. The terminal post portions of each assembly are then pattern wired with leads terminated through wire-wrap or clip-on procedures to duplicate the function of the patchcords described in the Sitz patent. FIGURE 24 shows an end view of a movable patchboard 400, having mounted therein one of a number of connectors 404 through an aperture 402 through the board. Board 400 is typically of an insulating material such as diallyl phthalate. The front of the board or the face which is placed adjacent to a rear bay or board contact spring array is oriented upwardly in the figure. The connector 404 includes a central mounting portion 406 similar to the mounting portion 74 shown in the embodiment of FIGURE 3. As an integral extension from 406 is an upper barrel tip portion 408 supported by an integral transition portion 410 similar to transition portion 60 shown and described with respect to FIGURES 2–4 above. The barrel tip 408 has the function of engaging a contact spring in an opening rear bay such as spring 78 shown in FIGURE 1, to provide a conductive path from the lead associated with the contact spring through the barrel tip to 404. At the edge of portion 406 and its junction with transition portion 410 is an outward projection 412 which operates to engage the face of board 400 to lock 404 against axial movement down through the aperture.

At the opposite end is a further integral extension of 406, including a portion 414 having a pair of tabs 416 extending outwardly from the body thereof to engage the board underface to prevent axial movement through the aperture in the opposite direction. In use, the assembly 404 is inserted downwardly through the aperture to a point wherein the tabs 416 snap outwardly to lock the assembly within the board. Extending as an integral piece from 414 is a terminal post 22, supported by a transition section 60, both identical to the similarly numbered parts described and shown relative to FIGURES 1–7.

The connector of FIGURE 24 is manufactured by a method similar to that shown in FIGURE 8 with progressive operations being performed on flat stock material to achieve the geometry represented in FIGURE 24.

Turning now to an alternative embodiment of the terminal post construction of the invention, FIGURES 25 to 32 depict a post construction and method of manufacture for a post of relatively thin sheet material formed without a central channel.

As can be seen from FIGURE 25, a connector 420 is provided including a non-channeled forward terminal post 422 supported by an integral transition portion 460 joining a support portion 462 similar to the mounting sections 206 shown with respect to FIGURE 14. The mounting section 462 is utilized in the manner indicated in FIGURE 14 to latch connector 420 within an aperture in an insulating panel board. It is contemplated that as in the above case, assemblies 420 could be molded into insulating boards rather than fitted into pre-formed apertures; in which event the mounting section such as 462 could be considerably simplified by removal of the latching spring members. The transition section 460 is similar to the transition sections 60 heretofore described.

Post 422 as shown in FIGURES 25 and 26 differs from the post construction heretofore described, in that it is of a rectangular configuration with respect to cross-section rather than of a square configuration. More importantly, post 422, as compared with post 22, is not channeled, but is solidly formed, although not of solid sheet material. Like post 22, the alternative embodiment includes three walls, but such are forced together along the post length. The construction of post 422 may at times be preferred to that of the construction of post 22 above described with respect to clip-on type applications. In certain instances and with either the larger sizes of conductive cable or with cable having an especially tough insulating material, the stresses developed by the application of the Cobaugh clip are such as to make the construction of the terminal post shown in FIGURES 25 and 26 better suited.

As will be hereinafter demonstrated, the method of forming connector 420 is similar to the method above described with respect to terminal post 22. As can be seen from FIGURE 26, the cross-sectional area of post 422 is such as to define a rectangular configuration with side surfaces 426 and 428 separated by top and bottom surfaces 430 and 432, respectively. The abutment of pairs of surfaces defines four parallel edges or corners extending along a substantial length of the post. As will be hereinafter described, the method of forming post 422 leaves distinct zones of hardness in the pattern indicated by the small lines in zones such as 440 and 442 in FIGURE 26 due to the working of the material which occurs as flat, thin sheet stock is transformed into the configura-

tion shown. The zones of relatively hard material, **440** and **442**, serve to stiffen substantially the post against axial bending movement in use. The particular extruding step of the method of the invention folds the walls together to leave abutting surfaces **443** and **438** which, as is shown in FIGURE 26, are in a close interlocking engagement. This has been found to rigidify the post by preventing relative movement between walls when the post is loaded. The post end **422** is bevelled inwardly to define entry for tooling and a clip or clips driven thereover.

FIGURE 27 shows a progression depicting the steps of the method to produce contact members having the alternative terminal post construction shown in FIGURES 25 and 26. As a comparison of FIGURE 8 will show, the connector embodiment shown in FIGURE 27 is identical to connector **70** with the exception that different terminal post construction is used. Reference may be had to the description of the steps of the invention relative to FIGURE 8 for a more complete understanding of the method hereinafter described in an abbreviated form. Reference may also be had to the description of the method of the invention relative to FIGURES 9–13 with reference to the various die stations I–X and the operations performed thereat.

As can be seen from FIGURE 27, operations performed at stations I, II, III, IV, V, and VI thereof are substantially identical to the operations performed to produce the connector **70** at similarly identified stations in FIGURE 8. As the single difference up through station VI, the edge of the strip material **448** is blanked to define two closely spaced small V indentations shown as **450**. This blanking and the forming at station VIII of FIGURE 27 is such as to provide the bevel of end **424** shown in FIGURE 25. As the progression leaves station VI, the terminal post cross-sectional configuration is identical to that shown in FIGURE 10 with respect to its U shape. At station VII, an alternative step to provide the alternative embodiment and post **422** includes a pre-closing of the channel of the U. At station VIII there is a further step of flattening-extruding and swaging the end **424**. Stations IX and X of FIGURE 27 are as heretofore described with respect to FIGURE 8.

Turning now to FIGURES 28–32, the foregoing alternative method to provide the alternative construction of the terminal post will now be described in detail. FIGURE 28 shows a partial sectional end view of the tooling utilized at station VII, including a die carrier **470**, an upper die **474** secured to **470** by a pin **472**. Carrier **470** and die **474** are driven in the path indicated in FIGURE 28 in the same manner as the die and die carrier shown and described with respect to FIGURE 9. The bottom face **476** of die **474** includes a relatively wide, flat section and in the center thereof a die face **478** better shown in FIGURE 29, to comprise a concave V having its widest portion such as to slightly overlap the widest portion of the lower die face beneath **474**. Die **474** is driven against a lower die **480** supported in a die guide plate **482** and by a stage **484**. As compared to the tooling shown in FIGURES 9–13, stage **484** is fixed against downward travel to thus offer a solid resistance to the metal being worked between the die faces. Lower die **480** includes a relatively wide upper surface **486** and, disposed along the center line of upper die travel, a die face **488** consisting of a rectangular channel. This is better shown in FIGURE 29 which depicts the upper die in travel downwardly to perform the method step of pre-closing. As can be seen from FIGURE 29, the post **422** is at that point in the U shape provided at station VI. FIGURE 30 depicts the upper die in closure against **422** and lower die **480**. This step serves to produce the cross-sectional configuration indicated in FIGURE 30, which operates to close the side walls of **422** inwardly and into abutment. During the operation depicted in FIGURE 30, additional working of the material in the side and bottom walls takes place. The material of **422** has, of course, been pre-worked to an extent by the preceding steps at stations II–VI.

Following the step shown in FIGURE 30, the dies **474** and **480** are, of course, opened, and the work piece is transferred to the next station, station VIII. FIGURE 31 depicts a fragmentary view of the tooling at station VIII to include an upper die **490**, which has an axis of travel as shown and is supported and operated as generally heretofore described. Die **490** includes a flat face **492** of a width to extend over the die face of a lower die face **494** of a lower die **496**. As can be seen from FIGURE 31, the lower die face is a channel of rectangular cross-section having relatively sharp corners. FIGURE 32 depicts the ends of dies **490** and **496** which include faces **491** and **497**, respectively, each sloped inwardly to accomplish the bevelling of the end of the post into the configuration **424** as shown in FIGURE 25. Thus, face **491** of die **490** is sloped inwardly such that, as the die is driven to bottom against the terminal post, the end thereof is swaged as indicated against face **497**. The result of the step depicted in FIGURES 31 and 32 is to flatten and extrude the post and swage its end from the configuration shown in FIGURE 30, to the configuration shown in FIGURE 31. The force driving die **490** is made considerable in order to force the post material into the relatively sharp corners defined by the die faces in closure. It has been found that the foregoing operates to provide interlocking faces of the surfaces within the post.

The foregoing embodiments of the invention demonstrate the advantages inherent in the construction and method of the post section of the invention. In each instance with respect to the embodiments including tab or spring extensions and particularly, the crimp barrel extension, manufacture has heretofore been extremely difficult in the respect to the provision of an integral structure having a wire-wrap or clip-on type terminal post.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.

We claim:

1. In an article adapted to be mounted in a board member to receive electrical leads applied thereto, a terminal device formed of one piece, thin metal sheet material including an anchoring portion for supporting said device in the board member, a transition portion axially extending from said anchoring portion and a post portion axially extending from said transition portion, the said transition portion including walls shaped to resist bending and twisting movements of said post portion relative to said anchoring portion, the said post portion having four sharp, parallel edges each comprised of a zone of work-hardened material localized to each edge with each edge exteriorly disposed on said post about at least three distinct walls separated by at least two distinct interior corners, the material adjacent each said corner having a zone of work-hardened material extending outwardly thereform to rigidly join said walls against relative movement so as to define a cross-sectional configuration of said post portion to resist bending and twisting movements therein and to preclude collapse of said walls under forces developed by the application of electrical leads thereto.

2. The device of claim **1** wherein there is included as an integral extension to said anchoring portion, a further portion of a geometry in conjunction with said thin sheet material to provide substantial spring characteristics, said section carrying a contact surface for engagement with other connector means.

3. The device of claim 1 wherein there is included as an integral extension to said anchoring portion a further portion of a geometry in conjunction with the said thin sheet material to provide a relatively low force of deformation of said other portion.

4. In an article adapted to be mounted in a board member and to be terminated to an electrical lead, the device including a terminal post, means for rigidly mounting said post in a board member against bending and twisting movements resulting from the application of leads thereto, said post having a channel shaped cross-section with two parallel walls separated by a third wall re-entrant of said channel shape, said post further having four sharp exterior edges each formed of work-hardened material localized to said edge relative to said walls, the said post further having extending between the ends of the said third wall and the said parallel walls localized zones of work-hardened material positioned in intersecting planes relative to each other to rigidly join said walls and to resist bending and twisting and inward collapse of said walls due to loads developed during application of electrical leads thereto and during use of the said device.

5. In an article adapted to be mounted in a board member to receive electrical leads, the terminating connecting device comprised of a single piece of thin metal sheet material having spring characteristics, a mounting portion for mounting said device in a board member, a transition portion shaped to provide a geometry resistant to bending and twisting movements developed in the application of leads to said device and use of said device and a post portion carried by said transition portion, said post portion having four sharp exterior edges positioned about at least three distinct walls, the material

of said post portion being impact extruded along the length of the post portion so as to resist bending and twisting movements of the post portion relative to said anchoring and transition portions during application of leads thereto and the material of said post portion being impact extruded in a sense transverse to the length of said post portion relative to said wall to resist deformation of said walls during the use of said device by reason of forces developed in applying leads to said device.

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