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# A method of making a connection between a metal member and a metal braid

This invention relates to a method of connecting a metal braid to a metal member having particular but not exclusive reference to connecting a metal braid to the terminal rod or wire of a diode of the press-fit type.

Generally the electrical and physical connection of a braid to a metal member is problematic in that the braid must remain readily flexible, but strong. Attempts have been made in the past to weld a braid directly to a metal member without the use of an intervening connector tag, and in such attempts it is found that the braid tends to fracture in use very close to the point at which it is welded to the metal member. This is believed to be because the welding of the braid to the metal member renders the braid solid at the point of weld and also usually produces a reduced thickness region at the periphery of the weld with the attendant risk of the fracture of the braid at this point.

A press fit diode has a semi-conductor diode chip housed in a metal cup with one terminal of the chip electrically connected to the cup and the other terminal electrically connected to a metal rod or wire which extends from the cup through a glass seal. The glass seal is fragile and so a predetermined length of the terminal wire or rod must extend beyond the seal so that mechanical forces and/or heat used in making connection to the wire or rod are isolated to some extent from the seal by the length of the wire or rod. A known method of connecting the copper braid to the wire or rod terminal of the diode involves a tag which is crimped to the braid, the tag having a projection thereon which is projection welded to a flattened region of the wire or rod terminal. While producing an efficient electrical and physical connection this method suffers from the disadvantage that it produces a diode arrangement which is large in terms of the length of the wire or rod plus the connector tag since the crimped region of the tag and the region carrying the projection are spaced in the direction of the length of the tag and wire or rod terminal. German Offenlegungsschrift 2134078 discloses a structure wherein this undesirable lengthening is readily apparent. An intermediate connector tag 1 is used to make electrical connection between a number of leads 9 and the terminal blade 10 of a device.

It was proposed to overcome this length problem by dispensing with the tag and using in its place a strip of metal which is bent to define a band then crimped around the braid, the strip carrying a projection on its face which, after crimping, is opposite the two ends of the strip. This proposal proved unsatisfactory in that after crimping of the strip around the braid, the subsequent step of projection welding the crimped strip to the flattened region of the terminal of

the diode caused the crimp to open thus releasing the grip of the strip on the braid.

It is an object of the present invention to provide a method of connecting a metal braid to a metal member, which when utilised to connect a metal braid to the rod or wire terminal of the diode or similar semi-conductor device results in a shorter device than the known method and which does not suffer from the disadvantage mentioned in respect of the previously proposed method.

According to the present invention, a method of connecting a metal braid to a metal member includes the steps of crimping a strip of metal around the braid so that the strip is electrically connected to, and physically grips, the braid, the crimping operation in effect rolling the two end regions of the strip so that they extend towards the intermediate region of the strip trapping the braid, contacting the two rolled end regions of the strip against the metal member and effecting the weld between the rolled end regions of the strip and the metal member.

One example of the invention is illustrated in the accompanying drawings wherein:—

Figure 1 is a perspective representation of a press-fit semi-conductor diode;

Figure 2 is a perspective representation of a connector member;

Figure 3 is a side elevational view of a copper braid having a connector member of the kind shown in Figure 2 secured thereto;

Figure 4 is a transverse sectional view of the braid and the connector member of Figure 3; and

Figure 5 is a sectional view illustrating the connection of the braid to the terminal rod of the diode of Figure 1.

Referring to the drawings, the semi-conductor diode to which an electrical connection is to be made comprises a semi-conductor diode chip housed within a cylindrical copper cup 11. One terminal of the semi-conductor chip is electrically connected to the cup 11 and the other terminal of the chip is electrically connected to a terminal wire which extends through a glass seal 12 closing an open end of the cup. Secured to the glass seal 12 is an iron-nickel alloy tube 13 within which the terminal wire extends. At its free end the tube 13 is flattened to define a spade end portion 14 the flattening of the tube serving to electrically interconnect the terminal wire and the tube, and to seal the tube. The interior of the cup 11 is thus hermetically sealed. The glass seal 12 is of a relatively fragile nature, and it is important therefore that there is a predetermined minimum length of the tube 13 intermediate the seal 12 and the spade end portion 14 to which electrical connection is to be made.

In order to make an electrical connection between the spade end portion 14 of the ter-

minal of the diode and a copper braid connector without adding significantly to the length of the rigid part of the device, that is to say the length of the terminal of the diode, there is provided a connector 15 in the form of a strip of nickel plated mild steel. The strip is bent to U-shaped form as shown in Figure 2 and the braid is placed between the limbs 17 of the U-shaped strip 15. Thereafter, using a conventional crimping tool or crimping press, the two limbs 17 of the strip 15 are crimped around the braid 16. The crimping action in effect rolls the two limbs 17 inwardly towards the portion of the strip intermediate the limbs, so that the braid is tightly gripped, and in addition the end surfaces, or parts thereof, of the limbs 17, bite into the braid so that the braid is nipped against the surface of the intermediate portion of the strip 15. The braid 16 carrying the strip 15 is then engaged with the spade end portion 14 of the terminal of the diode to which the braid is to be connected. The braid is positioned in relation to the spade end portion 14 such that the rolled limbs 17 of the strip 15 engage the spade end portion 14. Since the rolled limbs are of generally cylindrical form then they will make line contact with the spade end portion 14 rather than surface contact. The strip 15 and the spade end portion 14 are then gripped between appropriately shaped electrodes of the resistance welding machine which applies pressure of 533.76N (120 lb f) to the strip 15 and spade end portion 14 while passing an electric current of 3000 amperes therethrough for a period of 4 cycles. The electric current passing through the line contact between the strip 15 and the portion 14 rapidly causes heating of the two parts, and the pressure applied to them causes flattening of the rolled limbs 17 thus increasing the area of contact. The parameters of pressure and time, and electric current, are controlled such that a weld is produced between the crimped limbs 17 of the strip 15 and the portion 14. It is found that an extremely strong connection is produced between the braid 16 and the portion 14 and it is believed that the reason for the surprising strength of this connection is firstly that the limbs 17 are caused more tightly to grip the braid, and secondly that in addition to the limbs 17 welding to the spade end portion 14 of the terminal the braid actually bonds to the strip 15. It will be recognised that provided that the width of the strip 15 is not greater than the length of the spade end portion 14 then the connection between the braid 16 and the terminal of the diode can be effected without increasing the effective length of the rigid terminal of the diode it being recognised that the braid itself is extremely flexible. Thus where necessary the braid can extend away from the terminal at right angles thereto, the braid being flexed immediately adjacent its connection with the strip 15.

During development of the present invention an attempt was made to obtain the same effect

by providing the strip 15 with a projection extending from its face remote from the rolled limb 17, and then welding this face to the spade end portion 14. However, it was found surprisingly that this attempt was unsatisfactory in that a very much reduced strength connection between the braid and the strip 15 occurred in many cases. It is believed that this failure resulted from a tendency of the limbs 17 to be opened relative to the braid during the application of pressure thereto by the welding electrodes. Any tendency towards opening of the limbs 17 of course releases the grip of the strip 15 of the braid. Clearly in accordance with the arrangement described above the pressure applied by the welding electrodes causes the strip 15 to tighten its grip on the braid.

The term weld is used above to denote the connection between the strip 15 and the spade end portion 14, but it is to be understood that since the strip 15 is nickel plated then the plated layer of nickel on the strip may act as a brazing material so that the connection between the strip and the spade end portion might be more properly described as a braze. Similarly, it is possible, as mentioned above, that the braid also becomes brazed to the strip 15 with the nickel plating on the strip 15 again constituting the brazing material. Moreover while in the example described above the strip 15 extends transverse to the length of the tube 13, across the spade end portion 14 thereof, where it is necessary to provide a right angled connection between the braid and the tube 13 then the strip 15 can be orientated with respect to the spade end portion 14 so that the strip extends parallel to the length of the tube. In such a situation in order to ensure that there is no increase in the length of the rigid part of the device, the length dimension of the strip 15 when crimped around the braid, will be such that when the two rolled over portions of the strip engage the spade end portion 14 of the tube, then the strip does not project beyond the axial free end of the spade end portion 14.

It will be recognised that although the foregoing method is of particular benefit when making a connection between a copper braid and a terminal of a press-fit diode, in that the connection can be made without any effective increase in the length of the terminal, a similar method can be employed to produce a strong connection between a metal braid and a whole range of other metal members.

#### Claim

A method of connecting a metal braid to a metal member including the steps of crimping a strip of metal around the braid so that the strip is electrically connected to, and physically grips, the braid, the crimping operation in effect rolling the two end regions of the strip so that they extend towards the intermediate region of the strip trapping the braid, contacting the two

rolled end regions of the strip against the metal member and effecting the weld between the rolled end regions of the strip and the metal member.

#### Patentanspruch

Verfahren zum Verbinden einer metallischen Litze mit einem metallischen Bauteil, umfassend die Schritte des Umfalzens eines Metallbandes um die Litze derart, daß das Band mit der Litze verbunden wird und sie physikalisch klemmt, wobei der Umfalzvorgang im Ergebnis die zwei Endbereiche des Bandes so rollt, daß sie sich unter Erfassung der Litze zum Zwischenbereich des Bandes hin erstrecken, des Kontaktierens der beiden gerollten Endbereiche des Bandes gegen das metallische Bauteil und des Bewirkens der Verschweißung zwischen

den gerollten Endbereichen des Bandes und dem metallischen Bauteil.

#### Revendication

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Procédé pour connecter une tresse métallique à un organe métallique, caractérisé en ce qu'on sertit une bande de métal (15) autour de la tresse (16) de manière que la bande (15) soit électriquement connectée à la tresse, et la serre physiquement, l'opération de sertissage faisant en fait rouler les deux régions d'extrémité (17) de la bande de sorte qu'elles s'étendent en direction de la région intermédiaire de la bande (15) emprisonnant la tresse, on met en contact les deux régions d'extrémité roulées (17) de la bande avec l'organe métallique (14) et on effectue un soudage entre les régions d'extrémité roulées de la bande et l'organe métallique.

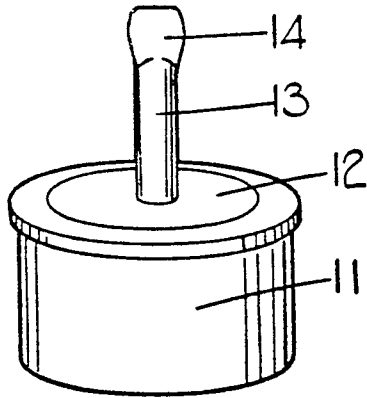


FIG. 1.

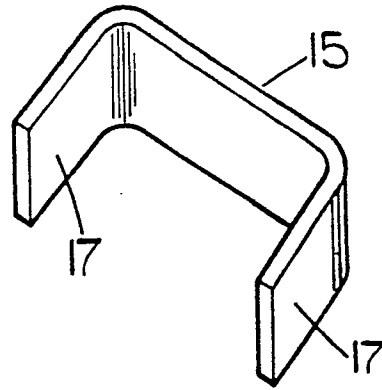


FIG. 2.

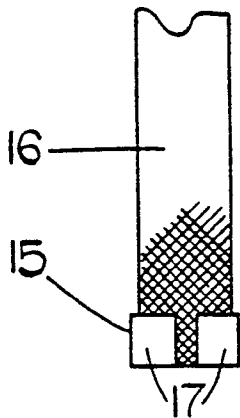


FIG. 3.



FIG. 4.

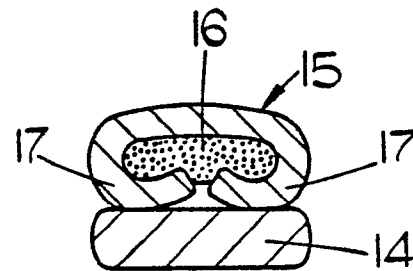


FIG. 5.